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A STRATEGIC FRAMEWORK FOR OFFSHORE WIND DEVELOPMENT IN **SOUTH AFRICA**

REPORT

SEPTEMBER 2026



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Department:
Electricity and Energy
REPUBLIC OF SOUTH AFRICA

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FOREWORDS



Dr Kgosientsho Ramokgopa
Minister of Electricity and Energy
The Government of South Africa

Energy security is the foundation of dignity, development and national confidence. For South Africa, reliable and affordable electricity is central to household welfare, industrial competitiveness, investment certainty and our ability to lead a just and inclusive energy transition. This ***Strategic Framework for Offshore Wind Development in South Africa*** advances the Department's strategic priorities by linking energy security, industrialisation, innovation, transformation and regional leadership to a disciplined assessment of South Africa's long-term energy options.

South Africa is endowed with nearly 2,800 kilometres of coastline, globally competitive offshore wind resources, strategic ports and coastal industrial corridors. The analysis presented in this report estimates approximately 95 GW of indicative technical potential in selected suitable regions, most of it associated with floating offshore wind technologies. This potential is significant; it must, however, be approached with discipline, realism and responsibility.

This report is not a procurement plan, a policy determination, a capacity allocation or a commitment of public funds. Decisions on future generation technologies will continue to be guided by the Integrated Resource Plan (IRP), affordability, system need, bankability, environmental authorisation, grid readiness and the applicable governance processes. The value of this work is that it strengthens South Africa's evidence base and preserves future choices. Offshore wind should therefore be considered as part of a diversified, reliable and affordable energy mix, not as a standalone technology decision. Its possible value extends beyond electricity generation. In the right conditions, it could support green hydrogen, port and grid modernisation, industrial clusters, skills development, and new manufacturing and services opportunities aligned with the South African Renewable Energy Masterplan (SAREM).

Our energy transition must be developmental and inclusive. It must create space for workers, communities, women, youth, Black industrialists, persons with disabilities, small enterprises and coastal economies to participate meaningfully in emerging energy value chains. It must also respect the marine environment and the livelihoods of fishers, maritime users, tourism operators and communities who depend on our oceans.

I welcome the collaboration between the Department, the World Bank Group, CSIR and all stakeholders who contributed to this work. I commend this report as a contribution to South Africa's long-term energy planning and to the national effort to build an energy future that is reliable, affordable, industrialised, environmentally responsible and just without leaving anyone behind.



Satu Kahkonen
World Bank Division Director for South Africa

South Africa is at a critical juncture in its energy journey, confronted by a unique set of challenges and opportunities that will shape its future energy landscape. The country is faced with the need to ensure energy security while striving towards its 2050 net zero goals. Offshore wind offers an opportunity to support the country's transition to renewable energy while contributing to the security of supply.

Global experience from established markets indicates that offshore wind is not only an environmental consideration but also a viable method to achieve reliable, large-scale energy generation. Today's offshore wind farms supply power to millions of homes and businesses, while also creating substantial economic value through job creation, industrial development, and enhanced energy security.

This report, prepared in close collaboration with the Department of Electricity and Energy, is the 9th major country-level publication in the World Bank Group's offshore wind development series. It explores how South Africa can harness its offshore wind potential to drive sustainable economic growth while advancing its clean energy transition.

The report reveals that large-scale offshore wind development could support over 300,000 full-time equivalent job years and contribute $6.7 billion in employment wages to the South African economy by 2050. These opportunities are rooted in the creation of local supply chains, manufacturing capabilities, adjacent industries such as green hydrogen production and other sectors directly aligned with South Africa's Just Energy Transition priorities.

Moreover, the report suggests that the environmental benefits of offshore wind present a good rationale for South Africa to consider developing offshore wind projects. Over the next 25 years, offshore wind development could reduce South Africa's electricity generation emissions by 530 million tons of CO_2, significantly contributing to the continent's climate goals and positioning the country as a leader in clean energy deployment.

However, realizing this potential requires deliberate action across four critical pillars: strategy, policy, frameworks, and delivery. Therefore, the path forward demands comprehensive planning, robust regulatory frameworks, and sustained commitment from government, industry, and civil society partners.

The World Bank Group, together with our partners, stands ready to support South Africa in navigating this transformative journey. We believe that by harnessing its offshore wind potential, South Africa has an opportunity to develop a sustainable and resilient energy system.

EXECUTIVE SUMMARY



Photo: Saldanha Bay, South Africa © Getty Images

EXECUTIVE SUMMARY

Tapping into offshore wind could pave the way for a new industry in South Africa while supporting job creation and the country's 2050 net zero aspiration.

South Africa has abundant potential for offshore wind (OSW) development, with high wind speeds and ample areas for development along its 2,800 km coastline. Offshore wind can provide a low-carbon, secure, and affordable electricity supply, and represents a promising new economic opportunity to create jobs and support the country's energy transition.

Over the last decade, South Africa's slow economic growth has been insufficient to address the triple challenges of unemployment, inequality and poverty. The Government of South Africa has formally recognised the need for a just transition to a decarbonised economy that leaves no one behind and creates decent work for all. By tapping into the country's offshore wind potential, South Africa can usher in much-needed economic growth and diversification opportunities, which align with the priority areas in the critical investment plan for South Africa's Just Energy Transition-Implementation Plan (JET-IP).

OSW development creates many new jobs, bolsters adjacent industries and attracts investment. Large-scale development will require the creation of a new, local supply chain, opening up significant and wide-ranging opportunities for employment and upskilling. These include jobs within the offshore wind industry — such as the manufacturing of floating wind components — and adjacent sectors, such as green hydrogen, which can be produced using OSW power and could present a major export opportunity for South Africa. Finally, the South African government's investment, commitment and support for significant offshore wind deployment can help mobilise external investment.

This study finds that large-scale OSW development could support over 300,000 full-time equivalent (FTE) years in direct jobs and US $6.7 billion in associated employment wage contribution to the South African economy by 2050[1]. These economic benefits grow with the amount of OSW deployed and the extent to which this deployment is driven by local manufacturing capacity. Similarly, over the next 25 years, OSW development could reduce the country's electricity generation emissions by 530 $MtCO_2$.

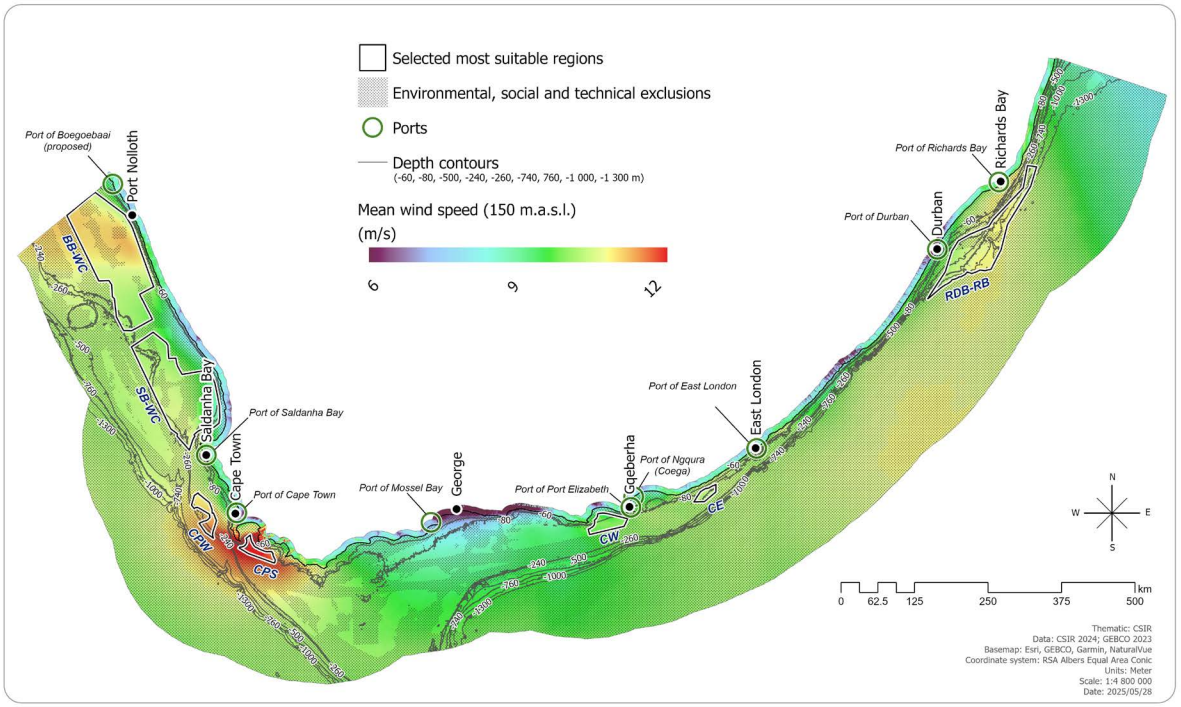
This report provides analysis of the transformative opportunities and challenges associated with varying levels of OSW development. It aims to help inform the government of South Africa and support decision-making to establish a successful offshore wind sector in both the short- and long-term. To support the drafting of this report and ensure comprehensive consideration, multiple rounds of stakeholder engagements were held with industry developers (through the South Africa Wind Energy Association), national and provincial government, statutory bodies, civil society, think tanks, and other marine users.

1 Each FTE year of employment is the equivalent of one person working full time for a year. In reality, the 300,000 FTE years of employment will be made up of some people working in the sector for less than a year and others working in the sector for many years, especially during the operational phase.

SOUTH AFRICA'S OFFSHORE WIND POTENTIAL

An initial geospatial analysis of technical, environmental and social constraints identified approximately 95 GW of OSW potential throughout South Africa's Exclusive Economic Zone (EEZ) (0-200 nautical miles from shore). Most of these areas have wind speeds exceeding 9 m/s (Figure 1) which is considered highly suitable for offshore wind projects. Nearshore environmental and social constraints, as well as the sudden increase in water depth along the contours of the continental shelf, mean that most of South Africa's OSW capacity must be harnessed with floating technology at 75-500 m depths.

FIGURE 1: THE MOST SUITABLE AREAS FOR OSW DEVELOPMENT BASED ON AN ANALYSIS OF TECHNICAL, ENVIRONMENTAL, AND SOCIAL CONSTRAINTS.



The suitability and high potential for floating wind off the less populated West Coast, totalling 64 GW between Saldanha Bay and Port Nolloth, would enable South Africa to power industrial development with renewable energy and facilitate green hydrogen (GH_2) production for domestic use and potentially export. Saldanha Bay, in particular, has an existing Special Economic Zone (SEZ) that focuses on repairs and maintenance for oil and gas rigs, vessels, equipment, and repair and service operations (including drilling units) for current offshore exploration and production operations. South Africa can leverage this existing base to be part of the early development of floating OSW projects, positioning itself as a leader for this nascent technology and a hub for OSW development in the future.

Significant floating potential is also available near high-demand areas such as Cape Town (6.4 GW) and Durban (17.4 GW). The City of Cape Town's peak demand is approximately 2 GW, with industrial users accounting for 80%.[1] The City of eThekwini (Durban) has a peak demand of roughly 1.7 GW. The OSW potential in these two areas is enough to supply their current electricity demand and support substantial growth. In addition, areas like Cape Town host large energy users, such as data centres, that have high demand for secure and reliable energy sources. For example, Cape Town has already

attracted a large data centre operator by guaranteeing access to clean energy, currently powered by the Northern Cape's solar PV capacity. This demonstrates the potential for Cape Town to develop as a clean energy data centre hub if OSW generation is added to the mix.[2]

Some areas suitable for fixed OSW near Saldanha Bay (1.4 GW) and Gqeberha (1.3 GW) are available, which can facilitate a proof-of-concept, commercial development in South Africa in the near term (up to 2040) as larger-scale, floating OSW development becomes operational after 2040.

The geospatial analysis developed for this study identified the most suitable areas for development based on assumptions regarding known technical, environmental, and social constraints. It is important to note that these are not intended to designate strict "go/no-go" areas. With additional data, further analysis, and different choices, these areas could be expanded or reduced, and viable project sites could be identified.

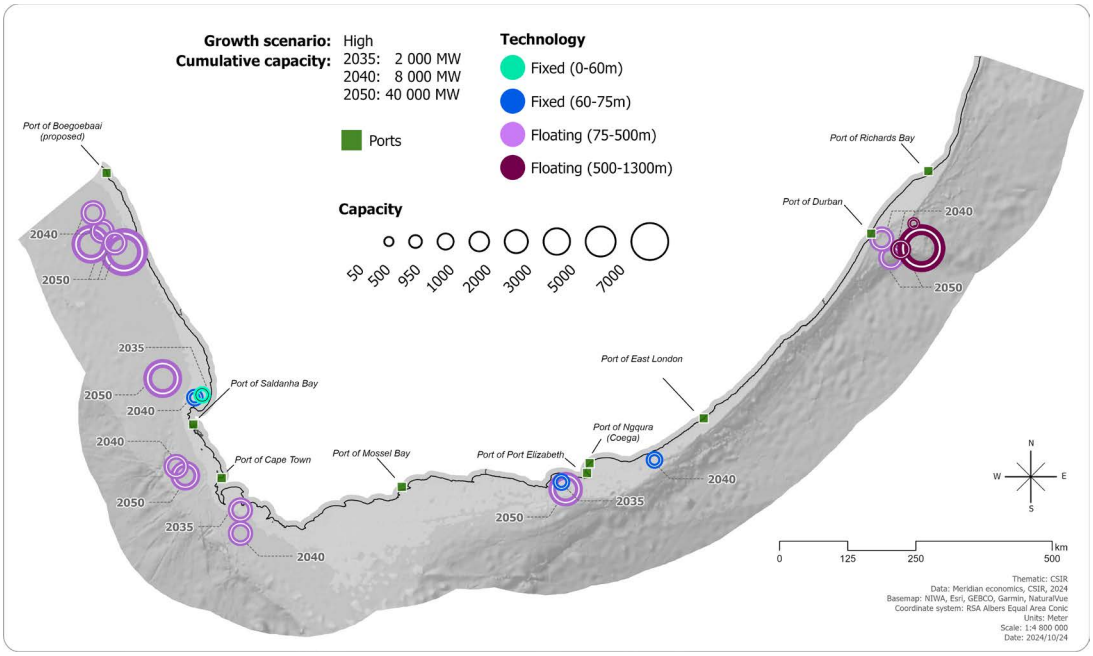
THE MORE OSW THAT IS DEPLOYED IN SOUTH AFRICA, THE GREATER THE ECONOMIC BENEFITS

Three growth scenarios have been considered for South Africa. The scenarios are based on geospatial analysis, as well as South Africa's socio-economic objectives for economic growth, energy security, and decarbonisation. This scenario-based approach allows for detailed evaluation of the OSW opportunity at this nascent stage of the market.

High growth: ambitious development leading to transformational change

In a high-growth scenario, South Africa can maximise its abundant OSW resources to fulfil its electricity needs, become a regional leader in floating OSW scale-up, and produce GH_2 for domestic and export use.

FIGURE 2: POTENTIAL OSW DEVELOPMENT IN SOUTH AFRICA FROM 2035 TO 2050 UNDER THE HIGH GROWTH SCENARIO.



This would lead to 1 GW of installed capacity by 2035, 8 GW by 2040, and 40 GW by 2050. Of the three scenarios, the high growth scenario requires the most energetic pace of development (roughly 2.5–3 GW per year from 2040 to 2050) and the highest level of investment. It also provides the most accelerated path to support the country's industrialisation and energy security ambitions, providing roughly 26% of South Africa's total demand.

Unlocking large-scale deployment of floating OSW in South Africa will introduce significant economic benefits for the country's population. The high growth scenario could see several gigawatts of floating OSW capacity near high-demand areas and the development of the South African supply chain, resulting in new opportunities for sustainable economic growth and high value-added jobs. This wave of decarbonised industrialisation aligns with South Africa's JET-IP.

The high growth scenario will create the need for more than 300,000 full-time equivalent (FTE) years' worth of new, green jobs between 2030 and 2050. This is more than twice the number of jobs per MW as the low growth scenario. This scenario will also support the creation of direct jobs in green hydrogen production and energy system integration, as well as the thousands of indirect and induced jobs to support this growth. Through economies of scale and increased utilisation of the local supply chain, it offers the most significant reduction in OSW's levelized cost of electricity (LCOE) between 2035 and 2050, at just over 60% reduction for both fixed and floating OSW. Finally, the OSW deployed under this scenario could reduce South Africa's electricity generation emissions by 15 $MtCO_2$ in 2035, 96 $MtCO_2$ in 2040, and 530 $MtCO_2$ in 2050.

Medium growth: moderate development to establish a new green industry and create high-value jobs

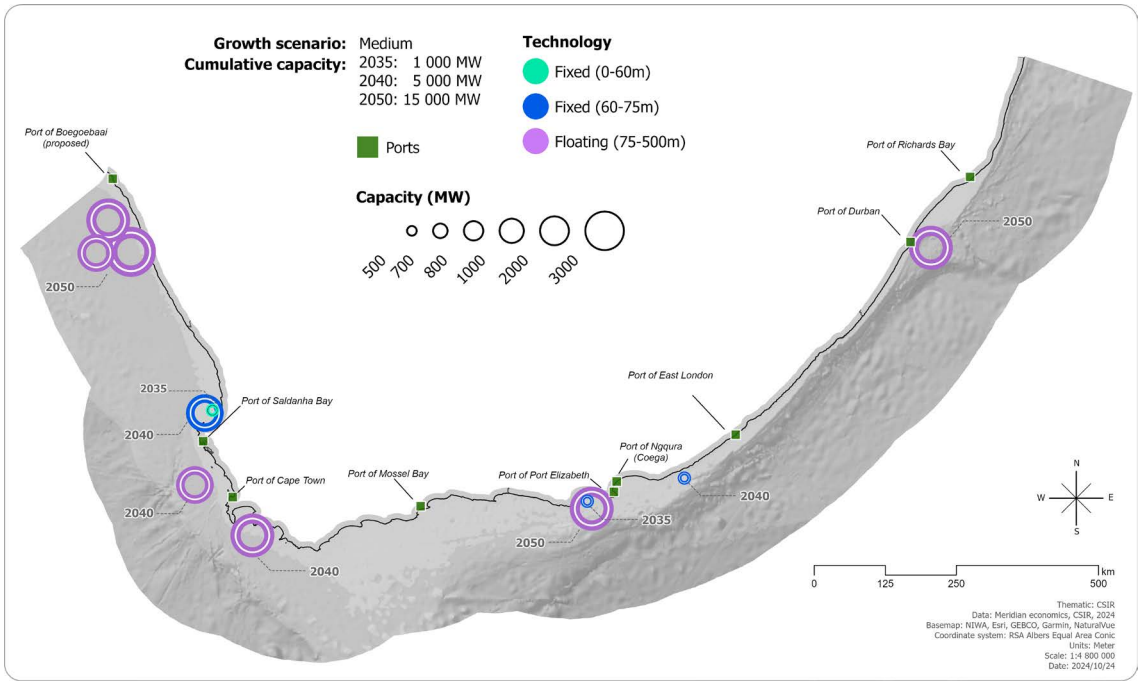
The medium growth scenario would result in just over one-third of the capacity developed in the high growth scenario, reaching 15 GW by 2050, or just above the total installed OSW capacity in the UK as of early 2025. This development would account for roughly 16% of South Africa's total electricity demand.

In this scenario, a collection of first-mover projects would lead to 1 GW of installed capacity by 2035. Over the next half-decade, a steady stream of development would be required to commission another 4 GW by 2040, followed by another 10 GW by 2050. The pace of growth in the 2040s would be strong, at approximately 1 GW per year.

The economic benefits to South Africa would be more limited than the high growth scenario but would still be sufficient to kick start a new green industry. Developing 15 GW over the next 25 years would require over 100,000 FTE years in local, direct jobs, translating to US$2.4 billion in employment wage contribution. As per the high scenario, this is more than twice the number of jobs per MW as the low growth scenario. The scale of floating OSW development under this scenario would drive LCOE reduction and global interest in the South African market, unlocking private investment in local supply

chain development and manufacturing facilities. By 2050, this scale of OSW deployment could reduce electricity generation emissions by 362 $MtCO_2$.

FIGURE 3. POTENTIAL OSW DEVELOPMENT IN SOUTH AFRICA FROM 2035 TO 2050 UNDER THE MEDIUM GROWTH SCENARIO.



Low growth: minimal development to support the country's renewables portfolio

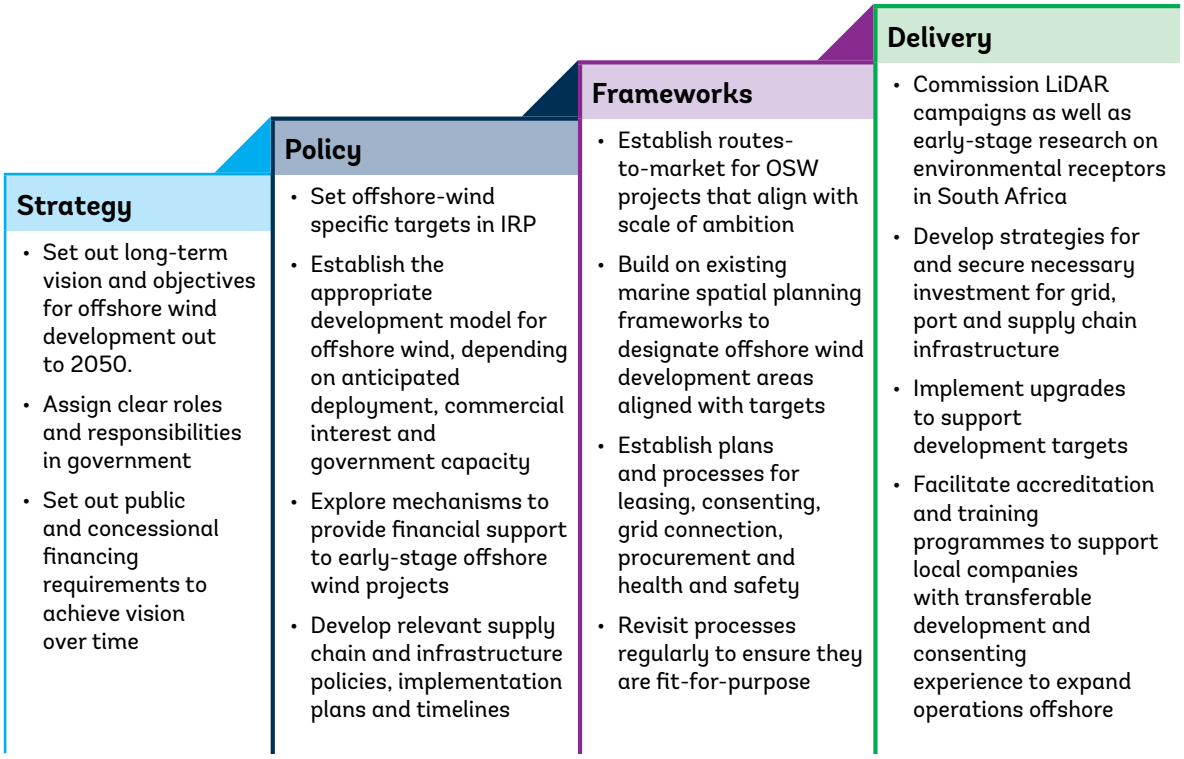
The low growth scenario would see up to 5 GW of OSW developed between 2035 and 2050, representing roughly 6% of the country's total demand. Initial pathfinder projects totalling 500 MW would be installed by 2035, with a potential 1 GW of cumulative capacity installed by 2040. By 2050, with 5 GW installed, South Africa will have developed all of its potential fixed OSW capacity and a small proportion of its floating OSW capacity.

The low growth scenario would still contribute to decarbonising South Africa's electricity sector (141 $MtCO_2$ by 2050) while minimising public investment in a new sector. However, the wider economic benefits of OSW development would be much lower than those realized under the higher growth scenarios. The small deployment pipeline is unlikely to stimulate private capital investment in ports and manufacturing facilities or attract international supply chain Original Equipment Manufacturers (OEMs) and developers to establish significant local operations. As a result, the South African OSW market would not benefit from the economies of scale or improved learning rates as in the higher growth scenarios. This means the LCOE of OSW would remain relatively high compared to other renewable energy technologies. Furthermore, the country would not see significant job creation benefits in the manufacturing and installation stages of development.

RECOMMENDED ACTIONS

De-risking large-scale OSW development in South Africa can be achieved by targeting the four pillars of OSW market development outlined in the World Bank's Key Factors report: strategy, policy, frameworks and delivery[2]. Under each pillar, we have identified specific no-regret actions that the South African government can take to facilitate market development irrespective of which growth scenario is pursued. The recommended actions are summarised in Figure 4 below and explained in more detail, with tailored recommendations for each growth scenario, in the Main Body.

FIGURE 4: THE SOUTH AFRICAN GOVERNMENT CAN TAKE NO-REGRET ACTIONS TO SUPPORT THE DEPLOYMENT OF OSW IN SOUTH AFRICA UNDER THE LOW, MEDIUM AND HIGH GROWTH SCENARIOS.



1. Establish market scale and visibility through appropriate strategy and policy

Once there is clarity on the scale of opportunity supported by government, developers can be expected to set up operations in South Africa, quickly establishing the country as a regional hub for OSW development.

Given the country's abundant potential for floating OSW, the government may consider whether it is necessary to facilitate fixed OSW development or whether the market can leap-frog straight to floating OSW development.

2 https://www.esmap.org/Offshore-Wind-Key-Factors

2. Create an enabling environment for industry by establishing the necessary frameworks and evidence base

Once the scale of opportunity is clear, regulatory frameworks can enable developers and the wider supply chain to invest in the market and ensure that generated electricity or other power can ultimately be sold. These frameworks will allow developers to investigate specific opportunities (e.g. project sites), compete for seabed leases, ensure project plans align with the country's social and environmental standards, and more. If developers and their suppliers engage in the development of the market's rules, they can plan and deliver projects more predictably and efficiently, reducing costs more rapidly over time.

3. Resolve barriers to delivery, particularly those related to site development, grid and port infrastructure, and the local supply chain

In South Africa, government collaboration with other public bodies and industries will be essential to underpin the construction and maintenance of OSW farms. The government can support first-movers in developing projects by helping to reduce uncertainty and streamline development. For example, leveraging public and concessional finance to commission the first wind and metocean data campaigns in key locations will clarify the nature of opportunities and may reveal greater interest in South African sites than expected (for instance, if wind speeds are above current estimates in particular areas). Supporting research on critical species and environments will reduce the risk that individual projects will be delayed due to a lack of data and understanding during the permitting process.

By implementing these priority actions over the next five years, the government of South Africa can help to de-risk offshore wind development and attract the financing necessary for the country's first OSW projects to be commissioned by 2035. The main body of this report explores OSW in South Africa in more detail and sets out the additional actions required to achieve the low, medium and high growth scenarios.

1. INTRODUCTION

As the most industrialised country on the continent, South Africa's economic and societal energy demand is currently met by over 40 GW of electricity from predominantly coal-fired power plants (CFPP). Renewable energy technologies contribute only 8% to the national energy mix. South Africa's ambitions for decarbonisation require replacing the current energy mix with cleaner technologies between now and 2050. This effort requires deploying renewable energy at a significant scale that is capable of powering the economy and supporting development aspirations. South Africa has abundant potential for offshore wind (OSW) development. Its exceptional wind speeds and ample areas for development along its 2,800 km coastline can bring two unique benefits to the country: the introduction of a much-needed, low-carbon, secure, local and affordable electricity supply and a new economic opportunity that could support a just transition and the country's energy transition.

This study, *A Strategic Framework for Offshore Wind Development in South Africa*, forms part of the World Bank Group's (WBG) OSW Development Program, established in 2019. It aims to accelerate the uptake of OSW in WBG client countries and support the upstream work needed to build a pipeline of bankable projects. Aligned with this aim, this study informs the WBG's advice to South Africa's Department of Electricity and Energy (DEE) to provide a basis for the consideration of policy and investment options for OSW as part of South Africa's future energy mix.

This report provides evidence-based recommendations that inform the South African government's decision-making on feasible pathways to develop an OSW market. These recommendations are informed by independent analysis from experts in OSW development, economics, energy systems and price modelling, geospatial analysis, environmental and social impact, and South Africa's energy and environmental policy landscape. In addition, several stakeholder engagements were held with civil society, government, and industry.

In this way, local information and understanding are the foundation of these recommendations for OSW development in South Africa, ensuring all key stakeholders are part of the process.

2. BACKGROUND

2.1. SOUTH AFRICA'S ECONOMIC AND DEVELOPMENT CONTEXT

South Africa's economic growth has remained largely stagnant for the last decade, with GDP growth averaging only 0.8% since 2012.[3] This is insufficient to address the high levels of unemployment, inequality and poverty observed in the country, known as the triple challenges. The National Development Plan (NDP) envisages a future for South Africa where these triple challenges have been eradicated. The country's policies and plans, including for the electricity and energy sector, aim to ensure alignment with the NDP. Further, the government of South Africa has more recently reaffirmed its vision for a transition to a just and sustainable economy. This is alluded to in the country's Nationally Determined Contributions (NDC) commitment, Climate Change Bill, and NDC Pathways.

South Africa's new OSW industry must support the country's just transition agenda to achieve buy-in across government and broader social license. The Just Transition for South Africa is defined as " *...a shift towards a low-carbon, climate-resilient economy and society and ecologically sustainable economies and societies which contribute toward the creation of decent work for all, social inclusion and the eradication of poverty.*" [4] The Presidential Climate Commission (PCC) has been established to ensure a just transition and has published the cabinet-approved Framework for a Just Transition.[5] The Just Energy Transition-Implementation Plan (JET-IP), the critical investment plan for South Africa's Just Energy transition, supports the development of large-scale and distributed renewable energy generation. This plan anticipates that the private sector will primarily meet the generation demand, with the state and the private sector procuring power. Beyond energy generation, the JET-IP identifies the opportunities and required support for New Energy Vehicles (NEVs) and green hydrogen (GH_2).

OSW development in South Africa will create many opportunities for economic growth and diversification required for GDP growth, and more generally, help eliminate the triple challenges. It provides additional opportunities and avenues for employment and skill deployment and redeployment. The scale of OSW development under the medium and high growth scenarios provides an opportunity to support the development and growth of the NEV and GH_2 sectors not only through the supply of reliable, clean energy but also through shared infrastructure, technology incubation, and contribution to workforce upskilling and development.

2.2. SOUTH AFRICA'S ELECTRICITY SECTOR

South Africa's electricity sector is a crucial component of the country's infrastructure, which is pivotal in supporting economic and social development. One of the defining features of South Africa's electricity sector is its historical reliance on coal as the primary power source. Coal-fired power plants (CFPPs) have been the backbone of the country's energy generation for decades, comprising around 70% of the country's energy mix.[6] However, this heavy reliance on coal has led to environmental concerns, particularly regarding air pollution and greenhouse gas emissions. South Africa has recognised the importance of diversifying the energy mix and transitioning to clean power for several decades, as demonstrated in the White Paper on Energy Policy (1998). South Africa has also committed to decarbonisation in line with its fair share contribution to global action on climate change through its NDC targets under the United Nations Framework Convention on Climate Change (UNFCCC). The Integrated Resource Plan 2010 (IRP2010) included solar PV, Concentrated Solar Power (CSP) and onshore wind allocations; at the time, these technologies were more costly than the CFPPs, but were included in recognition of the need to diversify and move towards cleaner and sustainable sources. Implementation of this policy has been slow and mired by 'stop/start' national processes.

The country faces significant challenges in ensuring a stable and reliable supply of affordable, reliable and sustainable electricity for all and has had to implement load shedding.[3] Many businesses and households go without power for up to 10 hours per day, and in 2023 alone, the nation experienced 335 days of load shedding.[7] This dampened economic growth and negatively affected various industries, leading to a drop in overall productivity.

The IRP2019 stated that South African electricity demand is set to grow at an estimated 2% per year, with the total demand expected to be between 280 and 320 TWh.[8] However, the Draft IRP2023 indicates that electricity demand is 19% lower than projected in the IRP2019. Load shedding and other local and international factors, such as the COVID-19 pandemic and the conflict in Eastern Europe, are significant factors in suppressed demand and dampened economic growth.[9]

The ripple effects of South Africa's power crisis extend far beyond its borders. South Africa occupies a central position in regional trade and electricity exports, and many neighbouring countries depend on its electricity supply, ports, and logistics network. If its logistics infrastructure underperforms due to load shedding or other factors, it can seriously delay the movement of goods across the entire region.

The South African government has long recognised the need for reform in the electricity sector and has taken steps to address these challenges. The measures include plans for restructuring the state-owned utility Eskom, introducing competition in the generation sector, and enhancing the role of independent power producers. The National Development Plan (NDP) for 2030 envisages an energy sector that provides reliable and efficient energy service at competitive rates, that is socially equitable through expanded access to energy at affordable tariffs, and that is environmentally sustainable through reduced emissions and pollution. The IRP2023 reiterates the importance of pursuing a diversified energy mix that will provide security of supply while ensuring compliance with the emissions reduction plan.

3 Planned, rotational power outages

2.3. RENEWABLE ENERGY IN SOUTH AFRICA

South Africa's renewable energy landscape has evolved as the country grapples with requirements to meet its electricity demand, address environmental concerns and promote a just energy transition. The transition to least-cost renewable energy sources is a critical component of the country's broader energy strategy, aimed at reducing its reliance on fossil fuels and mitigating the environmental impact of energy generation cost-efficiently. The country receives abundant sunlight and has areas of favourable wind conditions along its coast, making solar and wind power competitive options for electricity generation. The country has successfully scaled up national renewables-based generation at a competitive cost. Utility-scale solar PV, large-scale onshore wind farms, and smaller-scale distributed solar installations have been deployed nationwide, contributing clean energy to the grid.

The Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) is a flagship initiative that attracts private investment in onshore wind, solar, and biomass projects. Through a competitive bidding process, independent power producers are awarded contracts to generate and supply a predetermined amount of electricity to the national grid. Since REIPPPP was introduced in 2011, over 100 projects have been established under the various bidding windows for onshore wind and solar IPP schemes.[10] REIPPPP currently does not include OSW projects.

While the REIPPPP has historically achieved considerable success in attracting private investment and facilitating the development of RE projects in South Africa, it has recently faced challenges that must be addressed. These include the slow pace of project implementation, delays in bid window rounds from 2015-2021, regulatory uncertainties, and constraints to grid capacity. In terms of new capacity over the last few years, peer-to-peer projects have considerably outpaced the programme since regulatory amendments removed the licencing threshold limits and are likely to continue in this trend. Consideration for future new RE capacity growth must assume roles in the market for both public and private sector actors.

Eskom, which has historically relied on CFPPs for electricity generation, faces profound financial and operational difficulties and underinvestment across the power sector value chain. These difficulties impact the quality of electricity service and the pace of renewable energy integration. Continued investment in grid infrastructure, policy stability, and ongoing commitment to the diversification of the energy mix are essential for South Africa to realise the full potential of renewable energy and contribute to a sustainable and low-carbon future.

According to the World Bank South Africa Country Climate Development Report (CCDR), wind and solar energy could account for 85% of electricity generated and 67% of capacity installed by 2050 under the Net Zero scenario.[11] It follows that renewable energy has been shown to play a crucial role in addressing South Africa's electricity crisis in the short-term. It will support decarbonisation efforts and provide the least-cost generation options in the long-term. Several markets worldwide have demonstrated that a high penetration of renewable energy can provide a reliable and stable electricity supply. In addition, several local and international studies indicate that the least-cost pathway for energy security, with or without a carbon constraint, is a high deployment of renewable energy with other technologies to provide additional system balancing and peak demand support.

2.4. THE VALUE OF OSW TO SOUTH AFRICA

OSW can potentially provide valuable services to South Africa's renewable energy mix. Given the scale of renewable capacity required to meet the requirements of the CCDR and similar studies, approximately 5 GW–6 GW must be added every year. From 2013 to 2023, an average of only 1 GW/annum of renewable energy (onshore wind and solar PV) has been added to the grid. While this slow build-out rate can be attributed to several factors, including regulatory and grid constraints, this relatively slow growth points to several reasons why OSW development could be attractive in South Africa:

- **Scale of deployment:** the scalability of OSW projects presents an opportunity to meet the country's aspirational annual targets. Fewer grid upgrades and expansion could be required than for more dispersed technologies onshore.
- **Geographic diversity of optimal sites:** new capacity at scale can be built near demand, for example, to support GH_2 production or energy-intensive industries.
- **Stability:** the lower variability of OSW resources, harnessed through large-scale projects (>500 MW), can provide near baseload capacity that contributes to grid stability.

While South Africa is fortunate to have good renewable energy resources inland and offshore, over the next decade and beyond, it may become more difficult to identify available and feasible onshore development opportunities. This is due to, for example, conservation concerns, environmental sensitivities, land rights/ownership disputes, or geographical constraints for grid expansion. Accordingly, OSW attractiveness could be expected to increase over time.

OSW energy has emerged as a promising and innovative avenue for South Africa to diversify its energy mix by harnessing wind power along its extensive coastline. The country's strategic location and favourable wind conditions make OSW a compelling option to augment its renewable energy capacity and contribute to a sustainable energy future. The coastal provinces, particularly along the Western and Eastern Cape, offer significant OSW potential with strong and consistent winds, creating optimal conditions for harnessing this renewable resource. Good OSW resources have been identified near demand centres such as Special Economic Zones (SEZs) and existing port infrastructure, e.g. Cape Town, Durban, and Gqeberha (Port Elizabeth). OSW farms can take advantage of the stronger and more consistent winds at sea and fewer planning restrictions around the size/height of individual turbines. This scalability is crucial for maximising energy output and making OSW a competitive and viable component of South Africa's energy portfolio.

However, the development of OSW in South Africa does not come without its challenges. There are relatively limited areas for less expensive fixed-foundations (under 60 m water depth); most resources are suitable for floating-foundation OSW which is a less mature technology compared to fixed. As with all new OSW markets, several policy interventions are needed to create an enabling framework. Attracting private investment to stimulate a local supply chain will require deployment at scale. Financing the first OSW projects will require consideration of risks and appropriate financial mechanisms that can be leveraged. For example, concessional finance reduces public sector costs (e.g. grid connection) and private sector (blended finance to reduce cost of capital) elements. Collaborative efforts between government, industry stakeholders, and local communities will be essential to address these challenges and ensure OSW projects' responsible and sustainable deployment.

While OSW may currently not be fully competitive with other RE technologies in terms of price alone, it provides high levels of economic investment and creates large numbers of high value-added jobs. Therefore, considering the overall value of OSW, it can make a positive contribution to South Africa's energy mix and economy.

3. KEY FINDINGS

3.1. SOUTH AFRICA'S OSW POTENTIAL

This study assesses the main technical, environmental and social constraints in South Africa's EEZ to identify potential OSW development areas. In summary, South Africa has strong and consistent wind speeds along its entire coast, but further analysis of technical constraints indicated that floating OSW development will be required to realize this potential.

3.1.1. Technical constraints

To identify potential development areas, this study considered three main technical requirements, or constraints, for OSW development in the South African EEZ:

- **Average wind speeds** – greater than 8 m/s at 150 m hub height (although most areas are greater than 8.8 m/s)
- **Bathymetry/depth** – less than 1,300 m (although most areas are less than 500 m)
- **Distance to port** – less than 250 km

The majority of South Africa's EEZ has excellent wind speeds, averaging around 9 m/s for most West and Southeast coasts. These average wind speeds are comparable to those observed near planned and operational projects in the Netherlands (9.2 m/s), Germany (9.5 m/s) and UK (9.7 m/s).[4][12] The highest mean wind speeds (above 10 m/s) are found south of Cape Town, followed by the areas west of Port Nolloth and around Durban and Richards Bay (see Figure 1, Executive Summary). Only the area between the Port of Mossel Bay and the Port of Ngqura has wind speeds of less than 8 m/s.

Although good wind is plentiful, the abrupt increase in water depth along the contours of the continental shelf means that most of South Africa's OSW capacity will be harnessed with floating OSW technology at depths ranging from 75 m to 500 m (Figure 5). Floating OSW development could also be pursued in areas with depths up to 1,300 m, particularly around Durban and Richards Bay. Likewise, there are small areas off the coast of Gqeberha and Saldanha Bay where wind speeds are sufficient and depths are suitable for current and future fixed OSW technology (0-60 m and 60-75 m depth, respectively).

Given the expansiveness of South Africa's EEZ, distance from the nearest port was also treated as a technical constraint. This study considered eight ports in South Africa and a port in the planning stages, the Port of Boegoebaai, near the border of Namibia (Figure 5). Due to the number of ports along South Africa's coast, distance from the port did not constrain OSW development areas as significantly as wind speed and depth.

4 Averaged over a 22-year period (2000-2021) weighted by planned capacity, as of 2022.

Other technical constraints were explored but not used in the geospatial analysis: metocean conditions (beyond average wind speed) and geophysical conditions. This study analysed existing statistical metocean data to determine whether novel technologies and engineering applications would be required for OSW developments in South Africa's EEZ (see Appendix 2). This initial analysis showed that conditions in South Africa's EEZ are, for the most part, comparable to those at existing project sites in the UK, Norway, Portugal and the US. Looking ahead, detailed metocean measurement campaigns and analyses will be needed to site and plan individual projects. Such data will be needed to understand how metocean conditions could impact project development along South Africa's EEZ, particularly concerning unfavourable conditions for transportation, installation, and operations of floating OSW.

Data was requested from the Council for Geoscience to identify faults or other geophysical barriers at a high level; however, due to the limited availability and quality of data, these data sets were not assessed. Geophysical and geotechnical conditions should be considered in future assessments of technical constraints.

3.1.2. Environmental and social constraints

OSW projects must be developed sustainably to avoid negative environmental and societal impacts. Furthermore, most OSW projects must meet certain environmental and social (E&S) standards (e.g. IFC Performance Standards, such as PS6 "Biodiversity Conservation and Sustainable Management of Living Natural Resources"; World Bank Environmental and Social Standards) to access international and concessional financing. Meeting these standards requires a thorough understanding of the potential environmental and social constraints before project development to facilitate project planning, design, and implementation that mitigates impacts, preserves biodiversity and respects local communities.

A strategic assessment and rating of environmental and social constraints was performed based on a desktop literature review, expert analysis and engagement with stakeholder organisations in South Africa, alongside an assessment of relevant geospatial data for each constraint (see Chapter 5: Environmental and social constraints). This assessment identified exclusion zones (containing 'red' or hard constraints) and restriction zones containing 'amber' constraints; high-risk areas requiring further risk assessment during Marine Spatial Planning (MSP), site selection or Environmental Impact Assessment (EIA). The spatial distribution of the identified constraints is presented in Figure 5 and the exclusion and restriction zones are summarised in Table 1.

FIGURE 5: MAP OF SELECT ENVIRONMENTAL, SOCIAL AND TECHNICAL CONSTRAINTS IN SOUTH AFRICA'S EEZ.

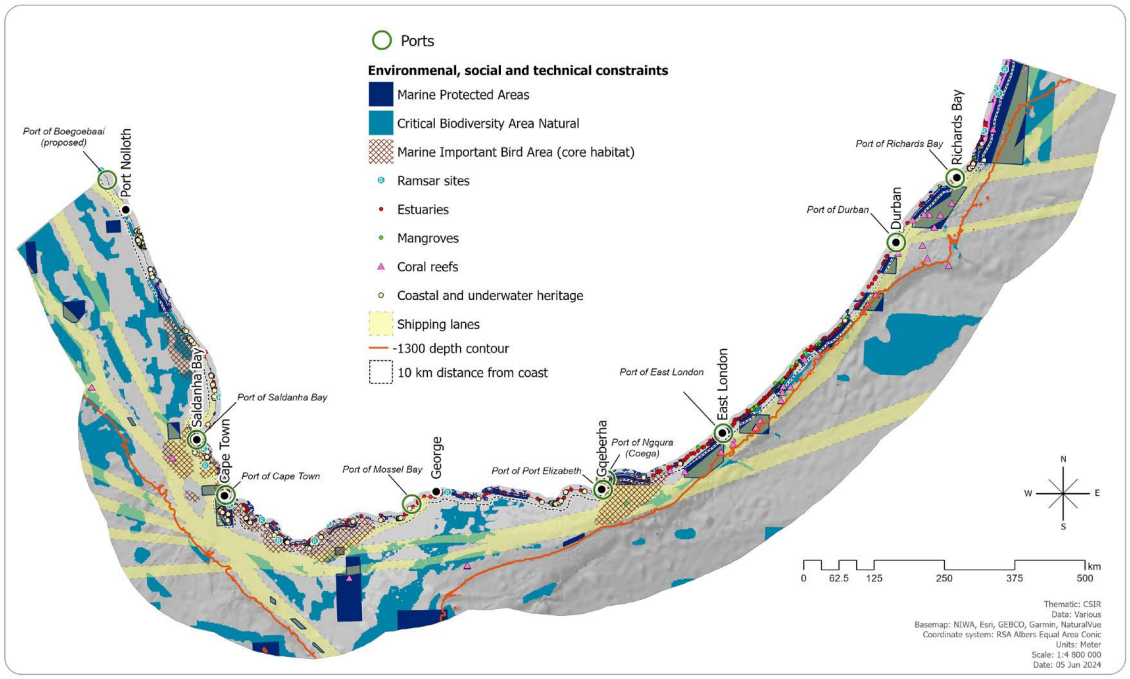


TABLE 1: SUMMARY OF TECHNICAL, ENVIRONMENTAL AND SOCIAL CONSTRAINTS IDENTIFIED IN THIS STUDY.

Exclusion zones (where constraints assigned a 'red' rating are present)	Restriction zones (where constraints assigned an 'amber' rating are present)
Marine Protected Areas (MPAs)[13] as defined by the National Environmental Management: Protected Areas Act (NEM: PAA).[14]	National Protected Areas Expansion Strategy (NPAES) focus areas [15]
Critical Biodiversity Areas (CBAs) (natural)[16] as defined by the National Coastal and Marine Spatial Biodiversity Plan, Version 1.2.[17]	CBAs (restore) and CBAs Ecological Support Areas (ESAs) as defined by the National Coastal and Marine Spatial Biodiversity Plan.[18]
Marine Important Bird Areas (MIBAs) (core bird habitat) for African penguin, Cape gannet, Cape cormorant.[19]	Ecologically or Biologically Significant Marine Areas (EBSAs) [20]
Distance within 10 km of the coastline (estuaries[21], Ramsar sites[22], mangroves[23], nearshore coral reefs[24] and coastal heritage were therefore also excluded).	Key Biodiversity Areas (KBA)
Underwater heritage.[25]	
Shipping lanes, as derived from marine traffic records.[26]	Important Marine Mammal Areas (IMMAs)
	Important Shark and Ray Areas (ISRAs)
	Fauna species
	Tourism areas (Blue Flag sites)
	Fisheries and aquaculture
	Subsea telecoms and internet infrastructure

Exclusion zones (where constraints assigned a 'red' rating are present)	Restriction zones (where constraints assigned an 'amber' rating are present)
	Aviation
	Seismic activity
	Petroleum and mining
	Military / Navy areas
	Dredging

3.1.3. Summary and further analysis

Based on the analysis of technical, environmental and social constraints, seven large areas in the South African EEZ were identified as likely to be the most suitable for OSW development, assuming a 3 MW/ km^2 density (see Figure 6, further detail provided in Chapter 6: Geospatial Analysis.

All but one of the development areas have average wind speeds greater than 9 m/s (the final area averages 8.8 m/s).

- **Boegoebaai - West Coast (BB-WC)** – an area over 13,000 km^2 west of Port of Nolloth and the proposed Port of Boegoebaai. This area has excellent mean wind speeds (9.2 to 9.7 m/s) and depths ranging from 75-500 m. This area would support roughly 40 GW of floating OSW capacity but no fixed OSW capacity. Beyond technical requirements, the area is constrained by a major shipping lane running parallel to the coast and environmental protections and designations (primarily CBAs (Natural) and four MPAs, established mainly to reduce the impact of existing marine activities (e.g. fishing) on the environment). There are some EBSAs within this region, but these were treated as 'amber' or soft constraints in this analysis, meaning further assessment of the impact of the influence of OSW development is recommended.
- **Saldanha Bay - West Coast (SB-WC)** – an area over 8,600 km^2 northwest of Saldanha Bay, characterised by strong mean wind speeds (~8.8 m/s) and depths ranging from 0-500m. Due to the bathymetric profile, this area is predominantly suitable for floating OSW technology (24 GW), but just over 1.4 GW is ideal for fixed OSW technology. CBAs and an avifauna core habitat constrain this area, and EBSAs are also present. The marine area south of Saldanha Bay, despite its high mean wind speeds, has a high density of social and environmental constraints (including a MIBA for cape cormorants and cape gannets, an MPA, Ramsar sites, coastal and underwater heritage, and high marine traffic density) and therefore was excluded from the analysis.
- **Cape Point West (CPW) and Cape Point South (CPS)** – two areas west (1,282 km^2) and south (932km^2) of Cape Point, characterised by extremely high mean wind speeds (9.9–10.6 m/s) and depths ranging from 75-500 m. Although the analysis revealed a small area suitable for a fixed-bottom pathfinder project near False Bay, there is assumed to be a low social license for development due to the various environmental and social constraints near Cape Town, as well as the potential for visual impacts. The Cape Point region offers nearly 6.5 GW of floating OSW capacity.

- **Coega West (CW) and Coega East (CE)** – two areas west (1,365 km^2) and east (537 km^2) of the Port of Ngqura (Coega)/Gqeberha, characterised by moderate mean wind speeds (9 m/s). Apart from the Saldanha Bay — West Coast development area, this is the only other area identified in this analysis suitable for fixed OSW technology. However, other areas could be identified in the future using different constraints or assumptions. This development area could support smaller-sized fixed OSW projects (roughly 750 MW in the Coega West area and 550 MW in the Coega East area), as well as more substantial floating OSW projects (over 3 GW in Coega West and 1 GW in Coega East). The area is constrained to the south by major shipping lanes and to the east by a large MPA and coral reefs. If any OSW projects are developed nearby, an IMMA near Coega West should also be considered.
- **Durban - Richards Bay (RDB-RB)** – a nearly 2,900 km^2 area between the Port of Durban and Port of Richards Bay with strong mean wind speeds (~9.4 m/s). Just over 2 GW is suitable for floating OSW development at a depth of 75-500 m, but another 15 GW is available for floating OSW development at depths between 500-1300 m. In total, this area could support over 17 GW of floating OSW development. This area is constrained not only by the profile of the continental shelf (resulting in a steep drop-off in depth to the east) but also by MPAs to the north and south. There is also a high marine traffic density in and around both ports.

Although this study considered several environmental, social and technical considerations to identify the potential areas for OSW development in South Africa, significant data and knowledge gaps exist. Further data, research on impacts on local species, analysis, and consultation with stakeholders are required to gain a better understanding of potential impacts and mitigation measures, particularly for the identified restriction zones, as well as the potential for co-benefits and co-existence.

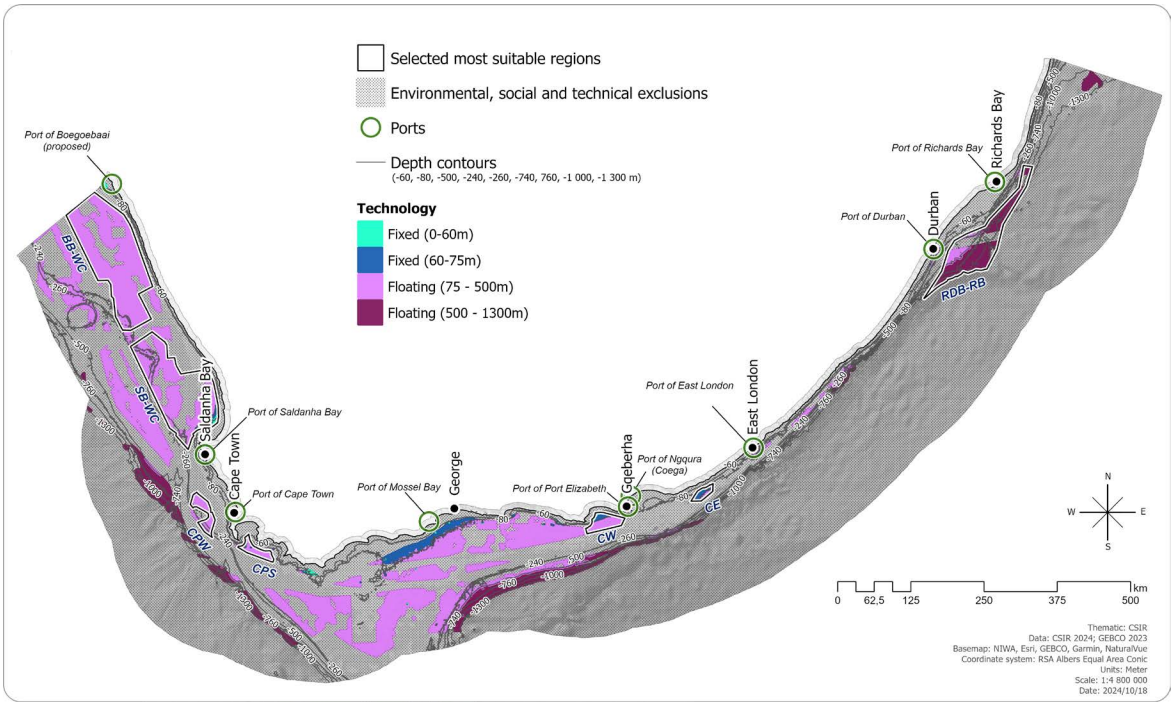
Priority should be given to surveys required at the earliest stages of OSW development and planning and those that take the longest to complete. These include the wind resource assessment campaigns, which can take two years or more, more detailed metocean surveys at a range of key sites across the South African coast, and studies on South Africa-specific receptor groups (e.g. cetaceans, birds and bat).

It is important to note that within the areas identified as most suitable, there may still be various environmental, social and technical constraints to OSW development. Similarly, viable opportunities for OSW development are likely to be available outside the identified regions. Other areas could be determined upon further investigation, e.g. from developer surveys or more in-depth marine spatial planning activities. This analysis relied on several conservative assumptions (10 km distance from shore; development density of 3 MW/km^2; MPA restrictions around the Durban — Richards Bay area; consolidation of shipping activity to specific areas), some of which could be relaxed or changed in certain circumstances, allowing for the inclusion of additional locations.

Marine Spatial Planning, accompanied by plan-level Strategic Environmental Assessment (SEA), should be conducted to support development decisions in the marine environment. OSW should be included in strategic planning instruments, such as future iterations of the National Coastal and Marine Spatial Biodiversity Plan (NCMSBP). The Government of South Africa will need to engage with the International Maritime Organisation (IMO) and shipping industry to coordinate and structure shipping activity along the EEZ to maximise the areas available for OSW development and improve navigation safety. OSW planning must prioritise the avoidance of adverse impacts, apply best practice

mitigation strategies and promote the coexistence of wind energy with existing marine activities, supported by procedurally just frameworks (see sections 3.5.3: Aligning OSW development with the Just Transition and 3.6: Regulatory frameworks and route-to-market and the relevant technical appendices for further detail).

FIGURE 6: MOST SUITABLE AREAS FOR FIXED AND FLOATING OSW DEVELOPMENT BASED ON TECHNOLOGY REQUIREMENTS AND ANTICIPATED AVAILABLE CAPACITY IN MW, BASED ON A 3 MW/KM² DENSITY.



3.2. OSW GROWTH SCENARIOS

This study outlines three potential growth trajectories, or scenarios, for South Africa's OSW market over the next 25 years. The low, medium and high scenarios represent 5, 15 and 40 GW of OSW capacity by 2050 respectively. Outlining and evaluating different growth scenarios helps illuminate the costs, benefits and trade-offs of different ambitions. The government of South Africa also uses scenario analysis in its energy system planning; the Integrated Resource Plans (IRP), which form the basis for public procurement for new electricity capacity. OSW has not explicitly been included in any previous IRPs to date, but this report *A Strategic Framework for Offshore Wind Development in South Africa* can support its inclusion in future iterations. This study also sets out the electricity emissions reductions potential associated with OSW deployment in each scenario.

The three scenarios are informed by the most recent draft IRP and demand forecasting. For example, under the current 2035 plan, it is expected that Eskom will decommission approximately 20 GW of coal capacity by 2040 and another 30 GW by 2050 creating long-term demand for new generation. South Africa already relies on onshore wind and solar PV generation, and the generation profiles of these technologies appear to be highly complementary. OSW is expected to have the same synergies with PV as onshore wind.

The low and medium growth scenarios assume the electricity demand profile of the Draft IRP2023. The high growth scenario considers additional growth in electricity demand, electrification of industrial process heat and transportation, and the use of GH_2. Finally, under the low, medium and high growth scenario, it was assumed that 2035 would be the first year that OSW projects would be commissioned due to the long lead time for development. Under every scenario, we anticipate there will be an initial period of developing pathfinder projects. These trailblazing projects provide an understanding of challenges and risks in a new market, before large-scale commercial development picks up. The three scenarios are described in further detail in Chapter 7:

Offshore wind growth scenarios.

FIGURE 7: VOLUME AND TIMING OF OSW CAPACITY UNDER EACH GROWTH SCENARIO.

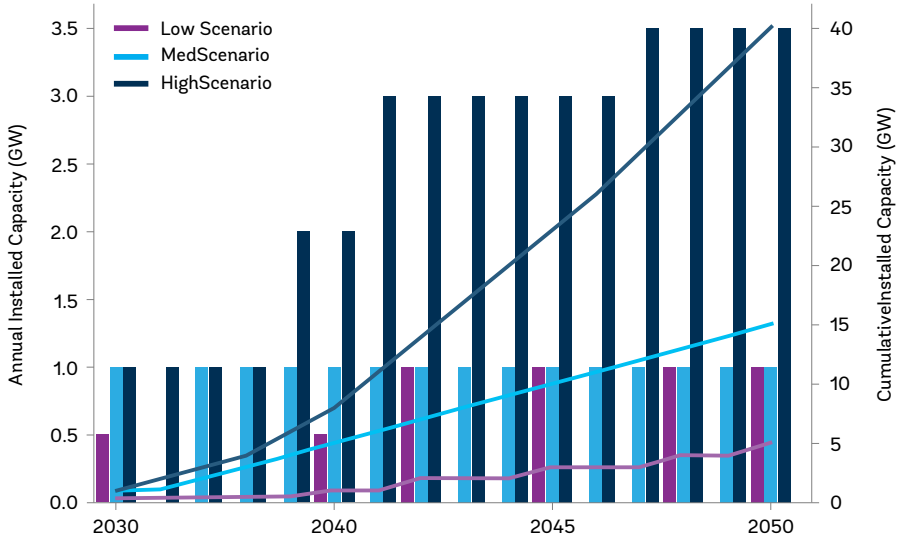


TABLE 2: CUMULATIVE VOLUME OF OSW CAPACITY UNDER EACH GROWTH SCENARIO IN 2035, 2040 AND 2050.

Scenario / Year	2035	2040	2050
Low growth	500 MW	1 GW	5 GW
Medium growth	1 GW	5 GW	15 GW
High growth	1 GW	8 GW	40 GW

3.3. PROJECTED LEVELISED COST OF ENERGY

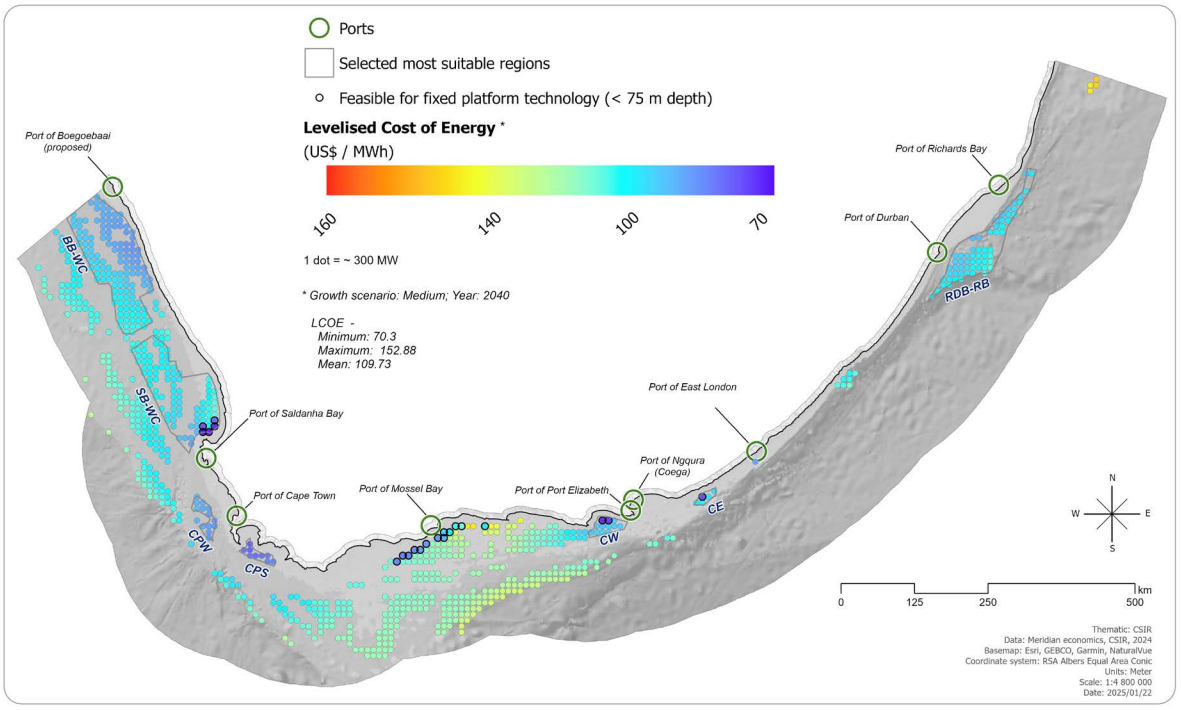
3.3.1. Levelised cost of electricity

Accelerating OSW development will reduce costs and make OSW cost-competitive with other renewable technologies in South Africa. This study derived preliminary estimates of the LCOE of fixed and floating OSW from 2035 to 2050 under the low, medium, and high growth scenarios to assess OSW's cost-competitiveness against other technologies (see Chapter 8: Levelised cost of energy).

LCOE projections were developed using a bottom-up cost model that considered capital costs[5] (CapEx) from Northern Europe and China, operating costs (OpEx), annual energy production (AEP), expected lifetime, and discount rate. The model used the projected future cost of OSW in established markets and several assumptions about the South African market, including the readiness of the local supply chain, to estimate CapEx and OpEx costs in the three scenarios.

This approach calculated LCOE for over 800 locations within the least constrained suitable regions (i.e., outside of and within 'most' suitable areas identified in Figure 8) identified in the geospatial assessment. Typical site characteristics considered include wind speed, water depth, distance from the port, and distance to the transmission network to determine an area-specific LCOE.

FIGURE 8: PROJECTED LEVELISED COST OF ELECTRICITY FOR OSW IN THE LEAST CONSTRAINED AND SELECTED SUITABLE REGIONS BASED ON SITE-SPECIFIC PARAMETERS.



5 Some data comes from a period of unusually high inflation, so costs were compared and adjusted. Additionally, as detailed cost data from the Chinese market is not available, this study assumes that Chinese CapEx costs are 28% less than European costs based on available data.

Fixed OSW development is anticipated to have the lowest initial LCOE under all assumed growth scenarios. Given their lower cost, developers are expected to prioritise sites in Saldanha Bay — West Coast, Coega West and Coega East. Across these areas, LCOE values range from US$ 94/MWh to US$ 116/MWh for all growth scenarios in 2035.

Globally, the LCOE of fixed OSW is expected to be lower than that of floating OSW, primarily due to differences in technological and commercial maturity. However, the premium associated with developing floating OSW is anticipated to decrease between 2035 and 2050 as the technology matures and the South African OSW market grows.

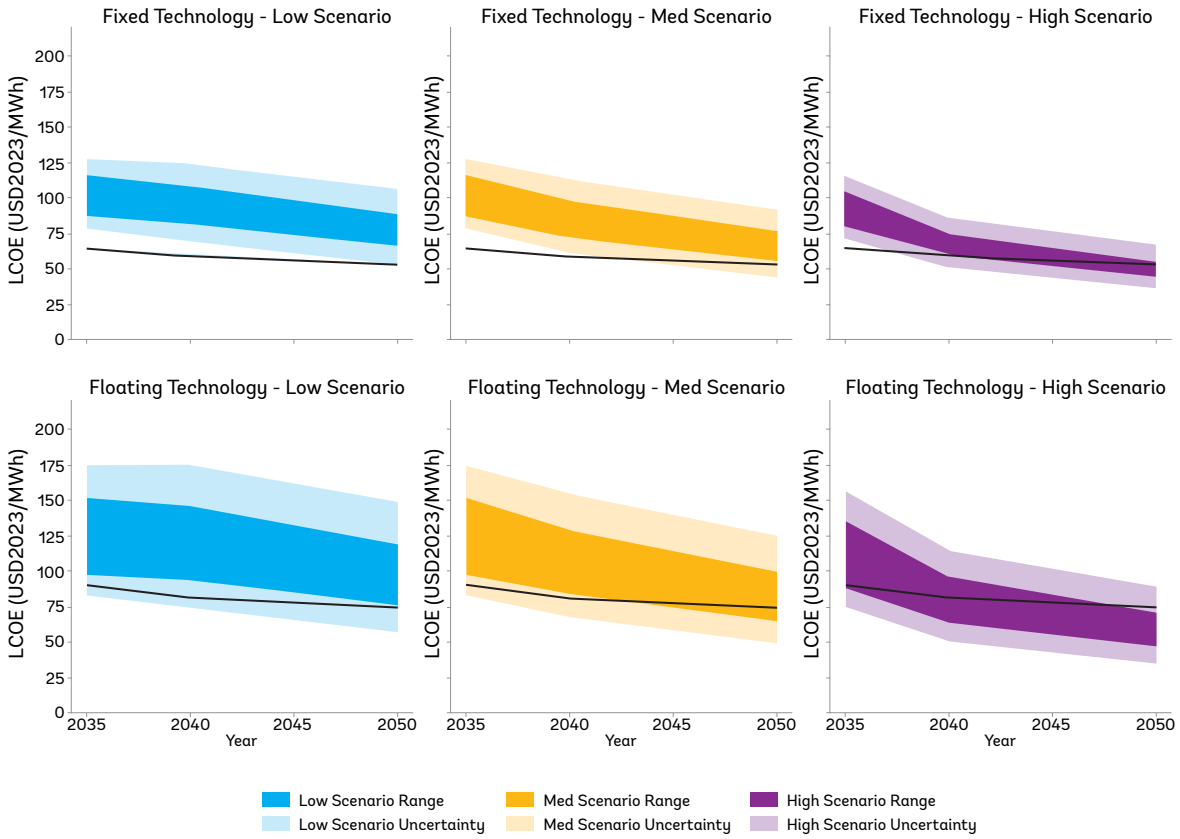
The magnitude of cost reduction in floating OSW development depends heavily on market growth rates. For instance, in the low growth scenario, LCOE for South Africa's floating OSW areas is expected to decrease by approximately 4% between 2035 and 2040 (US$ 97-126/MWh — US$ 93-121 MWh), while in the medium and high scenarios, costs decrease by ~13% and 27%, respectively over the same five-year period. By 2050, the anticipated LCOE of floating OSW projects could reach US$ 65-84/MWh in the medium growth scenario and US$ 47–60/MWh in the high growth scenario. The model assumes that South Africa can realise further cost reduction through increased learning rates and greater utilisation of the cost effective local supply chain.

In 2040, the Cape Point region will have the lowest LCOE across the floating OSW areas assessed in this study, at US$ 63-104/MWh. In the medium and high scenarios, there is a cost difference in developing floating OSW in the Cape Point region (US$ 77.25/MWh, on average) versus Durban/ Richards Bay (average 14.6% higher), Saldanha Bay (average 19.7% higher) and Boegoebaai (average 11.8% higher). The premiums for developing in these areas may be offset by other factors, such as social and economic constraints, feasibility of hydrogen development, and suitability of ports (e.g. Port of Saldanha Bay). For example, while onshore RE has a lower cost than OSW, in KwaZulu-Natal, over 30% of the land is held in communal trusts, and it is challenging to secure project rights. Another 9% of the province's biodiversity-rich area is under conservation, while dams, lakes, and other water bodies comprise 10% of the total land area. In addition, land use in the province is divided among cities, towns, townships, and Agriculture, Forestry and Other Land Use (AFOLU). Consequently, even today, there is little readily available land for RE development.[27] These challenges and costs for onshore development could render OSW the more attractive and affordable option for secure energy.

The trajectory of LCOE between 2035 and 2050 for both fixed and floating OSW wind installations in South Africa is illustrated in Figure 9. The darker shaded region in each plot represents the range of LCOEs that could be achieved in different offshore areas with different CapEx cost assumptions. The lower band represents the lowest LCOE areas using a hybrid of baseline CapEx costs taken from the lowest cost potential import market (most components imported from Europe, with any imported turbines and foundations from China). The upper band represents the highest LCOE areas using only European baseline CapEx costs. The lighter shading indicates the range of uncertainty in the analysis.

South Africa has enough OSW potential to meet the high-demand scenario of 40 GW by 2050 without pursuing prohibitively expensive regions. It is important to note that the LCOE calculated in this study is a baseline; LCOE can be further reduced through investment in cost-reduction activities, such as ambitious local supply chain development and targeted research and development (R&D), among other efforts (see Section 3.5.1).

FIGURE 9: LCOE TRAJECTORY FOR FIXED AND FLOATING OSW INSTALLATIONS IN SOUTH AFRICA COMPARED TO ESTABLISHED MARKET TRENDS.



3.4. INFRASTRUCTURE REQUIREMENTS

3.4.1. Grid integration and transmission system upgrades

South Africa's electricity demand is concentrated in the northeast (Gauteng, North-West Province, Mpumalanga), with lesser demand in the Western Cape and KwaZulu-Natal. Most coal-fired power plants are also located in the northeast, aligning with demand centres. With the shift to renewables, most new generation is expected to be located in the southwestern regions (Northern, Western, and Eastern Cape), where the best solar and wind resources are found, but with historically lower grid capacity. As such, grid capacity is already a significant constraint to renewable energy development in South Africa. It has already affected the REIPPPP, limiting the capacity allocated in previous bid rounds.

Grid capacity and power evacuation capability are critical for investor confidence and project bankability. Deliberate grid planning is essential in future Transmission Development Plan (TDP) iterations to prepare for OSW capacity expected to be operational in 2035. Action should be prioritised in the short term to put the necessary plans, processes, and investments in place.

Grid upgrades will be necessary for the most promising sites for fixed and floating OSW development identified in this report, but site leasing decisions and commitments by OSW developers to progress individual projects should inform where and when those upgrades take place. Further analysis should be completed to assess the cost of grid upgrades driven by OSW against projected LCOE to better understand the trade-off between OSW development areas, especially in the medium and high scenarios.

Mitigation measures that reduce the grid burden, such as applications for storage, flexibility, demand-side response, and Power-to-X (P2X), should be further explored for the high growth scenario. Given the grid constraints, P2X applications, in particular, are likely to be enablers of OSW development in South Africa. Grid upgrade options should be considered against the opportunity and cost of P2X.

3.4.2. Power-to-X: production of green hydrogen

Offshore wind generation can be used to produce green hydrogen (GH_2) through the provision of high volumes of "variable baseload" power[6]. Using OSW generation for GH_2 production can help manage OSW output variability and reduce the amount of transmission system upgrades needed to fully harness the country's OSW capacity (i.e. in a high growth deployment scenario). Furthermore, GH_2 and its derivatives offer a decarbonisation solution for 'hard-to-abate' sectors where direct use of electricity generated from renewable sources is not feasible, including heavy-duty transport and industry. Several countries have announced plans to import GH_2; therefore, GH_2 production could serve as both a domestic solution and an export opportunity.

The levelised cost of hydrogen (LCOH) was calculated for two of the OSW development areas identified in Chapter 6: Geospatial Analysis:

- Saldanha Bay — West Coast: GH_2 production from the fixed OSW capacity could start in 2035**,** as this area is likely to be one of the first to be developed in South Africa and because there are already plans for GH_2 projects near the Port of Saldanha Bay.[28]
- Richards Bay: GH_2 production from the floating OSW capacity in the Durban — Richards Bay area starting in 2040, as the introduction around the Port of Richards Bay could be assumed to follow the successful introduction in the Saldanha Bay — West Coast area.

The projected LCOH at Richards Bay in 2040 is lower than that of Saldanha Bay — West Coast in 2035, although Richards Bay is likely to rely on more expensive floating OSW. This result is due to several assumptions about the Richards Bay site, including increased electrolyser capacity factor (due to more consistent wind resources), cheaper and more efficient electrolyser technology (due to an extra 5 years of development), more favourable WACC, and a slightly longer plant life (refer to Chapter 10: Power-to-X: Green hydrogen and desalination for further detail).

Notably, the range of LCOH values achieved using OSW generation at these two sites, assuming a connected grid approach, (US $4.6/kg–US $5.3/kg for Saldanha Bay — West Coast; US $3.80/kg–US $4.4/kg for Durban — Richards Bay) are higher compared to the international target of US $2/kg–US $3/kg.

6 The International Energy Agency (IEA) defines offshore wind as "variable baseload" to reflect its relatively higher capacity factors and lower variability as compared to onshore renewables.

These costs are expected to decrease if GH_2 were to be produced with a combination of OSW and solar PV generation, since solar has a complementary generation profile with OSW and lower costs. An initial analysis of capacity factor distribution at the two sites suggests that GH_2 produced from a combination of OSW and solar PV generation may be cost-competitive with GH_2 from onshore wind and solar PV. Further analysis of the LCOH that could be achieved using a mix of OSW and solar PV is recommended. If the results are positive, GH_2 production could be a catalyst to kickstart South Africa's OSW market.

3.4.3. Port infrastructure

South Africa has several major ports with potential to support fixed and floating OSW installation and O&M with minor upgrades. An assessment of seven ports in South Africa highlighted that ports are currently suitable for O&M, supported by both CTVs and SOVs (Table 3; for definitions of ratings, refer to Chapter 11: Port Infrastructure). However, upgrades would be required in select ports to support fabrication of floating OSW installations, which will be essential in the medium and high growth scenarios. Upgrading crane capacity, which is low cost compared to other upgrades and easy to resolve, is not included in Table 3 but will be required at all ports.

TABLE 3: SUMMARY OF REQUIRED PORT UPGRADES TO FACILITATE INSTALLATION AND O&M OF FIXED AND FLOATING OSW PROJECTS, EXCLUDING ADDITIONAL CRANE CAPACITY.

Red shading (values not acceptable for the required purpose), amber shading (acceptable values), and green shading (preferable values). Grey signifies missing data.

	Floating OSW fabrication port	Fixed OSW fabrication port	Fixed OSW marshalling port	CTV based O&M port	SOV-based O&M port
Port of Richards Bay	Quay length Quayside draft	Quay length	Quay length Harbor entrance		
Port of Durban	Quay length Quayside draft	Quay length	Quay length Harbor entrance		
Port of East London	Quay length Quayside draft	Quay length	Harbor entrance		
Port of Ngqura	Wet storage area (Quay length) (Quayside draft)	Quay length	Quay length Harbor entrance		
Port of Mossel Bay	Yard area Quayside draft Harbor entrance Quay strength Quay length	Yard area Quay strength Quay length Quayside draft	Yard area Quayside draft Harbor entrance Quay strength	Yard area	Yard area Quayside draft
Port of Cape Town	Yard Area Quayside draft Quay length	Yard area	Yard area Harbor entrance		
Port of Saldanha Bay	Yard area				

Because South Africa has relatively low fixed OSW potential and several ports that essentially meet suitability requirements for fixed OSW fabrication, marshalling and O&M, substantial port upgrades to support fixed OSW development are likely not needed. The Port of Saldanha Bay is suitable for fixed OSW fabrication and marshalling, as only additional crane capacity is required. Likewise, the Port of Ngqura and Port of East London may also be capable of supporting some fixed OSW development, given their proximity to fixed OSW areas surrounding Gqeberha.

Some ports, e.g. Port of Saldanha Bay, could first serve fixed OSW projects and be upgraded over time to service floating OSW development. Upgrading the Port of Saldanha Bay would be a no-regret action in all scenarios, given its sizeable wet storage and good transport links; few upgrades are needed for floating OSW fabrication, and it is close to potential fixed and floating OSW sites. In the longer term, the Port of Saldanha Bay and the surrounding SEZ could serve as a manufacturing and production hub, including GH_2.

However, two to three ports supporting 1 GW per year will be needed to support the floating OSW development envisaged in the medium and high growth scenarios. South Africa's floating OSW capacity is dispersed along the coastline, and servicing projects through the Port of Saldanha Bay would increase transport times and costs. Upgrading the Port of Richards Bay or Port of Durban (or both) through quayside extension, dredging, and crane upgrades could address this gap. Additionally, the Port of Boegoebaai, currently under development, could be adapted to support floating OSW development. South Africa's approach to port development will have to be weighed against other aspects, e.g. the rate and location of development, the projected LCOE of floating OSW, the location of potential manufacturing capability, and investment appetite. For this reason, the South African government, relevant port authorities and industry should collaborate in a formalised and strategic manner to ensure that port upgrades and the investment needed to facilitate those upgrades align with development plans.

3.5. THE ECONOMIC CASE FOR OSW DEVELOPMENT

3.5.1. South Africa's current supply chain capabilities, capacity and potential

A strong, local, and sustainable supply chain will boost the economic benefits and reduce the cost of OSW development in South Africa. Like many new markets, South Africa's OSW industry is expected to rely on imported components and services in the short term as the local supply chain develops necessary expertise and infrastructure. However, the country's distance from all other established OSW markets will affect costs and increase complexity for developers. Local supply chain development — particularly in the medium and high growth scenarios — would more rapidly reduce LCOE, create high-quality jobs, and support economic growth.

South Africa has some experience in offshore oil and gas (O&G) to support skills transfer to OSW, although this is less significant than other OSW markets such as the UK and Norway. However, South Africa has a growing onshore wind sector, and the capability and workforce to manufacture onshore wind components. Table 4 summarises South Africa's current supply chain capabilities, where lower scores indicate lower capacity and benefits, and higher scores indicate higher existing capacity and potential benefits (refer to Chapter 12: Supply Chain Analysis for further detail).

TABLE 4: SUMMARY OF SOUTH AFRICA'S SUPPLY CHAIN CAPABILITIES AND CONSIDERATIONS FOR THE LOW, MEDIUM AND HIGH GROWTH SCENARIOS.

The shading refers to (1) one, (2) low, (3) med, and (4) high, in relation to track record, parallel sectors and potential benefits.

Supply chain category	Track record	Parallel sectors	Potential benefits	Low growth	Medium growth	High growth
Planning and development	3	4	4	Upskilling the local workforce is required, but there is a good local track record. Although job creation is limited, local presence is beneficial.	Upskilling the local workforce is required, but there is a good local track record. Local presence is essential to scale-up and cost reduction.	Same as the medium growth scenario.
	Many (28) developers, project design companies, and environmental consultancies are involved in onshore renewables in South Africa, in addition to one joint venture developing floating OSW. South Africa's business support services sector has the largest workforce compared to other relevant industries, and many students are enrolled in technical training.					
Manufacturing — turbine	2	3	2	Due to the lack of track record in OSW turbine manufacturing, significant capital investment required for facilities and comparatively low costs in established markets, turbines are expected to be imported.	Same as the low growth scenario.	Same as the low growth scenario.
	Although several (37) companies based in South Africa are involved in manufacturing (blades, small components, and towers) and the assembly of turbines, these all support the country's onshore wind sector, and the facilities are unsuitable for OSW turbines. The manufacturing sector has a large workforce, but it faces labour shortages.					
Manufacturing — Balance of plant	3	3	3	Significant capital investment requirements may limit local opportunity in low-growth scenarios, resulting in industry reliance on imports.	Significant capital Investment is required to develop a floating OSW balance of plant manufacturing facilities near ports. Public financing is likely needed, but this will support local job creation.	This is the same as for the medium growth scenario, but significantly more local jobs are expected to be required to support the deployment pipeline.
	Electrical systems and cable suppliers (12) support the country's onshore wind sector. Companies providing solutions for marine flotation and anchoring (4) could be relevant for future floating OSW development. There is an established supply chain for steel, and several companies have supplied concrete for onshore wind projects. South Africa has a large manufacturing workforce compared to other sectors, but the industry faces labour shortages.					

Supply chain category	Track record	Parallel sectors	Potential benefits	Low growth	Medium growth	High growth
Installation and commissioning	2	2	3	Upskilling of the local workforce is required. Due to high capital costs, specialist vessels and most crew are presumed to be primarily imported. Most jobs are expected to be fulfilled globally.	Upskilling the local workforce is necessary, especially for floating OSW installations. Some investment will be required to catalyse growth, as longer-term cost reduction will rely on the ability of South African suppliers to support installation.	It is the same as the medium growth scenario. Still, significantly more local jobs are expected to be required to support the deployment pipeline, so long-term upskilling and workforce development are essential.
	There are companies in South Africa with experience in onshore cable and substation installation and other onshore work (16), but none have maritime experience. There are a few parallel sectors whose workforce would have transferable skills (e.g. specialised construction, transport, building and repairing of ships, and the petroleum sector). Still, these workforces are small and are supported by fewer technical courses.					
Operation, maintenance and services	2	2	4	Upskilling the local workforce is required. After 2035, locally based specialist vessels will be needed for ongoing operations.	Upskilling the local workforce is required and essential for long-term cost reduction. Locally based specialist vessels will be needed to support the deployment pipeline.	It is the same as medium growth, but significantly more local jobs are expected, so long-term upskilling and workforce development are essential.
	South Africa has at least one specialised blade maintenance and inspection contractor, but this company is only active in the onshore wind sector. South Africa has an offshore O&G sector; some vessels and equipment currently serving that industry may be available. There are several relevant parallel sectors, but most have small workforces (<1% of national employment).					
Decommissioning	1	2	2	Expect to follow on from skills and investment in installation.	It is the same for low growth, but increased deployment will require a larger local workforce.	It is the same for medium growth, but increased deployment will require a larger local workforce.
	No contractors or companies with relevant decommissioning experience were identified. Few parallel sectors exist, supported by a small workforce and limited technical courses.					

Based on South Africa's track record, capacity in parallel sectors and the potential benefit of local supply, it is expected that with dedicated training and upskilling in OSW, a local South African workforce could support development and consenting and O&M activities in all scenarios. The cost reduction associated with using the local installation and commissioning services supply is expected to offset the necessary investment in upskilling and equipment in a high-growth scenario.

The most significant opportunity for South Africa will be developing manufacturing capabilities for floating OSW balance of plant components due to the scale of the economic benefit (See Chapter 13: Jobs and Economic Benefits) and its relative strength compared to other supply chain categories.

In the short-term (e.g. up to 2035) and regardless of its ambition level, South Africa's government should invest in skills and training for development, consenting, and O&M activities. Supporting upskilling O&M technicians will be a comparatively low-cost way to support supply chain development compared to the extensive-scale capital outlays required for manufacturing facilities. The government could explore public-private-partnership or mandate existing organisations (e.g. Energy and Water Sector Education Training Authority (EWSETA), South African Renewable Energy Technology Centre (SARETEC), Centre for Renewable and Sustainable Energy Studies (CRSES)) to lead new training initiatives.

To support the medium and high scenarios, focus should be given to maximising the local investment for global OEMs, especially on installation and balance of plant. Early engagement with OEMs to understand their interest in entering the South African market and mechanisms to facilitate entry should be further explored. Based on this engagement and further analysis of capabilities at a national and regional level, the Government of South Africa should develop a supply chain strategy aligned with OSW ambitions and economic policy to make the long-term opportunity visible to OEMs and developers.

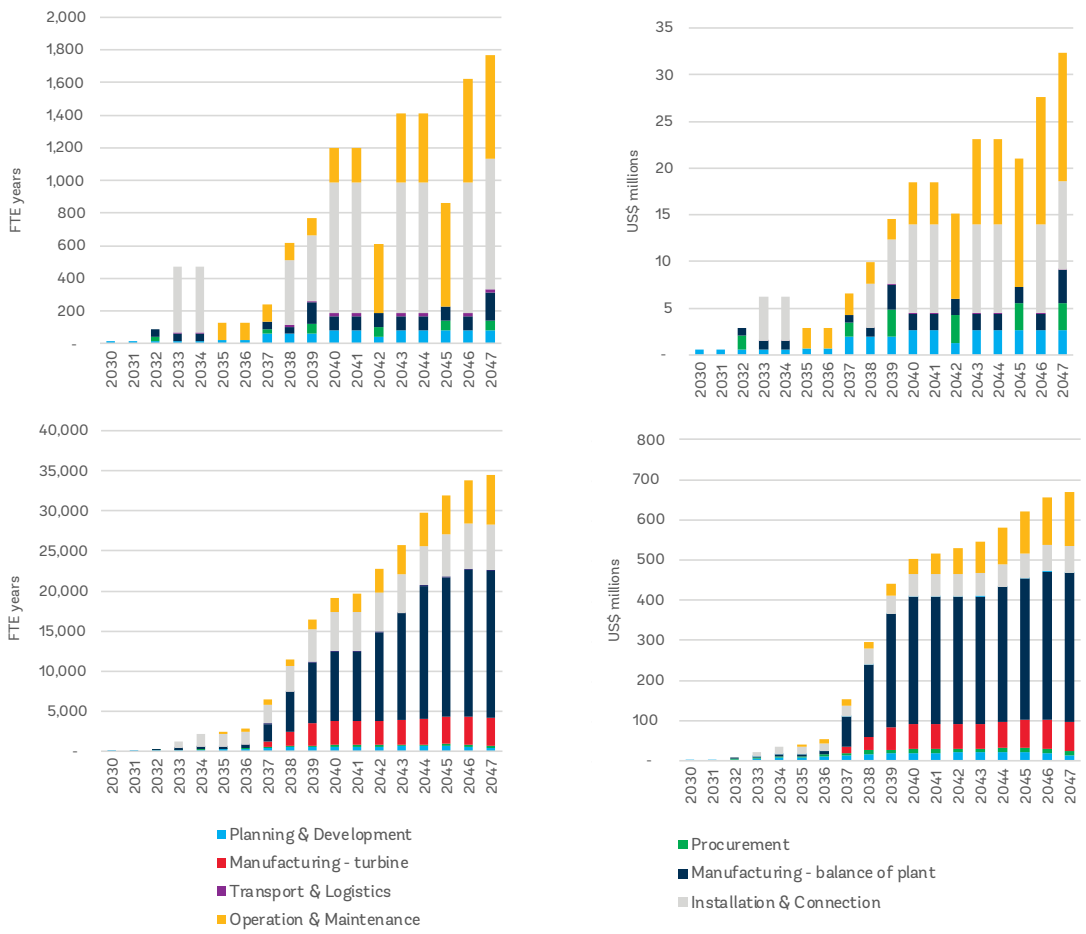
3.5.2. Projected economic impact of OSW development

OSW development can create new jobs, support GH_2 and NEV industries, and increase investment. This would support the country's 2050 Net Zero aspiration while addressing the triple challenges of unemployment, poverty, and inequality. South Africa's economic benefits scale directly with the amount of OSW deployment and the extent to which South Africa's supply chain supports this deployment.

Several jobs and skill sets are needed across the OSW project lifecycle phases: planning, manufacturing, installation, operations, and decommissioning. An estimate of the number of direct jobs needed to support OSW capacity expected under the growth scenarios and the associated employment wage contribution shows that economic benefits scale with cumulative installed capacity over time. This means that nearly 18 times more local jobs could be expected by 2050 in the high-growth scenario compared to the low-growth scenario (Figure 10). Likewise, employment wage contribution from the various project phases per year between 2030 and 2050 in the high growth scenario shows an eightfold increase compared to the low growth scenario. This study likely underestimates the total employment potential and employment wage contribution, as it does not account for the indirect and induced job creation in the secondary markets, which can increase job numbers by 100%.

Under every scenario, it is unlikely that the local supply chain will have the capacity to supply all of the required roles in the early stages of OSW development in South Africa. In nascent OSW markets, local content primarily involves jobs related to operations and installations at local ports. Supply chain policies, such as local content requirements (LCR), can be introduced to encourage local development. LCR should be carefully balanced with the capability of the supply chain and matched with deployment scale and growth rates.

FIGURE 10: LOCAL FTE YEARS AND ASSOCIATED EMPLOYMENT WAGE CONTRIBUTION CREATED UNDER THE LOW GROWTH SCENARIO (TOP) COMPARED TO THE HIGH GROWTH SCENARIO (BOTTOM), SPLIT BY PROJECT PHASE.

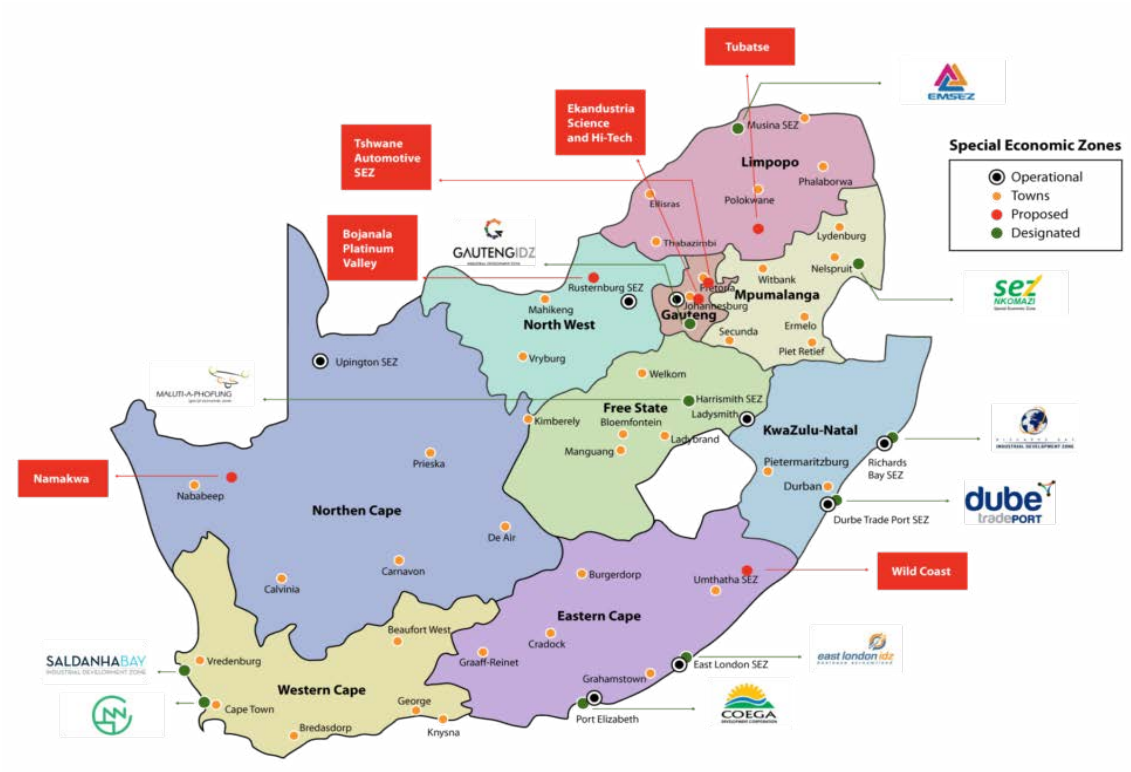


Based on the limited deployment under the low growth scenario, it is assumed that manufacturing and supply of turbines and most balance of plant components would take place outside of South Africa, in established, low-cost markets with existing facilities and experienced workforces.

In the medium and high growth scenarios, the increased scale of ambition and pipeline of projects could attract inward investment by global OEMs and local job creation, strengthening the supply chain and industrial growth, increasing resilience and reducing import reliance. It is expected that some turbine manufacturing activities, for example the manufacture and assembly of towers, could take place in South Africa starting in 2040.

In the two higher growth scenarios, it is assumed that South Africa could develop substantial manufacturing capability in balance of plant components for floating OSW projects (i.e. manufacturing of array and export cables, cable accessories, offshore and onshore substations, floating substructures and mooring systems), supplying over 50% of needs by 2040 and 100% by 2050. Developing new manufacturing facilities in existing or designated SEZs close to ports, such as the ones near the Port of Saldanha Bay, Port of Durban and Port of Richards Bay (Figure 11), could reduce transportation and logistics costs for nearby projects. Thus, the many new manufacturing jobs required in the medium and high-growth scenarios will likely be located in coastal provinces near existing SEZs.

FIGURE 11: OPERATIONAL, DESIGNATED AND PROPOSED SEZS IN SOUTH AFRICA.[29]



Although not as numerous, local O&M and installation jobs will be required under every scenario. Many of these jobs are shift-based, and employees live offshore for their shifts. As a result, installation and O&M personnel would not necessarily need to be based near OSW projects.

The potential for large-scale job creation and associated employment wage contribution in the medium and high scenarios can be enabled by strategic investment in local manufacturing, enabled by long-term planning and coordination between industry and government to identify high-quality investment opportunities.

3.5.3. Aligning OSW development with the Just Transition

South Africa has committed to ensuring that its shift towards a low-carbon, climate-resilient economy is undertaken in a way that contributes towards creating decent work for all, social inclusion and eradicating poverty. OSW development in South Africa creates many opportunities for economic growth and diversification. It provides additional opportunities for employment and can facilitate skills transfer from existing sectors, like manufacturing or oil and gas, into this new industry.

The inclusion of OSW in the country's long-term energy strategy, balanced use of LCR, education and training and initiatives to strengthen the capabilities of local firms can assist in developing an OSW sector and positively contribute to the Just Energy Transition Implementation Plan (JET-IP) by promoting procedural, distributive and restorative justice.

These opportunities align with the JET-IP, which supports the development of large-scale and distributed renewable energy generation. Further alignment opportunities between OSW and the JET-IP include:

- Shared infrastructure, e.g. port, grid, pipeline, rail.
- Technology incubation and workforce skills to build South Africa's competitive advantage.
- The establishment of Skills Development Zones (SDZs) focused on three core value chains: in Mpumalanga (renewable energy and transmission), in the Eastern Cape (NEVs) and in the Northern Cape (GH2). OSW development can expand these opportunities to regions like the Western Cape and KwaZulu-Natal.

There are some critical enablers to ensure that the socio-economic benefits and value creation of an OSW industry in South Africa are realised:

- Inclusion of OSW in long-term energy strategy in the context of plans to increase energy security and affordability alongside decarbonisation. Key policies that should include explicit reference to OSW include the Integrated Energy Plan and the Integrated Resource Plan.
- Specific deployment policies to stimulate market development and drive demand. These include:
  - Renewable energy portfolio standards, quotas, and feed-in tariffs or premiums
  - Fiscal incentives, such as tax exemptions, subsidies, grants, and rebates
  - Public finance mechanisms
- A balanced use of LCRs can enable steady growth of local economic benefits for OSW. Caution should be exercised to ensure LCRs don't reduce competition, increase cost and risk, and hold back market development for OSW.
- Key industry areas the South African government wants to prioritise for local development should be identified, supported by a current skills gap assessment. Plans to address skills gaps through education and training programmes should support these priority areas.
- Strengthening firm-level capabilities through cross-cutting policy initiatives geared towards technology transfer, lowering barriers to entry, improving the competitiveness of local firms, and broader socio-economic targets linked to employment creation.

South Africa's OSW industry must support the country's just transition agenda to achieve buy-in across government and broader social license. Firstly, the principle of procedural justice requires that all affected stakeholders, such as coastal communities, fishers and commercial shipping, are engaged early in the planning and, as necessary, throughout the project lifecycle in a meaningful way to address their concerns and build trust and support for new developments.

Secondly, developing an OSW industry will have a myriad of socio-economic impacts, both positive and negative. What is essential, however, is that these are distributed in a just manner that does not create an imbalance of winners and losers.

Finally, restorative justice focuses on addressing past injustices and improving community well-being. OSW development must comply with current policies and regulations to address past injustices and disadvantages.

3.6. REGULATORY FRAMEWORKS AND ROUTE-TO-MARKET

3.6.1. Regulatory, legal and permitting frameworks to facilitate development

Due to high capital expenditure and the long lead times and lifecycles of OSW projects, a practical, stable, and specific policy environment is essential for providing confidence and certainty for industry stakeholders to enter the market. The applicability and readiness of existing regulatory frameworks in South Africa have been assessed in the context of OSW development. This report outlines recommendations to achieve international good practice across seven regulatory aspects.

Although South Africa lacks specific policies or regulations tailored for OSW, its existing regulatory framework for renewable energy provides a foundation that is readily adaptable to accommodate OSW development. For example, South Africa's existing framework for environmental authorisations, which would also inform OSW consenting and permitting regimes, is well developed, and environmental impact assessment regulations are robust. In addition, several national government departments consider a range of policies applicable to OSW development.

However, to establish and support the development of an OSW market in South Africa, greater market scale and visibility, a clear site development process, and a process for grid connection will be needed (Table 5).

TABLE 5: SUMMARY OF THE MAIN REGULATORY, LEGAL AND PERMITTING FRAMEWORKS NEEDED TO ENABLE OSW DEVELOPMENT IN SOUTH AFRICA.

Market development stage	Regulatory aspect	Readiness of South African regulatory frameworks
Establishing market scale and visibility	Targets	No specific OSW targets in IRP, Integrated Energy Plan (IEP) or other relevant policy documents.
	Policies	There is no explicit mention of OSW in energy or industrial policy; no OSW-specific policies.
Facilitating site development	Marine spatial planning	Established marine spatial planning framework supported by legislation, but no designation of OSW development areas.
	Site investigation	Existing legislation and guidance related to reconnaissance for O&G, but no specific frameworks concerning OSW site surveys.
	Site exclusivity	There is no process or framework for granting or securing exclusivity of offshore sites for OSW development.
	Consenting and permitting, including the Environmental Impact Assessments	The existing permitting framework is robust, but should be updated to include OSW-specific requirements and streamlined to facilitate development.
Ensuring grid integration	Grid connection and market access	Existing regulatory frameworks guide grid connection and build-out but must be updated to support OSW development.

After securing political buy-in for the level of ambition for OSW development, the South African government should communicate this ambition by introducing a specific OSW deployment target through the IEP and IRP policies. The publication of the target should coincide with commitments to develop relevant policy frameworks and plans, such as South Africa's OSW development model and the government department(s) or agencies that will be collectively responsible for developing and implementing these. It will be essential to determine the roles and responsibilities of the public and private sectors at each stage in the development cycle and, for example, how each stage of the development process links to one another.

In particular, the government should clarify to the private sector which department(s) will facilitate the site development process — from MSP to authorising site surveys and granting site exclusivity — and how these processes and the responsible departments will work together. For example, there is a lack of clarity on the government department responsible for managing access to and granting exclusivity to the seabed for OSW development.

In addition, a comprehensive consenting and permitting framework for OSW will be required. This should include streamlining existing permitting processes for OSW projects, expanding existing EIA frameworks to consider OSW development and developing additional, South African-specific EIA needs not covered by international best practice.

Finally, the Grid Code governs grid connection and the provisions and plans of the Generation Connection Capacity Assessment (GCCA) and TDP guide upgrades. A vast transmission expansion programme is planned for future years to enable greater penetration of renewable energy into the grid. Including provisions for OSW capacity in future iterations of the TDP and wider transmission system regulatory frameworks is essential to ensure that sufficient grid capacity is available to align with OSW project development, and developers can adequately plan and price in grid integration.

3.6.2. Route-to-market and procurement options

A clear route-to-market, including viable revenue mechanisms for selling electricity generated by OSW projects, is essential for attracting investment and participation from developers and the wider industry.

Several different procurement mechanisms have been employed in mature and emerging OSW markets, including Contracts for Difference (CfD), Power Purchase Agreements (PPAs), Merchant projects and Feed-in Tariffs (FiT). South Africa already has a process for auctioning PPAs for renewable energy projects in the REIPPPP. Projects are assessed based on various factors, including price competitiveness and technical and economic feasibility, and successful projects are offered long-term PPAs with Eskom. In addition, bilateral private-sector PPAs, involving direct contracts between renewable energy developers and corporate entities, are increasingly used as a procurement option in South Africa since the amendment of regulations that has enabled a more competitive market. Bilateral PPAs provide long-term revenue certainty, thus reducing the overall project risk, and can be used to contract with significant consumers of renewable electricity, such as GH_2 developers and special industrial zones like the Atlantis Special Economic Zone, which includes a green manufacturing zone requiring clean energy.

Although PPAs are currently the most viable procurement mechanism under all growth scenarios, the first OSW projects are not expected to be commissioned until 2035. Therefore, while it can be assumed that PPAs, auctioned through the REIPPPP or negotiated bilaterally, would be suitable for the first OSW projects, consideration could be given to broadening the contracting options in future to include other options when a more competitive wholesale electricity market is established. For example, mechanisms like CfDs could encourage more participation in a competitive market by providing the necessary certainty. OSW projects could still be procured through processes like REIPPPP, but they could involve CfDs instead of PPAs.

To support the fast pace of development envisioned in these scenarios, the South African government is advised to consider designing and trialling a new OSW procurement mechanism by the mid-2030s, which could be applied in the latter half of the decade through 2050.

3.6.3. Health and safety regulation for installation, O&M and decommissioning

Health and safety are critical aspects of developing an OSW industry due to the inherently hazardous nature of marine environments and the complexity of OSW operations. For South Africa, developing robust health and safety frameworks for the OSW industry is crucial for fostering a sustainable, resilient, and socially responsible energy sector.

A review of the local and international guidance showed that while some guidelines cover areas of OSW development, these lack the detail and specificity required. Globally, the OSW industry has an established and comprehensive range of health and safety-related guidance from organisations such as the Global OSW Health and Safety Organisation (G+), the Global Wind Organisation (GWO), Det Norske Veritas, and the World Bank. Most international guidance has been specifically developed for the international OSW market. It provides a more specific response to health and safety in OSW than the regulations currently available in South Africa.

South Africa has extensive legislation relating to health and safety regulations, such as the Occupational Health and Safety Act (85 of 1993), its associated regulations, and the Maritime Health and Safety Regulations. While these regulations cover several general risks and hazards related to OSW development and operation, they are not specific and comprehensive enough to cover all requirements for OSW fully. Regulations under OHSA have been more generalised, applying to a range of occupations and risk or hazard contexts; a clear, thorough and central guidance document for the OSW industry in South Africa would remove ambiguity.

To address the gap between international guidance and existing local regulations, South Africa should adopt global best practices such as DNV and G+ Guidance and the CAP (Civil Aviation Publication) 437 for safe helicopter operations on offshore helidecks and implement mandatory training programs to ensure that installation, operations, and maintenance of OSW projects meet industry standards for health and safety.

Workers performing installation, operations, and maintenance activities in South Africa must be trained in working at heights, survival at sea, and first aid. In countries with established OSW markets, governments have introduced a requirement for OSW personnel to hold specific national accreditations or certificates; South Africa should also introduce additional training programs that align with international standards, such as the GWO Basic Training, designed for personnel involved in OSW operations.

3.7. BANKABILITY CONSIDERATIONS AND THE ROLE OF PUBLIC FINANCE

3.7.1. Bankability considerations

All OSW projects, especially those in emerging OSW markets, face cost challenges due to uncertainties and risks, such as incomplete and misaligned regulatory frameworks, unclear market prospects and lack of local supply chain capabilities. In the early stages of OSW development in South Africa, investors need to know that projects will be bankable.

For individual OSW projects to be bankable, an appropriate allocation of risk based on the expected return on investment is needed. Table 6 summarises the various bankability challenges that OSW projects in South Africa will likely face (discussed in more detail in the Bankability considerations Chapter).

The most significant challenges to project-level bankability in South Africa are:

- Lack of a clear policy (i.e. targets) and regulatory framework to enable OSW development;
- Lack of suitable routes to market;
- Lack of granular and high-quality wind speed data; and
- The capability of grid infrastructure to support the build-out of large-scale renewable energy.

Several measures can be taken to mitigate these challenges and others at the individual project level. However, many of these challenges can and should be addressed by the Government of South Africa and other public bodies at the market level (Table 6). For example, through the development of policies and a supporting regulatory framework to enable OSW development (see Bankability considerations).

As discussed in Section 3.6 and Chapter 16, a clear route to market is essential for project bankability. The government of South Africa will need to clarify to developers the procurement mechanisms for OSW projects and ensure that the procurement approach supports a consistent pipeline of projects over time. For example, the government should launch predictable offtake bidding rounds through the REIPPPP programme that are aligned with any new OSW targets and supply chain growth requirements. The government could also work with energy traders to aggregate demand for RE generation from multiple buyers (e.g. industrial consumers, utilities, etc.) and facilitate PPAs. If the government can provide targeted support at a market level in the early stages of OSW development, this will improve the baseline bankability across first-mover projects, which will, in turn, set a lower baseline LCOE. Likewise, any route-to-market must be supported by clear plans to upgrade the South African transmission system.

Table 6 provides an overview of the bankability challenges that OSW projects in South Africa are likely to face and high priority measures the South African government can take to address these challenges at a market level. Measures are prioritised based on ease of implementation, urgency of addressing, and impact on project bankability. For example, clarifying the route to market is critically important and will take time to resolve. Likewise, building the evidence base for OSW development through early-stage site surveys (targeted LiDAR campaigns) and research will also help improve the bankability of initial projects. See Bankability considerations for further details on medium and low priority mitigation measures.

TABLE 6: BANKABILITY CHALLENGES IN SOUTH AFRICA AND ASSOCIATED MITIGATION MEASURES.

Challenge	Ease of mitigation	Urgency of mitigation	Impact of mitigation	Overall priority	High-priority and quick-win mitigation measures
Development area conditions — wind	Moderate	High	High	High	**Commission wind measurement campaigns and facilitate data sharing among industry**
Development area conditions — metocean seabed	Moderate	Medium / High	High	Medium	Coordinate and strengthen national research initiatives to advance the local OSW market (*quick win*)
Environmental and social impacts	Easy / Moderate	Medium	Medium	Medium	Support studies to understand the likely impact of OSW development on local environmental receptors and biodiversity (*quick win*)
Technology	Moderate / Complex	Medium	Medium	Medium	*See the technical appendix for medium and low-priority actions.*
Revenue — route to market	Complex	High	High	High	**Ensure consistent and predictable scheduling of bid rounds under the REIPPPP program, aligned with any new OSW targets; Utilise energy traders to aggregate demand for renewable energy.**
Revenue — FX and inflation risk	Moderate	Medium	Medium	Medium	*See the technical appendix for medium and low-priority actions.*
Revenue — government credibility and credit ratings	Complex	High	Medium	High	**Create robust revenue frameworks and ensure that any counterparties to the developer revenue are chosen to minimise underlying revenue risk and exposure to low credit ratings.**
Grid — planning and capability of the infrastructure	Complex	High	High	High	**Integrate OSW in future iterations of the TDP and GCCA** **Prioritise grid upgrades in areas with promising floating OSW development first** **Continue developing options for private sector ownership of some aspects of the transmission infrastructure**

Challenge	Ease of mitigation	Urgency of mitigation	Impact of mitigation	Overall priority	High-priority and quick-win mitigation measures
Supply chain — workforce and facilities	Easy / Moderate	Moderate	Medium	Medium	Invest in catalysing local growth to maximise local economic benefit; Explore local tariffs and investment incentives to facilitate participation from the global supply chain (*quick win*)
Associated infrastructure — ports	Complex	High	High	High	**Develop plans and policies to catalyse port upgrades, focusing on the most appropriate ports for fixed and floating OSW.**
Market signals	Moderate	High	High	High	**Set OSW targets.**
Regulatory	Moderate	High	High	High	**Develop fit-for-purpose policies and frameworks.**

Addressing the regulatory framework, route to market, evidence base, and grid capacity is vital to improving project bankability. However, several other actions should be taken to support the overall development of the South African OSW market. These actions are outlined in Section 5: Recommendations.

3.7.2. Public and concessional finance

Public finance (including concessional finance) can help increase the attractiveness of the local market for OSW developers and accelerate deployment. Including public financial support can signal a commitment to developing OSW, providing greater certainty to investors. There are broadly two types of interventions: some target fundamental barriers, like port infrastructure for floating OSW, essential for large-scale OSW deployment; others ensure that OSW delivers local benefits, is economically efficient, and supports the just transition, such as by boosting regional supply chains.

The South African government should review how it can mobilise international and domestic public funding for future OSW development, considering its specific risk factors, such as limited borrowing and absorptive capacity. The government should assess available funding sources and focus on the most impactful areas for OSW development, considering local challenges and risk factors.

Based on an initial review of investment opportunity areas, success criteria for public finance, and recent examples of public financing mechanisms used in South Africa for infrastructure development and those used for OSW projects globally, we identified the following areas that would particularly benefit from public financing for OSW development in South Africa and merit additional investigation:

- Upfront site investigations, such as LiDAR campaigns, should be prioritised for public financing as a *quick win* to support industry participation. Investments here could significantly reduce costs and risk while increasing developer interest and improving deployment timelines. Sharing these findings publicly can enhance transparency, making the market more accessible and appealing to potential developers.

- Public financing can be pivotal in supporting the early development of floating OSW sites and infrastructure development in South Africa. For example, port upgrades are a significant investment but essential for floating OSW deployments and are a vital barrier to commercialising floating OSW in South Africa.
- Targeted investment in local supply chain development would stimulate local industry, reduce costs, and enhance the overall feasibility of South African OSW projects. By focusing public funds on infrastructure development, skills training, and early-stage project development, the government can create a supportive ecosystem that fosters the growth of the OSW sector and attracts further private investment.
- Further investigation and a better understanding of supply chain needs will help to evaluate the costs of other investment options, such as industry hubs. While initiatives like the Humber Offshore Wind Cluster in the UK offer long-term benefits by centralising OSW manufacturing and maintenance, they are not an immediate priority and should be considered as the market matures.

As the OSW sector in South Africa matures, investment priorities should be regularly reviewed to adapt to new market needs. This will ensure ongoing risk reduction and cost efficiency for developers while supporting South Africa's just transition.

4. RECOMMENDATIONS

The South African government, alongside leaders in industry and the non-profit sector, should consider the following actions to scale up the country's OSW market. These actions will need to take place over the short-term (i.e. in the next five years) to ensure that the first OSW projects can be commissioned by 2035. Many of these actions would need to be led by the South African government, and they would also require active participation from industry.

Note that the actions — categorized under each of the four pillars described in *Key Factors* — have been given a unique numbering code in the form (section — number) for the no-regret actions, and (section — number — scenario) for actions that are specific to the three growth scenarios. For example, REG1 is the first no-regret action in the Regulatory chapter, and SC5–MED-HIGH is the fifth action in the Supply Chain chapter and relates to the medium and high growth scenarios.

4.1. NO-REGRET ACTIONS

Strategy and policy: Vision and volume targets

- **REG1.** The department responsible for energy and electricity planning (DEE) should set the long-term vision and objectives for OSW development to 2050 by establishing OSW targets in the IEP and IRP and identifying the deployment trajectory needed to achieve these. This process should be done in a just manner by being transparent and inclusive of key stakeholders to signal the government's commitment to the sector.
- **REG2.** Key government departments, like DEE and DFFE, should determine and designate clear roles and responsibilities for facilitating site development (designating OSW development areas through MSP, site exclusivity, and leasing).
- **FIN1.** Key departments, such as the National Treasury, DEE, and the Presidency, should determine how to best leverage public and concessional financing opportunities for no-regret actions (primarily related to port and grid infrastructure) and align these with the JET-IP and other existing mechanisms.
- **SC1 / JT1.** The DEE should work with the Department of Higher Education, institutions of higher learning and training (including Technical and Vocational Education and Training (TVET) colleges and Sectoral Education and Training Authority (SETAs), and industry bodies to undertake a comprehensive skills assessment for the OSW industry, identifying existing and transferable skills that can be leveraged, and key gaps.
- **JT2.** Following (SC1 / JT1), The Department of Trade, Industry and Competition (DTIC) should explore how upskilling the domestic workforce and building the local supply chain can support distributive justice in the South African OSW industry. This work should be informed by the government's long-term vision for OSW development and consider how to balance international and domestic supply to manage the cost of energy generation and its impact on consumers.

Frameworks: Site development and power purchase

- **REG3.** Following REG2, the relevant government department(s) should establish or update the regulations and frameworks for site investigation, granting site exclusivity, leasing the seabed, etc., aligning these processes with existing provisions while tailoring them to meet international standards and the overall development model. These should be aligned to international best practice and incorporated into the Energy One Stop Shop (EOSS) mandate to expedite and streamline the OSW regulatory process.
- **REG4.** In parallel to progressing the actions set out in REG3, the responsible government departments (defined in REG2) should lead the process of determining and implementing the most suitable development model for South Africa's OSW market. Given the evolving nature of market dynamics and the various factors that influence the choice of model, this decision must be made with flexibility in mind, allowing for adjustments over time.
- **REG5.** DEE, DFFE and other relevant government departments and agencies should revise existing marine spatial planning frameworks to allow for the designation of OSW development areas, and the relevant department (REG2) should formally designate suitable areas based on the best available evidence and potential impacts, aligning with the wider development model (REG4) and regulatory framework (REG3).
- **E&S1.** The DFFE should seek to incorporate OSW development as a critical component in future iterations of the National Coastal and Marine Spatial Biodiversity Plan (NCMSBP).
- **E&S2 / GEO1.** Key government departments, like DEE and DFFE, should engage with the International Maritime Organisation, the South African Department of Transport (DoT) and the South African Maritime Safety Authority (SAMSA) to improve the coordination and structure of shipping movements (shipping lanes) alongside MSP. A desktop study of shipping and offshore wind interaction in South Africa should be leveraged as a supportive precursor to this engagement.
- **REG6.** DFFE should conduct a detailed gap analysis of current EIA processes in South Africa compared to international standard procedures for OSW development and establish a process to address gaps. Further research should also identify any additional South African-specific EIA needs not covered by global best practices.
- **REG7.** The government should fine-tune REG2-5 such that they support the appropriate growth scenario, revisiting any frameworks regularly, and at least by 2035, after initial projects have been developed.
- **REG8 / JT4.** DEE, DFFE and other relevant government departments and agencies should work together to establish guidelines for developer-led stakeholder engagement aligned with consenting frameworks and JET principles, to reduce consenting bottlenecks, avoid ineffective engagement and improve the social license for development.
- **PRO1.** Industry bodies representing developers, off-takers, and the financial sector should collaborate to develop a framework that makes bilateral PPAs as attractive to developers as possible. This would include creating frameworks that ensure the counterparty is creditworthy and allow OSW to be competitive in price with onshore wind and solar. Concessional finance could support this aim.

- **PRO2.** The DEE should incorporate OSW bid rounds, aligned with the OSW targets that would have been included in the IRP (REG1), into the REIPPPP framework.
- **H&S1.** The Department of Employment and Labour (DoEL) should collaborate with relevant authorities, such as the South African Maritime Safety Authority, to update existing legislation (Occupational Health and Safety 1993, Maritime Health and Safety Regulations) or, if appropriate, develop new regulations and guidance to ensure that the design, installation and O&M of OSW projects meet global industry standards for health and safety.

Delivery: Upgrading the evidence base, skills and infrastructure

- **SCEN1.** The DEE should carry out a time-series analysis, comparing the temporal profile of OSW, onshore wind and solar PV to identify complementarities in their outputs and to inform target-setting (REG1) and wider energy system planning.
- **BANK1.** Key departments such as DEE, DFFE, and Department of Science and Innovation (DSI) should collaborate to build up the evidence base for OSW development, as a quick win to improve bankability of initial projects and the market more broadly. Critical evidence can be gathered through the commissioning of LiDAR campaigns, targeted surveys and early-stage research on environmental receptors in South Africa, around the likely fixed OSW (Coega, Saldanha Bay — West Coast) and floating OSW (Saldanha Bay — West Coast, Durban — Richards Bay) development areas.
- **MET1 / FIN2.** As a quick win, the government should leverage concessional and donor funding for offshore measurement campaigns. Key government departments such as DEE, DFFE or Department of Science and Innovation should collaborate to commission a comprehensive metocean measurement campaign at key offshore locations, critical for informed decision-making in the early phases of OSW development.
- **GEO2.** In addition to collecting more comprehensive wind and metocean data (see MET1) a desktop appraisal of seabed conditions, building on existing geological and physical process knowledge, should be carried out and incorporated into any future constraints analysis.
- **MET2.** South African research institutions should work with DSI to coordinate research and development on the impact of South Africa's unique metocean conditions on wind projects, positioning the country as a leader in developing and testing advanced OSW technologies. These institutions should partner with international researchers with an established track record in OSW technologies (e.g. floating OSW systems) to develop expertise.
- **MET3.** Research institutions in collaboration with the DSI, SABS and other relevant government departments, should assess the performance of specialised maritime equipment required for OSW projects, ensuring it can meet the operational challenges posed by South Africa's sea states and align technology development efforts with countries that have similar oceanographic conditions.
- **E&S3.** The relevant authorities, representative bodies and research organisations should commission species monitoring campaigns (especially for seabirds) to determine high-risk species and habitats that need to be avoided, improve data gaps, plan OSW development, and inform EIAs.

- **E&S4.** In support of REG5, the DFFE should undertake a Strategic Environmental Assessment (SEA) for OSW development in South Africa to facilitate responsible and efficient decisions on OSW development projects. This will extend an evidence base for supporting development decisions to the marine environment (see https://screening.environment.gov.za/screeningtool).

- **GEO3.** Research institutions, relevant authorities and representative bodies should conduct further analysis to explore the potential benefits and impacts of OSW development on South Africa's unique ecosystems and existing marine activities. This research should aim to identify opportunities for coexistence or co-benefits alongside OSW development, such as protecting fish spawning areas.

- **GRD1.** The NTCSA should conduct a detailed grid study to determine the necessary upgrades to ensure sufficient grid capacity in the supply areas of identified OSW sites. This study should align with OSW targets set in planning policies (such as the IRP), include upgrade costs, timelines and certainty. Development of a time series OSW plant simulation would likely facilitate this planning effort.

- **GRD2.** Based on this study and the grid study in GRD1, the NTCSA should account for OSW development in upcoming TDP iterations and outline necessary upgrades.

- **PORT1.** DEE should work with the Transnet National Ports Authority (TNPA) to conduct a feasibility study to understand the detailed requirements, costs and business case for establishing the Port of Saldanha Bay as a fully operational OSW port.

- **SC2 – 4.** Industry bodies, project developers, the Department of Higher Education, and institutions of higher learning and training, including TVET colleges and SETAs, should:

    - **SC2.** Strategically plan for skills needs and education and training for the OSW industry; for example, through Sector Skills Plans developed by Energy and Water Sector Education and Training Authority (EWSETA) and Manufacturing, Engineering and Related Services Sector Education and Training Authority (MERSETA). Include OSW in university and TVET college-level programmes.
    - **SC3 / H&S2.** Expand the existing GWO courses available in South Africa by introducing and offering additional training programs that align with international standards, including the GWO Basic Training designed for personnel involved in OSW operations. Require personnel involved in OSW operations to hold specific certificates aligned with international standards.
    - **SC4.** Invest in training and education programmes and leverage existing skills development initiatives to equip the local workforce with the necessary skills to participate in the OSW industry. The focus should be on planning and development, operations and maintenance, and manufacturing.

- **JT3.** Invest in education and training to build local capabilities and ensure a just transition. This is important for both grassroots skills development and labour transitioning from other industries, especially sunset industries such as coal mining and coal-fired power generation.

- **FIN3.** Key departments, such as the National Treasury, DEE, and the Presidency, should continually review investment priorities as the market matures and other areas need funding. As a priority, these departments should identify mechanisms to provide financial support to early-stage OSW projects. Public finance can play a crucial role in risk reduction; therefore, the options, barriers and benefits should be analysed frequently.

FIGURE 12: TIMELINE OF NO-REGRET ACTIONS RECOMMENDED TO FACILITATE THE DEVELOPMENT OF LOW GROWTH AND PATHFINDER OSW PROJECTS (WHERE PD1 IS PROJECT DEVELOPMENT YEAR 1), ASSUMING THEY ARE COMMISSIONED IN 2035.

No-regret				2025	2026	2027	2028	2029	2030	2035
Strategy and policy	Vision and volume targets									
		REG1	Set vision and targets for scale of development to 2050							
		REG2	Designate roles and responsibilities across government							
		FIN1	Identification and mobilisation of public finance							
		SC1 / JT1	Undertake a comprehensive skills assessment							
		JT2	Explore role of domestic workforce and supply chain							
Frameworks	Site development and power purchase									
		REG3	Establish, update frameworks for site development, grid connection							
		REG4	Determine suitable development model							
		REG5	Designate OSW development areas through existing MSP frameworks							
		E&S1	Integrate OSW development areas into existing MSPs							
		E&S2 / GEO1	Coordinate shipping activity to maximise development areas							
		REG6	Assess and address gaps in existing EIA process							
		PRO1	Collaborate to establish process for bilateral PPAs							
		PRO2	Incorporate OSW bid rounds into REIP							
		H&S1	Update health and safety legislation							
Delivery	Upgrading the evidence base, skills and infrastructure									
		SCEN1	Assess temporal complementarity of OSW, onshore wind and solar PV							
		BANK1	Build up the technical and environmental evidence base							
		MET1 / FIN2	Leverage concessional funding for key OSW surveys							
		GEO2	Carry out a desktop appraisal of seabed conditions							
		MET2	Support research efforts on South Africa's metocean conditions							
		MET3	Assess the performance of specialised maritime equipment required for							
		E&S3	Commission species monitoring campaigns							
		E&S4	Undertake a Strategic Environmental Assessment (SEA) for OSW							
		GEO3	Support research and analysis of co-existence and co-benefits							

No-regret				2025	2026	2027	2028	2029	2030	2035
Delivery	Upgrading the evidence base, skills and infrastructure	GRD1	Conduct detailed grid study to identify upgrades for OSW development							
		GRD2	Include OSW grid upgrades in future TDP iterations							
		PORT1	Conduct feasibility study on the Port of Saldanha Bay.							
		SC2	Make plans to address skills/training needs for OSW							
		SC3 / H&S2	Expand GWO courses available in South Africa							
		SC4	Leverage existing skills development initiatives							
		JT3	Invest in education and training to support a just transition							
		FIN2	Review investment priorities as the market matures							
			First projects				PD1	PD2	PD3	PD8

4.2. ACTIONS TO REACH MEDIUM AND HIGH GROWTH SCENARIOS

Strategy and policy: Vision and volume targets

- All *no-regret* actions, and;
- **REG9 – MED-HIGH.** The government should revisit and refresh targets, development approaches and related OSW policies regularly to ensure they are fit-for-purpose with respect to national progress and global developments.
- **SC5 – MED-HIGH.** Key government departments such as the DTIC and National Treasury should implement policies that catalyse supply chain development to encourage local market investment. For example, tax incentives, grants, and subsidies for companies that invest in local manufacturing and supply chain capabilities. Engage with global OEMs early and often to encourage participation in the local market.
- **P2X1 – MED-HIGH.** Conduct further analysis to estimate the cost of producing green hydrogen using a combination of OSW and solar PV as electricity sources, in order to assess the cost competitiveness of these technologies.
- **P2X2 – MED-HIGH.** The DTIC should consider including provisions for OSW in the green hydrogen strategy and sector development plans.

Frameworks: Site development and power purchase

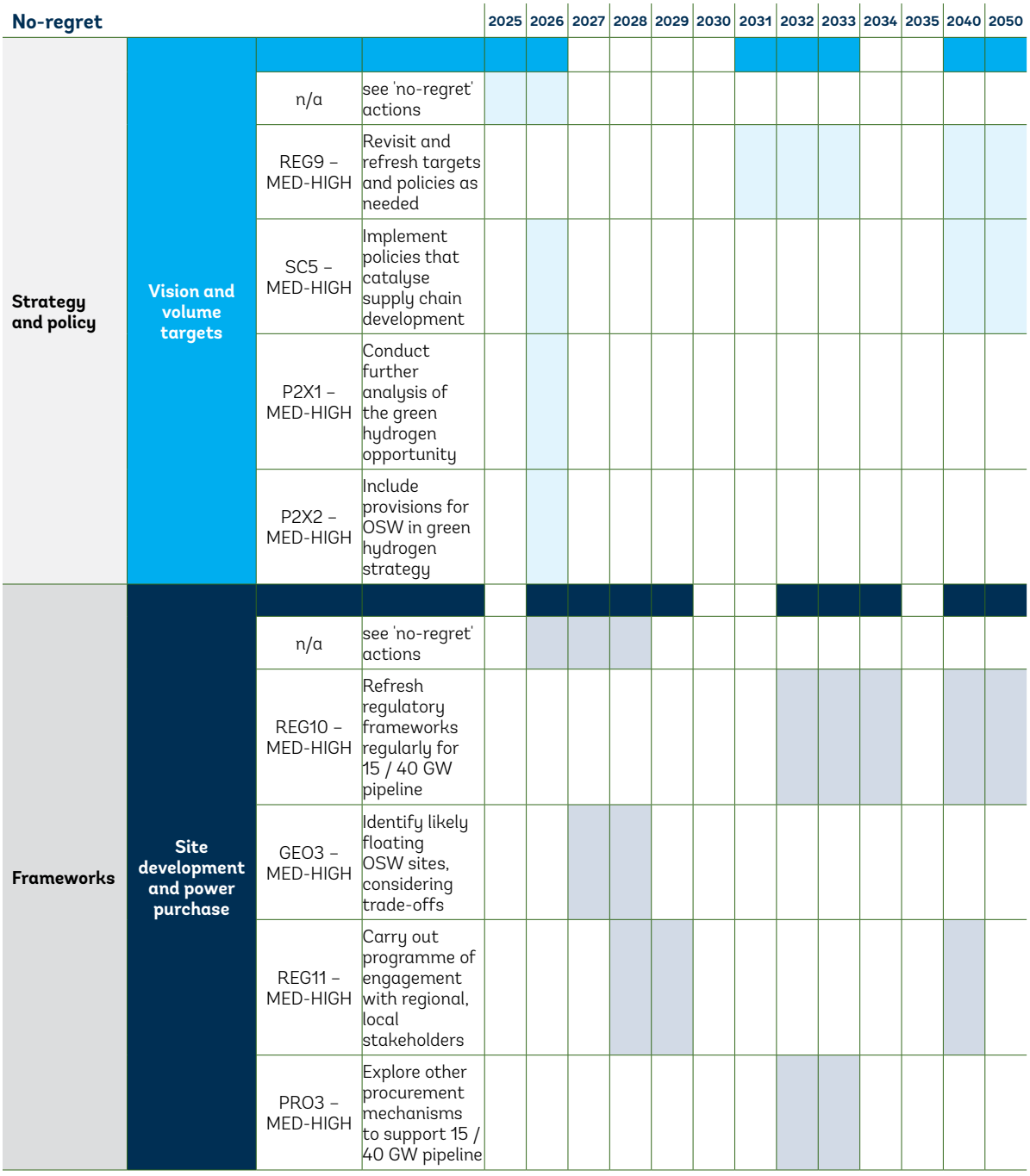
- All *no-regret* actions, and;
- **REG10 – MED-HIGH.** The government should refresh the aforementioned regulatory frameworks to support 15 GW (medium growth) or 40 GW (high growth) by 2050, communicating changes and developments to the industry with significant advance notice.

- **GEO4 – MED-HIGH.** Building on REG5 and with consideration of REG9, the DEE and DFFE should work together, alongside other relevant departments and agencies, to identify future floating OSW development areas by comparing projected LCOE to the cost of grid upgrades to further understand investment trade-offs, using this to inform future leasing rounds.
- **REG11 – MED-HIGH.** Proactive community engagement and consideration of other community benefits arising from OSW development should be undertaken to ensure that economic injustices are not exacerbated. For example, consideration of community enterprise development and socio-economic development projects.
- **PRO3 – MED-HIGH.** To support the continued growth of the industry, the government of South Africa should work with industry to develop revenue support mechanisms which procure energy at the lowest possible price, but also provide revenue certainty to developers, thereby lowering risk and cost. These could be CfD-type mechanisms or similar. A thorough review should determine, if required, the source of funding covering the price difference between strike prices and market prices required for CfDs.

Delivery: Upgrading the evidence base, skills and infrastructure

- All *no-regret* actions, and;
- **GRD3 – MED-HIGH.** The National Transmission Company of South Africa (NTCSA), in collaboration with relevant government departments, should assess the cost of grid upgrades against P2X costs and options, particularly with respect to OSW development around Saldanha Bay, Boegoebaai and Richards Bay.
- **E&S5 – MED-HIGH.** The DFFE should consider expanding tools that guide project-level assessments (e.g. Environmental Impact Assessments), like the National Web-based Screening Tool, to include the marine environment.
- **FIN4 – MED-HIGH.** DTIC should undertake further investigation into where the government can optimise funding to catalyse investment in the supply chain and reduce costs. This will help to understand the benefits and costs of other options, such as hubs and floating OSW needs.
- **JT4 – MED-HIGH.** In support of SC5 – MED-HIGH, DTIC should develop initiatives geared towards strengthening the capabilities of domestic firms while promoting technology transfer, lowering barriers to entry, and improving the competitiveness of these firms.
- **SC6 – MED-HIGH.** DTIC should leverage SEZs, such as the Atlantis SEZ, or establish industry hubs and clusters to support industry growth by centralising OSW manufacturing, assembly, and maintenance.
- **PORT2 - MED-HIGH.** To support medium and high growth scenarios, the government and relevant authorities such as the DEE and TNPA should carry out a more detailed analysis of port suitability and upgrade feasibility, using this to inform a long-term strategy for port development and financing and upgrade ports to accommodate floating OSW fabrication starting from 2040.

FIGURE 13: TIMELINE OF ADDITIONAL ACTIONS RECOMMENDED FOR ACHIEVING THE MEDIUM AND HIGH GROWTH SCENARIOS, COMPARED TO CUMULATIVE INSTALLED CAPACITY IN 2035, 2040 AND 2050.



No-regret				2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2040	2050
Delivery	**Upgrading the evidence base, skills and infrastructure**	n/a	see 'no-regret' actions													
		GRD3 – MED-HIGH	Assess grid upgrade costs against P2X costs and options													
		E&S5 – MED-HIGH	Support expansion of tools that guide project-level assessments													
		FIN4 – MED-HIGH	Assess where public funding could catalyse cost reduction													
		JT4 – MED-HIGH	Develop new initiatives to strengthen domestic OSW capabilities													
		SC6 – MED-HIGH	Leverage SEZs and/ or establish industry hubs													
		PORT2 – MED-HIGH	Develop and action strategy for additional port development													
Cumulative installed capacity (GW) | Medium growth														**1**	**5**	**15**
| High growth														**1**	**8**	**40**

SUPPORTING INFORMATION



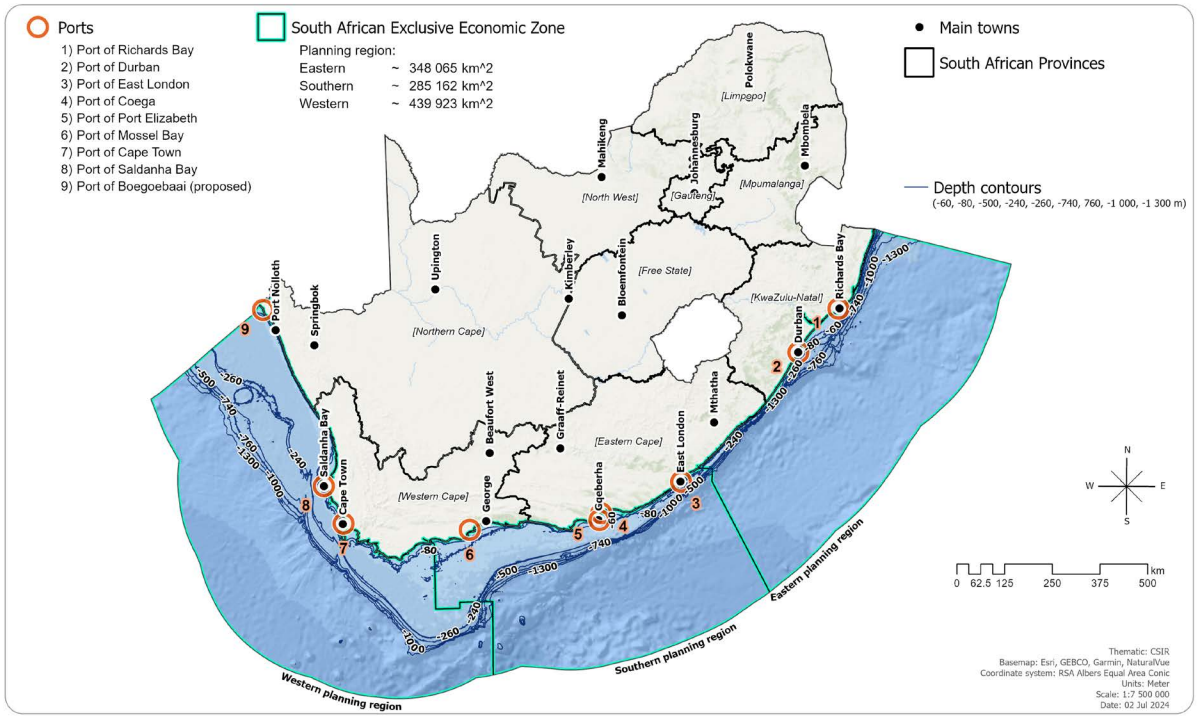
5. ENVIRONMENTAL AND SOCIAL CONSTRAINTS

5.1. PURPOSE

The South African EEZ has a wide range of marine biodiversity and ecosystems, managed through a unique regulatory regime that includes governance of marine services such as shipping, naval activities and fisheries.

This chapter provides a high-level overview and description of the environmental and social considerations for planning OSW development in the South African EEZ (Figure 14). This chapter focuses on offshore (marine) considerations rather than onshore considerations.

FIGURE 14: SOUTH AFRICA EXCLUSIVE ECONOMIC ZONE.



5.2. METHOD

A literature review of the applicable national laws, policies, regulations, and environmental, social and technical considerations associated with OSW development, installation, and operation was undertaken. This included information from The Biodiversity Consultancy (refer to Appendix 2), the World Bank's Environmental and Social Framework (ESF), previously published World Bank Offshore Wind Roadmap studies, and an OSW spatial data inventory collated by the Council of Scientific and Industrial Research (CSIR).[30]

From this literature review, we developed a list of environmental and social considerations (or constraints) and other relevant technical considerations for OSW development. Where freely available, spatial data for the environmental, social and technical features were collated. Some datasets were not obtainable for the study but are highlighted in this chapter as necessary for further review.

A RAG rating framework was used to determine the impact that OSW development would likely have on each constraint (see in Chapter 6: Geospatial Analysis). These categories were defined based on previous World Bank OSW Roadmap studies, The Biodiversity Consultancy's report, our expert opinion, and early engagement with relevant South African stakeholders.

An assessment of the following informed the final ratings for each consideration:

- How the consideration is treated in South African law and regulation.
- The spatial and temporal trends across the entire EEZ in the three established marine planning areas (Figure 15), and in the identified OSW development zones (refer to Chapter 6: Geospatial Analysis).
- The potential impact of OSW development and any options to mitigate that potential impact, adhering to the restorative justice principle through fostering community engagement, addressing environmental concerns, and promoting equitable outcomes for affected stakeholders.

Procedural justice requires identifying and including relevant and affected stakeholders to ensure their interests and concerns are considered. Their participation should also be transparent by allowing access to relevant information and opportunities to provide input and feedback. To this end, a diverse range of priority stakeholders and stakeholder organisations were identified. A stakeholder engagement workshop discussed the rating framework and definitions, the environmental, social, and technical considerations list, and the allocated ratings for each. During the workshop, stakeholders participated in an anonymous poll to indicate their level of agreement with the definitions and draft ratings. The organisations represented at that workshop included:

- Africoast Engineers
- Birdlife South Africa (BLSA)
- Coega Development Corporation
- Department of Mineral Resources and Energy
- East London Industrial Development Zone

- Endangered Wildlife Trust (EWT)
- FishSA
- Hive
- Northern Cape Department of Agriculture, Environmental Affairs, Rural Development and Land Reform
- PetroSA
- Richards Bay Industrial Development Zone
- Sky Consulting
- South African Maritime Safety Authority (SAMSA)
- South African National Parks (SANParks)
- Stellenbosch University (Aquaculture Association South Africa (AASA)
- Transnet Ports Authority (TNPA)
- University of the Western Cape
- Western Cape Department of Environmental Affairs and Development Planning

It is noted that the list of stakeholders engaged above is not exhaustive, but rather represents an initial group engaged during the early conceptualisation of *A Strategic Framework for Offshore Wind Development in South Africa.*

5.3. RESULTS AND DISCUSSION

5.3.1. Red-Amber-Green analysis

The critical environmental (e.g. biophysical, biodiversity and ecosystems) and social (other activities in uses of the marine environment) considerations are outlined in Table 7.

Many important natural marine habitats are potentially sensitive to impacts from developments such as OSW. As has been common in international experience, the areas that are most sensitive and have significant biodiversity value should be avoided in favour of areas with similar properties for wind energy generation but with low impact.

In addition to avoiding the most sensitive areas, the wind industry has developed several technical mitigation measures in other markets to reduce impacts further. These mitigation measures include modifying wind turbine operations in the presence of birds and bats [31] and using bubble curtains to limit noise disturbance to marine mammals during OSW turbine foundation installation.

To implement appropriate mitigation measures in South Africa, a robust regulatory and Environmental Impact Assessment (EIA) framework for OSW is required. The EIA process should consider guidance and clear environmental assessment and monitoring requirements, especially when developments are proposed near sensitive areas and important natural habitats.

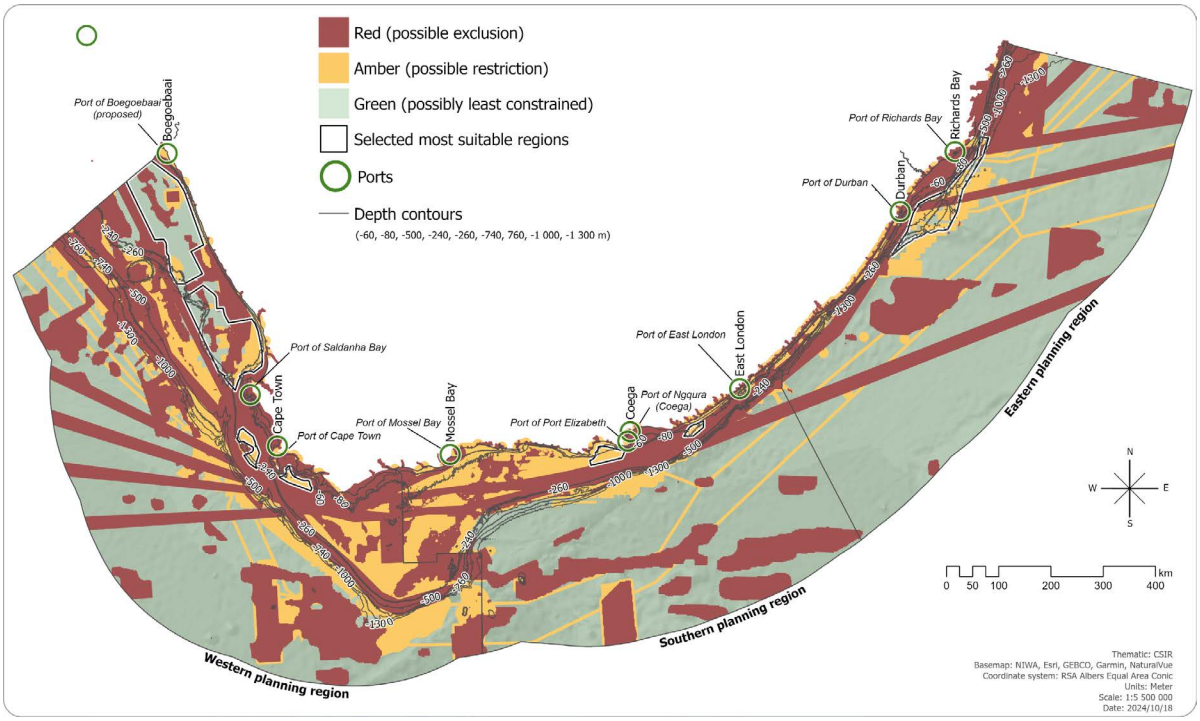
TABLE 7: SUMMARY OF ENVIRONMENTAL AND SOCIAL FEATURES THAT NEED TO BE CONSIDERED FOR OSW PLANNING AND DEVELOPMENT.

Features for which spatial data was not obtainable or used for the study are indicated with an asterisk (*). Features for which spatial data were obtained or derived for the Study but are not open source are marked with a hash (#).

	Feature	RAG	Summary of Consideration
1	Marine Protected Areas (MPAs)[32]	R	Environmentally designated sites of regional, national, and international significance, such as Biosphere Reserves, OECM, and most importantly, South African Marine Protected Areas (MPA).
2	National Protected Areas Expansion Strategy (NPAES) focus areas [33]	A	Priority areas identified for expanding MPAs to improve ecosystem representation in the South African protected area network towards ecosystem and climate resilience.[34]
3	National Coastal and Marine Spatial Biodiversity Plan [35] Critical Biodiversity Area (CBA) — Natural	R	The most comprehensive South African spatial plan for the natural coastal and marine environment, designed to inform planning and decision-making in support of sustainable development.[36] CBAs are natural or near-natural areas required to contribute to meeting biodiversity conservation targets features and to ensure that a viable, representative sample of biodiversity can persist. ESAs are areas where further deterioration in ecological conditions must be avoided.
	CBA — Restore	A	
	Ecological Support Area (ESA)	A	
4	Ecologically or Biologically Significant Marine Areas (EBSAs) [37]	A	Environmentally designated sites of regional, national, and international significance, such as marine parks and sanctuaries, which are under increasing anthropogenic threat.[38]
5	Key Biodiversity Areas (KBA)*,# [39]	A	Environmentally designated sites of regional, national, and international significance, such as marine parks and sanctuaries, are considered high-risk areas. Updated South African seabird KBAs have been proposed.#[40] An update to South African marine KBAs is underway*[41]
6	Marine Important Bird Areas (MIBAs)# [42]	R	Core bird habitat for African penguin, Cape gannet, Cape cormorant [43], and MIBAs include seabird breeding colonies, foraging areas around breeding colonies, non-breeding concentrations, migratory bottlenecks and feeding areas for pelagic (aquatic) species
7	Important Marine Mammal Areas (IMMAs) [44]	A	IMMA are discrete portions of habitat critical to marine mammal species that have the potential to be delineated and managed for conservation
8	Important Shark and Ray Areas (ISRAs) [45]	A	ISRAs are discrete, three-dimensional portions of habitat significant for one or more species of shark, ray, or chimaera species that have the potential to be delineated and managed for conservation
9	Ramsar Sites [46]	R	Ramsar sites are wetlands of international importance designated under the Ramsar Convention on Wetlands criteria for containing representative, rare or unique wetland types or for their importance in conserving biological diversity.
10	Estuaries [47]	R	Estuaries comprise less than 2% of South Africa's territory but are highly productive ecosystems that contribute R4.2 billion annually to the South African economy.[48] They support biodiversity, livelihoods, marine fisheries, tourism and recreation.
11	Mangrove ecosystems [49]	R	Mangrove ecosystems provide critical ecosystem services such as storm surge attenuation, carbon storage, and wood for building houses and fish traps.[50]

	Feature	RAG	Summary of Consideration
12	Coral reefs [51]	R	Coral reefs, especially on the east coast of South Africa near Durban and Richards Bay,[52] support a diving and fishing industry in addition to other ecosystem services such as biodiversity refuge.
13	Fauna species*	A	This feature includes mammals, turtles, and other marine fauna sensitive to survey, construction, and operational activities.
14	Coastal and underwater heritage [53]	R	Shipwrecks, shell middens, fish traps, and other recorded coastal and underwater features of cultural or heritage significance protected by the National Heritage Resources Act (No. 25 of 1999).[54]
15	Tourism areas (Blue Flag sites [55])	A	Tourism is driven by ecosystem services provided by biodiverse and unique ecosystems like estuaries and coral reefs, which support recreational activities (e.g. scuba diving, fishing, and birding). Any significant viewpoints (landscape, seascape, or visually significant landforms/structures) that will be affected by the visual impact of wind turbines and associated facilities, such as transmission lines and substations. South Africa has many recognised Blue Flag [56] sites, which are awarded to beaches, marinas, and sustainable boating tourism operators based on exceptional environmental, educational, safety, and accessibility.
16	Fisheries [57] and aquaculture# [58]	A	Comprises commercial fishing areas and small-scale fisheries for individual households or communities. Commercial fisheries occur all along the South African coastlines, but key fishing harbours are found in the Western Cape. Areas for coastal aquaculture and mariculture of fish, shellfish, and seaweed in the country. National Aquaculture Development Zones (ADZs) have been identified and proposed but have not yet been adopted in South African law.
17	Shipping routes[59]	R	Consists of shipping routes across the entire EEZ, the South African coastlines, and between multiple ports.
19	Subsea telecoms and internet infrastructure# [60]	A	Comprises of telecommunication and internet cables.
20	Aviation [61]	A	Comprises local and international airports, flight paths, restricted air space, and related radar systems.
21	Seismic activity# [62]	A	Offshore seismic activities that may pose a risk to the integrity of OSW infrastructure.
22	Petroleum* [63] and mining#	A	Permits and rights issued in the South African EEZ for petroleum (oil and gas) related activities. Mining mainly comprises commercial marine diamond mining relatively nearshore along the west coast of South Africa. Beach, diver-based, offshore and phosphate mining occurs to a lesser extent.[64]
23	Military / Navy areas*	A	Naval bases at Durban and Simon's Town and navy training units in the Western Cape. The extent of military exercises at sea could not be obtained.
24	Dredging*	A	This comprises sea dredging occurring nearshore along the coastline around Durban and Richards Bay and may be expected at other South African ports as part of maintenance activities.[81]

FIGURE 15: RAG RATINGS APPLIED TO CONSIDERED ENVIRONMENTAL AND SOCIAL FEATURES WITHIN THE THREE MARINE PLANNING AREAS OF THE EEZ.



5.3.2. Environmental considerations

South Africa has a wide range of biodiversity and ecosystems, specifically marine ecosystems. South Africa's marine ecosystems support more than 13,000 species and have amongst the highest marine endemism in the world after New Zealand and Antarctica. They provide services that benefit the well-being of the country's economy and inhabitants, especially for coastal communities. However, many of these ecosystems are under increasing pressure from fishing, reduced freshwater flow, pollution, coastal development, mariculture and mining.

South Africa has made significant strides in describing and mapping the marine environment towards prioritising critical environmental features of conservation value (e.g. MPAs, CBAs, MIBAs). Available local datasets are further complemented by several global and regional information sources.

5.3.2.1. Marine Protected Areas

The International Union for the Conservation of Nature (IUCN) defines protected areas as designated geographical spaces managed through legal or other effective means to ensure long-term nature conservation.[65] MPAs are formally protected under South African law. No activities may be undertaken in MPAs without permission from the Minister of Environment, Forestry and Fisheries. Section 9 of the National Environmental Management: Protected Areas Act (NEM: PAA) [66] further states that:

"Despite any other legislation, no person may in a marine protected area —

(f) carry on any activity which may have an adverse effect on the ecosystem of the area;

(g) construct or erect any building or other structure on or over any land or water within such a marine protected area;

(j) sink or scuttle any platform, vessel or other structure."

Legally protected areas in South Africa comprise 9.26% of land and 15.5% of marine areas.[67] The South Africa EEZ comprises areas in both the South Atlantic and the Indian Ocean, with a meeting point between the two at Cape Agulhas. Within this area, 42 spatially discrete MPAs cover a cumulative 23,905,000 ha and 65 coastal 'Nature Reserve' and Protected Environment' protected areas cover 125,646 ha (refer to Appendix 2 for more details on South African MPAs). The National Protected Areas Expansion Strategy (NPAES) identifies priority areas for the statutorily protected area network expansion, focusing on under-protected ecosystems. Within the South African EEZ, several proposed expansion areas exist that are not currently protected but may be negotiated for future proclamation. This intention is further solidified by South Africa's support of the 30x30 target of the Kunming-Montreal Global Biodiversity Framework as party to the Convention on Biological Diversity.[68]

Although OSW development may not be entirely incompatible with MPAs (internationally, there are examples of colocation between OSW farms and MPAs [69]), the outcomes of OSW development can vary across different ecosystem types and the services they provide.

Potential impacts to MPAs from OSW development include:

- Disturbance to and loss of the ecosystems and species the MPAs were established to protect, compromising South Africa's ability to meet its conservation obligations and ambitions and potentially associated compromised tourism and recreation value.
- Installing wind turbine bases and submarine cables can disturb the seabed and temporarily increase suspended sediments in the water column, which may lead to a decrease in water quality, which could affect marine species.
- Increased abundance, biomass, and size of species around infrastructure components (e.g. foundations) due to provision of artificial habitat with new infrastructure, space for fish nurseries and increased food resources. There is potential that this includes establishment of invasive species.
- Compromised marine water quality in the event of chemical spills (e.g. oil and fuel) from vessels and turbine infrastructure during construction, maintenance and operations, which results in knock-on effects to marine fauna and flora.
- Increased biodiversity due to the exclusion of fishing and other marine activities (where currently lawfully allowed and permitted in MPAs).

Ecosystem interactions are complex and quantifying how local changes interact and scale to an ecosystem level is challenging. Several research efforts are ongoing to understand the impacts of OSW development across a range of spatial scales.[70] [71] Due to their potential impacts, MPAs have been given a red RAG rating on a precautionary basis.

5.3.2.2. Areas of conservation value

The National Coastal and Marine Spatial Biodiversity Plan (NCMSBP)[72] for South Africa, developed through a systematic biodiversity conservation planning process, aims to inform planning and decision-making supporting sustainable development. In addition to MPAs, already protected in terms of South African law (see Section 5.3.2.1), the NCMSBP comprises three further categories: CBA Natural, CBA Restore, and ESAs.

Each NCMSBP category has associated management objectives and sea-use recommendations (Table 8). The plan did not explicitly consider OSW but does provide sea-use recommendations for renewable energy. Based on the most recent available evidence of the potential risks and benefits of OSW development to biodiversity and conservation objectives, it is recommended that OSW be considered in the next iteration of the NCMSBP.

TABLE 8: MANAGEMENT OBJECTIVES AND SEA-USE GUIDELINES FOR CBAS AND ESA.[73]

CBA Map Category	Description	Broad Management Objective	Recommended MSP Zones
Protected Areas	Areas that are formally protected in terms of the National Environmental Management: Protected Areas Act (No. 57 of 2003)	As per the gazetted purpose and objectives in Protected Area Management Plans	**Strict Biodiversity Conservation Zone: Marine Protected Areas** Additional broad compatibility with Marine Tourism, Heritage Protection, Fisheries Resource Protection
Critical Biodiversity Areas (Natural)	Areas that must remain in natural or near-natural ecological conditions to meet biodiversity targets	Maintain natural or near-natural ecological conditions	**Strict Biodiversity Conservation Zones: Biodiversity Conservation Areas** Additional broad compatibility with Marine Tourism, Heritage Protection, Fisheries Resource Protection
Critical Biodiversity Areas (Restore)	To meet biodiversity targets, these areas should be improved and restored to a natural or near-natural ecological condition (or as close to this state as possible). At a minimum, further deterioration in environmental conditions should be avoided, and options for future restoration should be maintained.	Improve ecological conditions and, in the long-term, restore to a natural / near-natural state or as near to that state as possible. At a minimum, avoid further deterioration in ecological condition and maintain options for future restoration.	**Strict Biodiversity Conservation Zones: Biodiversity Conservation Areas** Additional broad compatibility with Marine Tourism, Heritage Protection, Fisheries Resource Protection
Ecological Support Areas	Areas where further deterioration in ecological condition must be avoided to support environmental functioning, biodiversity patterns, and delivery of ecosystem services	Avoid further deterioration in ecological condition	**Biodiversity Impact, Management Zone** Additional broad compatibility with Marine Tourism, Heritage Protection, Commercial Fishing, Small-Scale Fishing, Fisheries Resource Protection, Aquaculture Development, Renewable Energy, Military, Maritime Transport, Underwater Infrastructure

Critical Biodiversity Areas (CBAs) must remain in natural or near-natural ecological conditions to meet biodiversity targets. Within the EEZ, MPAs comprise 5.4%, CBA Natural shall consist of 18%, CBA Restore shall consist of 3.6%, and ESAs comprise 6.6% of the area. MPAs and CBA Natural are prioritised with red RAG ratings, while CBA Restore and ESAs are flagged as amber.

Key Biodiversity Areas (KBAs) are globally significant places for distinct species and their habitats that have been rigorously and transparently identified using quantitative thresholds and multi-stakeholder collaboration.[74] South Africa has terrestrial KBAs approved by the KBA secretariat in 2024, and should develop marine KBAs to be considered when planning OSW development. Current globally delineated marine KBAs for South Africa are located well beyond currently considered feasible depths for OSW development.[75] Bird Life South Africa has proposed draft seabird KBAs between Saldanha Bay and Cape Town, south of Cape Town and in the Coega region (Figure 16). In consultation with BLSA, the draft broader seabird KBAs were assigned an amber RAG rating, while core bird habitat was assigned a red RAG rating (see Section 5.3.2.4).

Ecological or Biologically Significant Areas (EBSAs) are sites of regional, national, and international significance, such as marine parks and sanctuaries, which are under increasing anthropogenic threat. South Africa has identified 23 EBSAs intersecting its EEZ. Sea-use guidelines have also been recommended for different zones of the EBSAs: Conservation Zones where renewable energy and marine infrastructure are conditionally compatible with the implementation of appropriate management measures, and Environmental Impact Management Zones where renewable energy and marine infrastructure are compatible. The EBSAs have been integrated into the NCMSBP and can be seen chiefly aligning with ESAs. As such, EBSAs are flagged with an amber RAG rating.

Potential impacts to CBAs, KBAs and EBSAs from OSW development are the same as potential impacts identified for MPAs (see Section 5.3.2.1).

5.3.2.3 Estuarine habitats

South Africa has 290 estuaries and 42 micro-estuaries along its coast.[76] Estuaries support biodiversity, livelihoods, and marine fisheries and are hotspots for tourism and recreation. They also support mangrove and seagrass ecosystems. Estuaries were assigned a red RAG rating.

Mangroves are highly productive ecosystems crucial for fisheries sustainability and coastal erosion protection. They are also a natural resource for wood. In South Africa, they occur globally at one of the southernmost locations, spanning 37 estuaries, lagoons, and tidal basins across KwaZulu-Natal and the Eastern Cape. The southernmost extent reaches the Nahoon Nature Reserve in East London. The total mangrove cover is estimated at 1,921 ha, featuring six main species.[77]

Seagrass beds are highly productive ecosystems crucial for supporting marine life, stabilising sediment, and facilitating nutrient cycling. In South Africa, these habitats are vital for threatened and endemic species like the Knysna Seahorse, Estuarine Pipefish, and Bot River Klipfish. The country hosts temperate and tropical seagrass species, including Cape Dwarf-eelgrass, dominating waters deeper than six metres across 62 estuaries along the coastline.

Ramsar sites are wetlands of international importance designated under the Ramsar Convention on Wetlands for containing representative, rare, or unique wetland types or for their importance in conserving biological diversity.[78] There are 14 coastal or marine Ramsar sites in South Africa.[79]

Potential impacts to estuarine ecosystems from OSW development include:

- Disturbance to and loss of estuarine ecosystems and associated critical biodiversity predominantly due to infrastructure and activities in the coastal environment, for example, where subsea cabling comes to shore, increased vessel activities in ports, chemical spills, potential port expansion, as well as potential associated knock-on effects of compromised tourism and recreation value provided by estuaries.
- OSW infrastructure, including foundations and floating OSW anchors for floating OSW, may require piling into the seabed. Also, subsea cables require either burial or to be laid upon the seabed with appropriate cable protection. Each of these activities may impact the seabed and coral reef habitats.

Direct impacts on estuarine habitats are unlikely as OSW development would be expected to occur multiple kilometres from shore. Infrastructure such as power export cables and onshore grid infrastructure should be located to avoid direct impacts. Additional research and mitigation measures may be required if OSW development is to occur in these areas.

5.3.2.4. Seabirds and bats

Nearly 38% of seabirds that inhabit the South African EEZ are threatened. Key Endangered **nearshore species** include the African Penguin, Bank Cormorant, Cape Cormorant, and Cape Gannet. Cape Cormorant foraging ranges can extend up to 70 km offshore.[80] African Penguins exhibit wide-scale movements, with juveniles dispersing over 1000 km from their colonies.[81] The core / high-density use areas of the African Penguin, Cape Cormorant and Cape Gannet have been delineated as MIBAs (Figure 16), and used to derive CBAs (refer to Section 5.3.2.2) and draft seabird KBAs (refer to Section 5.3.2.2). Core nearshore seabird habitat was assigned a red RAG rating.

Threatened **pelagic species** that frequent the South African EEZ include the Indian Yellow-Nosed Albatross, Atlantic Yellow-Nosed Albatross, Wandering Albatross, Tristan Albatross and the Northern Giant Petrel. Tracking data does exist for some of these species but is not sufficiently accurate to inform the delineation of MIBAs or KBAs.

The impact of OSW-related activities may be challenging to estimate as turbine avoidance rates at the macro-scale, mesoscale, and micro-scale depend on individual species. These will significantly impact estimates of collision risk and displacement. Seabird monitoring campaigns can increase the evidence base for such estimates.

Potential impacts to seabirds from OSW development include [82]:

- Collision with spinning turbines leads to injury or mortality.
- Displacement from foraging areas and longer travel times to reach foraging areas.
- Altered predator-prey relationships.
- Compromised habitat quality and animal health due to accidental chemical spills (e.g. oil and fuel) from vessels and turbine infrastructure during construction, maintenance and operations.

Robust pre-construction bird and bat monitoring campaigns will need to be implemented at OSW development sites to determine high-risk areas and species. This recommendation is driven by:

- A lack of detailed seabird and bat data on distributions, abundance, seasonality, flight height and behaviour (especially the pelagic species).
- Lessons learned from the onshore wind energy industry in South Africa insofar as the number and diversity of terrestrial birds killed by wind turbines.[83] [84]
- Remaining uncertainties around how different seabirds and bats in other regions may interact with OSW development.[85]

Post-construction management should also focus on collision risk mitigation, for which various options emerge.[86] Pre- and post-construction monitoring should align with international guidance. [87] Additionally, the increasing global data and knowledge about how seabirds interact with OSW farms and which species are most at risk should be leveraged and applied wherever possible.

5.3.2.5. Marine fauna

Several endangered marine fauna species are found in the South African EEZ, including **cetaceans**, **cartilaginous fish (sharks and rays)**, **reptiles (turtles)** and **corals**.

IUCN geographic range data for threatened species were not granular enough to include in this study (e.g. the geographic range of some species consists of the entire EEZ). However, core areas for the most critical marine mammal and reptile species were considered in the NCMSBP to delineate CBAs and ESAs (see Section 5.3.2.2). For the study, delineated IMMAs and Important Shark and Ray Areas (ISRAs) were flagged with amber RAG ratings.

IMMAs are designated portions of marine habitat critical for the survival and conservation of marine mammal species.[88] The majority of the continental shelf off the southern tip of South Africa has been delineated as IMMAs, and there are currently seven ISRAs delineated on the east coast of South Africa. ISRAs delineate habitats important for distinct, vulnerable, range-restricted shark, ray, and chimaera species.[89]

Potential impacts to marine fauna (excluding corals) from OSW development include:[90]

- Collisions with vessels, resulting in injury or mortality.
- Changes in behaviour, distribution and predator-prey dynamics through acoustic disturbance and injury during construction or electromagnetic fields generated by transmission cables.
- Entanglement with floating OSW dynamic cables and mooring lines. Direct entanglement with cables and mooring is unlikely. However, secondary entanglement may occur when objects in the water column, such as ghost fishing gear, become entangled in OSW infrastructure and create a risk of entanglement for marine fauna.
- Compromised habitat quality and animal health due to accidental chemical spills (e.g. oil and fuel) from vessels and turbine infrastructure during construction, maintenance and operations.
- Positive impacts that may arise from excluding other marine activities, such as fisheries.

The presence of marine fauna can be difficult to establish during preconstruction monitoring to inform OSW planning and impact assessment, but surveys can be combined with seabird monitoring campaigns (aerial and boat based). Options for mitigating negative impacts include ceasing high-impact activities (e.g. pile driving) when certain species are detected near the OSW facility [91], seasonal work, and noise reduction techniques such as bubble curtains.

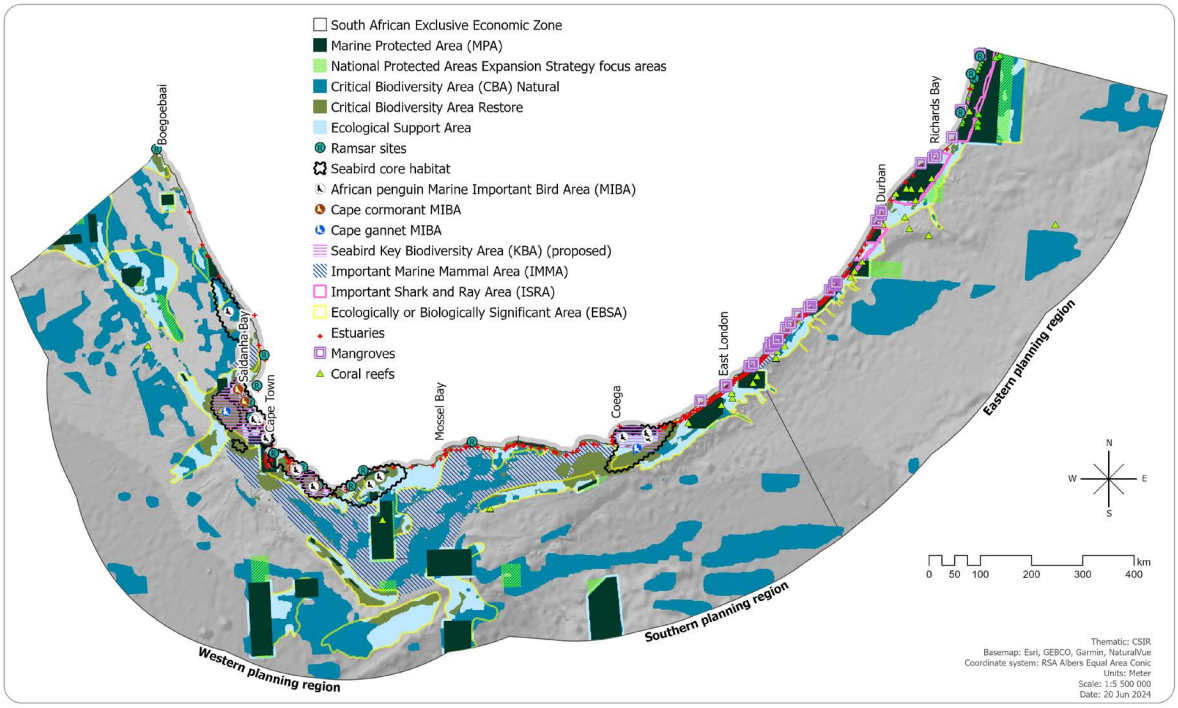
5.3.2.6. Coral reefs

Coral reefs are incredibly significant and often highly threatened biodiversity areas, and South Africa hosts the southernmost coral reefs on the African continent. Reefs also provide considerable tourism and recreation opportunities. For example, Sodwana Bay in iSimangaliso MPA is South Africa's most popular scuba diving and fishing destination, attracting more than 60,000 dives a year [92] with an economic value of up to R 175 million from diving charters and boat-based angling.[93] Warm-water corals are found at shallower depths on the east coast of South Africa, while cold-water corals are found in deeper water. Due to their uniqueness and recreational value, corals were assigned a red RAG rating.

Potential impacts to corals from OSW development include:

- Damage to or destruction of coral reefs due to infrastructure that needs to be secured to or laid on the seabed (foundations, anchors, cabling). This could have knock-on effects on fish and other fauna that rely on corals and compromise tourism value.
- Compromised habitat quality and animal health due to accidental chemical spills (e.g. oil and fuel) from vessels and turbine infrastructure during construction, maintenance and operations.
- Positive impacts include seabed infrastructure potentially acting as substrates for establishing new coral communities.[94]
- Monitoring of coral health can be undertaken using geophysical and geotechnical surveys.

FIGURE 16: KEY ENVIRONMENTAL CONSIDERATIONS FOR OSW DEVELOPMENT IN THE SOUTH AFRICAN EEZ.



5.3.3 Social and technical considerations

South Africa's ocean economy consists of several key socio-economic activities such as:

- Ecotourism, which contributes approximately ZAR 400 million directly and ZAR 2 billion indirectly to the South African economy.[95]
- Commercial fisheries, which is worth ZAR 6-8 bn (wholesale) and ZAR 5.3 bn (fish product export).[96]
- Logistics and maritime services, which contribute approximately ZAR 100 bn to the economy.[97]

Ecotourism is widely associated with the coast / nearshore environment, while shipping and fishing are widely distributed throughout the EEZ (Figure 18).

5.3.3.1. Coastal and maritime heritage

The National Heritage Resources Act 25 of 1999 (NHRA) governs South African heritage resources.[98] Archaeological artefacts, including shipwrecks, any submerged aircraft wreckages, prehistoric landscapes, sacred sites, shipwreck survivor camps, or rock art sites relating to maritime or underwater cultural heritage, which are older than 60 years, are protected in terms of the NHRA.[99] Any disturbance of such sites may only occur if permitted by the South African Heritage Resources Agency (SAHRA) or relevant provincial heritage authority. For the study, recorded heritage resources were buffered with 2 km and assigned a red RAG rating.

Potential impacts to coastal and maritime heritage from OSW development include:

- Damage to or destruction of heritage resources due to infrastructure that needs to be secured to or laid on the seabed (e.g. foundations, anchors, cabling) and where cabling comes to shore. This could have knock-on effects, compromising tourism value (e.g. shipwreck scuba diving).

Restorative justice requires that heritage records should be consulted to identify existing heritage features that seabed development activities should avoid. More detailed site-specific marine heritage assessments supported by surveys, such as magnetometer and diver surveys, should be used to ascertain the presence of heritage resources that have not yet been discovered. The *in situ* preservation of maritime heritage resources should be prioritised. Opportunities for mitigation and replacement of lost or damaged heritage are limited: once sites are lost, they cannot recover.

5.3.3.2. Seascape, landscape, and tourism

Coastal and marine tourism in South Africa includes beaches, hotels, natural areas, cultural/heritage buildings, and locations for water activities such as diving, surfing, recreational fishing, boating, sailing, and cruise ships. International experience suggests that OSW development should be avoided in areas with important tourism activities, which are usually site-specific and provide numerous jobs (adding economic and social value).[100]

Blue Flag sites are beaches, marinas, and sustainable boating tourism operators that are based on exceptional environmental, educational, safety, and accessibility.[71] For the study, Blue Flag sites (Figure 18) have been flagged with an amber RAG rating in addition to the seascapes, landscapes, and tourism value that are inextricably linked to the cultural ecosystem services provided by the habitats and species discussed in Section 5.3.2.

A distance of 10 km from the coastline was assigned a red RAG rating to mitigate potential visual impacts [101] and conflict with coastal and nearshore recreation activities. Recreational activities that take place farther away from the shore (e.g. fishing, boating, and sailing) may be at increased risk of visual intrusion and conflict with OSW development.[102]

Potential impacts to seascape, landscape and tourism from OSW development include:

- Compromised scenic value caused by the presence of OSW turbines and coastal infrastructure (and, to a lesser extent, shadow and flicker effects caused by rotating turbines).
- Conflict with or displacement of existing marine tourism activities.
- Knock-on negative impacts on the livelihoods of those working in the tourism and recreation sectors.

Strategies to determine risk of and reduce conflict with tourism activities and coastal communities include early and proactive engagement, and explicit consideration of tourism and recreation in EIA processes.[103] Options for mitigating potential negative impacts are primarily in planning OSW development sites to minimise potential visual intrusion. This could mainly be achieved by locating OSW development further offshore.

5.3.3.3. Fisheries and mariculture

The Marine Living Resources Act No. 18 of 1998 (MLRA) currently governs fisheries in South Africa.[104] It aims to enable the sustainable and equitable use of marine living resources. This includes zones that dictate allowable fishing activities and practices within MPAs. South Africa's fisheries consist of wild capture fisheries (commercial, recreational and subsistence) and a less-established mariculture (fish farming) sector.[105] The most commercially exploited fish species include hake, anchovy, sardine, horse mackerel, tuna, snoek, rock lobster and abalone, while squid, linefish and intertidal resources support livelihoods, especially on the East Coast.

Commercial fisheries occur all along the South African coastline and extend farther offshore along the western and southern coasts. Small/artisanal fishing communities are more prevalent along the East Coast Figure 18. Mariculture is considered more feasible in the nearshore environment due to harsh conditions in the open sea that pose risks to mariculture infrastructure. Several marine Aquaculture Development Zones (ADZs) have been proposed in the nearshore environment.[106] For the study, apparent fishing effort at a relatively coarse scale has been flagged with an amber RAG rating.

The commercial fishing industry comprises a complex subset of fishing gear types, vessel types, and target species, so estimated impacts of OSW development require specificity. Mobile bottom gear, trawling, and dredging techniques may be least compatible with OSW development due to risks of snagging on subsea cables, cable protection measures, and floating OSW mooring lines. Mid-water fishing techniques and pot fisheries may be more compatible with operational OSW developments.

Potential impacts to fisheries and mariculture from OSW development include:

- Conflict and displacement of fisheries in established fishing grounds, which may, in turn, lead to increased competition between fisheries elsewhere.
- Compromised habitat quality and animal health due to accidental chemical spills (e.g. oil and fuel) from vessels and turbine infrastructure during construction, maintenance and operations.
- Safety risks and damage to fishing boats and equipment due to collision with or snagging of OSW infrastructure (and vice versa).
- Positive impacts for fisheries include increased fish stocks due to OSW infrastructure acting as artificial reefs, fish nurseries and no-take zones where fishing is excluded in direct proximity.
- OSW infrastructure could present an opportunity for co-location of mariculture if co-management obstacles can be overcome.[107]

Policy frameworks should be established to support co-existence of OSW development and fishing activities. OSW development should avoid high-priority and high-value fishing grounds where possible, noting long-term temporal changes in fishing activity. Other potential strategies include introducing fair strategic compensation for displaced fisheries, noting restorative justice requirements, and assessing co-location potential. Engagement with commercial fisheries at a sectoral (e.g. through representative bodies such as FishSA) and local levels is an important first step to build trust, and to facilitate a cooperative and amenable relationship between OSW development and fisheries.

5.3.3.4. Shipping routes

The shipping corridor around the tip of South Africa links Asia, South America, and Africa's East and West coasts. More than 30,000 ships sail around South Africa's coast every year.[108] Currently, shipping is rather dispersed and uncoordinated across the EEZ. For this study, shipping is assumed to be better organised and constricted as other offshore development and activities are introduced. The derived constricted 'shipping lanes' were assigned a red RAG rating.

Potential impacts to shipping from OSW development include:

- Maritime navigational safety risks due to obstacles in the water that need to be avoided by ships, leading to increased ship traffic density and collision risk.[109]
- Safety risks and ship damage due to collision with OSW infrastructure (and vice versa).
- Increased traffic, space, facility and service requirements at ports.

To reduce maritime navigational safety risks and facilitate the coexistence of OSW development and shipping, shipping lanes that need to be avoided by OSW development will need to be better formalised in the future, guided by marine spatial planning. Port planning must also consider the increased space, facilities, and services that may be required to accommodate the development of the OSW sector. Key authorities to engage in this regard are SAMSA, TNPA and the International Maritime Organisation (IMO).

5.3.3.5. Aviation

South Africa has many aerodromes scattered along its coast (Figure 18). Areas around air traffic control centres (radars), airports, aerodromes, and air traffic zones can pose soft or hard constraints for developers. OSW turbines may pose a risk to aviation and require an obstacle assessment and consent by the South African Civil Aviation Authority (SACAA).[110] For the Study, aerodromes and main aviation routes are flagged with an Amber RAG rating.

Potential impacts to aviation from OSW development include:

- Physical obstruction and collision.
- Interference with radar and performance of navigation and communication systems.

The SACAA is responsible for developing plans, programs, regulations, and standards and providing flight management and aviation safety. For example, it includes guidance on obstacle limitation and marking outside aerodromes to limit aviation risks.[111] SACAA must be consulted during preconstruction OSW development planning.

5.3.3.6. Subsea telecommunication and Internet infrastructure

Several subsea Information and Communication Technology (ICT) cables are located within the South African EEZ (Figure 18) — These cables enable South Africa's Internet connection to the rest of the world. OSW constructions, maintenance, and operations should easily avoid them, and they were flagged with an Amber RAG rating.

Potential impacts to subsea telecoms and infrastructure from OSW development include:

- Damage to or snagging of subsea telecoms infrastructure by OSW infrastructure during construction, operations and maintenance (and vice versa).

Owners and operators of subsea ICT infrastructure must be consulted to ascertain the infrastructure's precise locations so OSW facilities may avoid them with appropriate buffer distances.

5.3.3.7. Seismicity

By global standards, Southern Africa is a seismically quiet region as it is remote from the boundaries of tectonic plates. Natural earthquakes do sometimes take place — driven by tectonic forces, such as the spreading of the sea floor along the mid-Atlantic and mid-Indian ocean ridges, the propagation of the East African Rift System, and the response of the crust to erosion and uplift.[112] Some seismic events have been recorded in the South African EEZ (Figure 18). Seismic activity may pose direct risks to OSW development through ground acceleration and seabed instability and indirect risks from extreme waves resulting from seismic events. Nonetheless, both are relatively unlikely in South Africa and flagged as amber considerations.

5.3.3.8. Petroleum and mining activities

Significant areas of the South Africa EEZ have been allocated rights for offshore petroleum activities (Figure 17). Many of these rights only allow oil and gas exploration activities, with limited areas currently under production rights (e.g. Sunbird and PetroSA off the West Coast). The extent to which exploration rights preclude areas for OSW development is uncertain and should be clarified. Established oil and gas exploration or production structures within licensed production areas pose a constraint for wind farms and are often surrounded by restriction zones. However, increasingly offshore oil and gas activities are being decarbonised using adjacent OSW generation, for example the Innovation and Targeted Oil and Gas (INTOG) leasing round in the UK.

When this study was compiled, the locations of offshore mining operations were not easily or freely available. The west coast of South Africa is known for diamond mining, both commercial and small-scale.

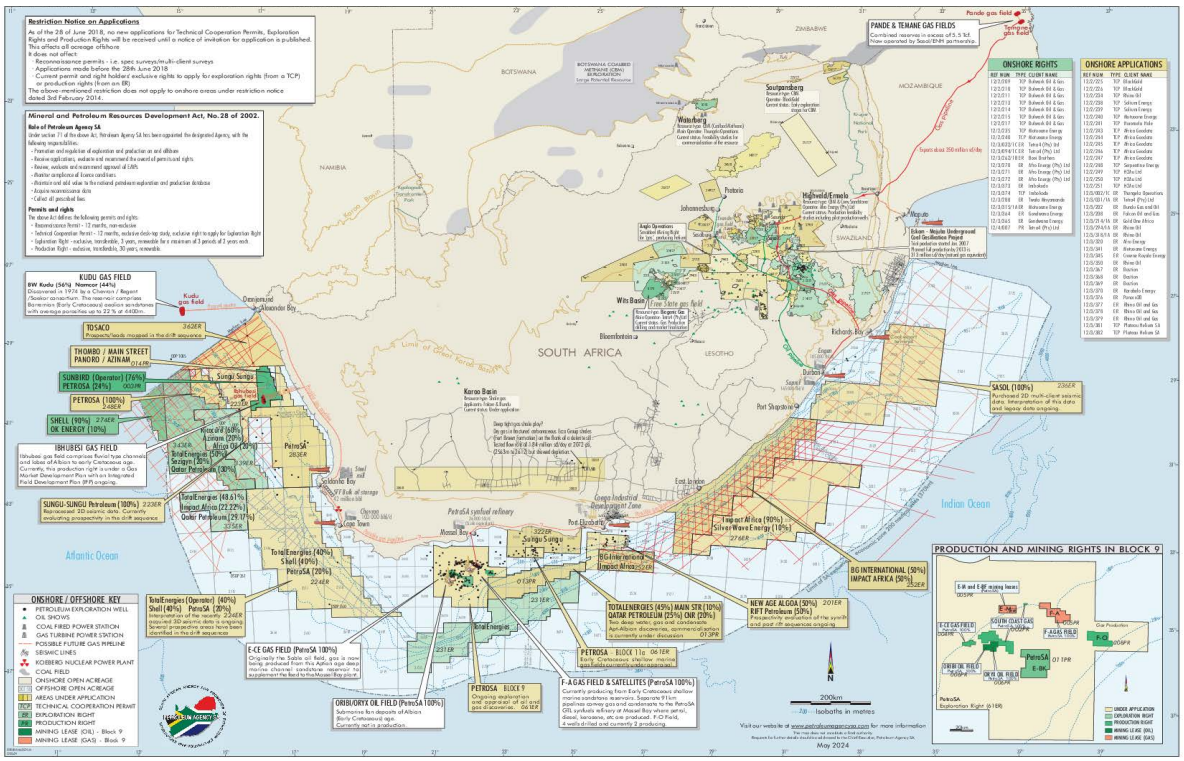
Raw spatial data for petroleum and mining activities could not be obtained for the study's development, but they are noted as an amber consideration.

Potential impacts to petroleum and mining activities from OSW development include:

- Conflict and displacement of petroleum and mining exploration and production.
- Safety risks and damage to petroleum and mining vessels and equipment due to collision with or snagging on OSW infrastructure (and vice versa).
- Oil and gas infrastructure (unused and operational) could present an opportunity for OSW development projects through data, shared infrastructure and offtake. This could build on existing work that aims to decarbonise offshore oil and gas using OSW, such as the UK's INTOG leasing round.

At a policy level, just frameworks should be established, and all relevant parties must be consulted to enable synergistic co-existence of OSW development and petroleum and mining activities. Inclusive engagement with the DEE and the Petroleum Agency of South Africa (PASA), which is done in a just manner where relevant information is accessible and transparency is promoted, should aim to ascertain the fine-scale locations of active mining and petroleum activities and to build trust towards facilitating a cooperative and amenable relationship between OSW development and such activities.

FIGURE 17: PETROLEUM EXPLORATION AND PRODUCTION ACTIVITIES IN SOUTH AFRICA.[113]



5.3.3.9. Military exercise areas and naval ammunition dumping sites

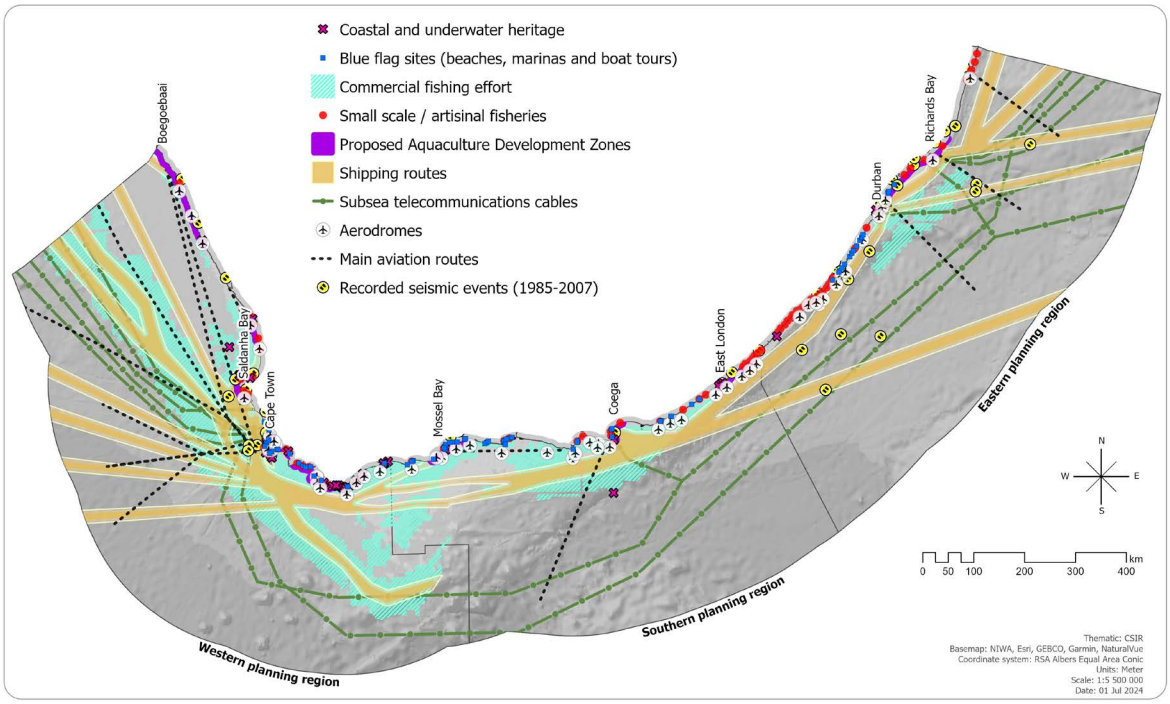
These areas compromise military bases, firing ranges, naval exercise areas, exclusion zones and military no-fly zones. There are naval bases at Durban and Simon's Town, as well as various navy training units on the Western Cape coast.[114] Historically, disused ammunition had been dumped at sea, relatively nearshore around Cape Town. Although the location and extent of military exercises at sea could not be obtained for this study, they should be considered an amber RAG rating.

Some temporary construction activities, such as the laying of cables and transporting material, are often accepted by the military (following consultation). Early liaison with the South African Department of Defence is required to determine restriction zones for OSW development to avoid spatial conflicts and safety risks. A more localised assessment could lead to mitigation measures regarding the layout design or location of wind farms, allowing some military activities to continue unimpeded (patrolling, transport, training).

5.3.3.10. Dredging

Dredging is uncommon in South Africa, generally occurring around ports such as Durban and Richards Bay. The dredged material is disposed of in the nearshore environment. Data on where maintenance dredging and disposal occur is not freely available. TNPA and DFFE must be consulted to determine where and when dredging operations may appear to avoid areas where dredged material is frequently dumped and to minimise spatial conflicts with OSW construction and maintenance activities.

FIGURE 18: KEY SOCIAL AND TECHNICAL CONSIDERATIONS FOR OSW DEVELOPMENT IN THE SOUTH AFRICAN EEZ.



5.3.4. Conclusion

This chapter provides insight into the critical environmental, social and technical considerations for OSW development planning. Susceptible areas/areas where OSW development may result in unacceptable impacts have been assigned a red RAG rating and excluded from South Africa's most suitable areas for OSW development (refer to Chapter 6). Other important features that require careful consideration during OSW development planning have been flagged with an amber rating. This study focussed on the marine environment, and additional considerations should be given to the impacts of OSW development on coastal (onshore) areas, particularly concerning grid connection and subsea cable landing points.

Although there is relatively rich spatial data on the various environmental and social features of the South African marine environment, many biophysical and socioeconomic aspects are still poorly understood. As a result, there is an ongoing need for improved monitoring and mapping of socioeconomic activity in the EEZ, as well as ground-truthed and refined conservation priorities in light of OSW development.

For any potentially sensitive environmental and social features, including those highlighted in this chapter, the relevant authorities and representative bodies should be engaged with both strategic planning and project-level planning and development to minimise impacts and enhance potential synergistic opportunities. A non-exhaustive and preliminary list of potential authorities and representative bodies who should be engaged is provided in Table 9 below.

TABLE 9: LIST OF POTENTIAL AUTHORITIES AND REPRESENTATIVE BODIES WITH INTERESTS OR RESPONSIBILITIES RELATED TO OSW PLANNING AND DEVELOPMENT (PRELIMINARY, NON-EXHAUSTIVE).

Authority/representative body or organisation	Responsibility/interest
Aquaculture Association of Southern Africa (AASA)	Mariculture
Birdlife South Africa	Seabirds
Council for Geoscience (CGS)	Seismicity
Department of Defence (DoD) and the South African Navy	Military and naval areas
Minister of Mineral and Petroleum Resources	Petroleum and mining
Endangered Wildlife Trust (EWT)	Species and ecosystems
FishSA	Fisheries
South African United Fishing Front	Fisheries
DFFE	Species, ecosystems, MPAs, fisheries and mariculture, marine spatial planning.
PASA	Petroleum exploration and production activities
Sentech	Subsea ICT
South African Bat Assessment Association (SABAA)	Bats at sea
SACAA	Aviation activities, air space, and obstacles
SAHRA	Coastal and maritime heritage, seascape and landscape.
SAMSA	Shipping
South African National Biodiversity Institute (SANBI)	Species and ecosystems
South African National Parks (SANParks)	MPAs
TNPA	Port activities and management (such as maintenance dredging)

The mitigation hierarchy (Avoid, Minimise, Restore, Offset) should always be pursued during OSW planning and development and informed by observed and verified data.

5.4 RECOMMENDATIONS

Procedural justice principles must be embedded in identifying the environmental and social considerations for planning OSW developments in the South African EEZ. This approach ensures that the development of an OSW market can harmoniously coexist, as far as possible, with existing environmental and social features. The following recommendations are drawn to guide regulators and developers to ensure responsible and sustainable development of the South African OSW sector:

- **E&S1.** The DFFE should seek to incorporate OSW development as a critical component in future iterations of the National Coastal and Marine Spatial Biodiversity Plan (NCMSBP).
- **E&S2 / GEO1.** Key government departments, like DEE and DFFE, should engage with the International Maritime Organisation, the South African Department of Transport (DoT) and the South African Maritime Safety Authority (SAMSA) to improve the coordination and structure of shipping movements (shipping lanes) alongside MSP and prior to leasing rounds. A desktop study of shipping and offshore wind interaction in South Africa should be leveraged as a supportive precursor to this engagement.
- **E&S3.** The relevant authorities, representative bodies and research organisations should commission species monitoring campaigns (especially for seabirds) to determine high-risk species and habitats that need to be avoided, improve data gaps, plan OSW development, and inform EIAs.
- **E&S4.** In support of REG5, the DFFE should undertake a Strategic Environmental Assessment (SEA) for OSW development in South Africa to facilitate responsible and efficient decisions on OSW development projects. This will extend an evidence base for supporting development decisions to the marine environment (see https://screening.environment.gov.za/screeningtool).
- **E&S5 – MED-HIGH.** The DFFE should consider expanding tools that guide project-level assessments (e.g. Environmental Impact Assessments), like the National Web-based Screening Tool, to include the marine environment.

6. GEOSPATIAL ANALYSIS

6.1. PURPOSE

Geospatial analyses have helped identify onshore Renewable Energy Development Zones (REDZ) in South Africa and are widely used to plan OSW development worldwide. This chapter presents the geospatial analysis undertaken to identify broadly suitable and the least constrained regions for OSW development in the EEZ based on environmental, social, and technical constraints unique to South Africa and outlined in Chapter 5.

6.2. METHOD

The geospatial analysis and mapping were performed using Geographic Information System (GIS) software to depict the environmental, social, and technical opportunities and constraints for OSW development in the South African EEZ. The analysis reveals suitable areas for OSW development, from which the seven most suitable OSW development regions were selected, and a spatial depiction of the calculated LCOE.

6.2.1. Technical potential

The technical potential assessment for OSW is broadly based on wind speed, water depth and distance to port. Seabed conditions are a material factor in OSW farm deployment. However, due to an absence of data, it is common for detailed geophysical investigations to be performed at a project level rather than the spatial scale considered in this analysis.

In this study, the annual average wind speeds (at 150 m height) exceeding 8 m/s are considered viable for OSW.[115] A distance within 250 km from a port represents a reasonable distance for construction and maintenance vessels.[116] The following depths were deemed feasible for fixed and floating OSW, accounting for the capabilities of current and possible future advancements in technologies.

TABLE 10: WATER DEPTHS CONSIDERED VIABLE FOR FIXED AND FLOATING OSW.

Technology	Viable water depth (m)
Fixed (current technology)	0 – 60
Fixed (future technology)	60 – 75
Floating (current technology)	75 – 500
Floating (future technology)	500 – 1,300

Conversely, wind speeds below 8m/s, distances beyond 250 km from ports, and depths exceeding 1,300 m were considered technical constraints (see section 6.2.2).

The data sets used to depict technical potential were:

- The Global Wind Atlas version 3.3[7] for the annual average wind speeds,
- The General Bathymetric Chart of the Oceans (GEBCO) [117] was used for water depths and
- Distances of 250 km derived from the locations of South African ports [118] (including the proposed Port of Boegoebaai in the Northern Cape province of South Africa).

6.2.2. Environmental, social and technical constraints

Various environmental, social, and technical features in the South African EEZ were considered to assess the areas more suitable for OSW development. Each environmental and social feature or constraint was evaluated against a RAG framework to determine the areas where OSW development may, for example, incur more cost, overlap with existing marine activities, or impact sensitive marine areas.

For this study, constraints that were assigned a Red rating were treated as precautionary 'exclusion' layers, meaning areas with these features were deemed unsuitable for development at this time, based on available data. Red, Amber and Green ratings are described below.

TABLE 11: RED-AMBER-GREEN (RAG) RATINGS FOR ENVIRONMENTAL, SOCIAL AND TECHNICAL CONSIDERATIONS.

Scale Values	Description
Red	OSW development can significantly impact or influence environmental and/or social considerations. Possible Exclusion Zone – i.e., areas of the highest biodiversity and social sensitivity to exclude from the technical assessment of OSW resources. The development of offshore wind farms within these areas is unlikely to be compatible with international good practise, such as complying with the World Bank Group's E&S Standards.
Amber	OSW development has the potential to have an impact or influence on environmental or social considerations. Possible Restriction Zone – i.e. high-risk areas requiring further risk assessment during MSP, site selection and/or EIA.
Green	The remaining areas are where OSW development is least constrained and is either unlikely to impact or influence environmental or social considerations or where there may be acceptable or negligible impacts/influences.

The precautionary approach to identify the most suitable OSW development regions aims to de-risk OSW development from the earliest strategic planning stage. Still, it does not result in a "go/no-go" outcome for project proposals. Development decisions must be based on further, more detailed site investigation, measured data, feasibility assessment and stakeholder engagement.

7 Data obtained from the Global Wind Atlas version 3.3, a free, web-based application developed, owned and operated by the Technical University of Denmark (DTU). The Global Wind Atlas version 3.3 is released in partnership with the World Bank Group, utilizing data provided by Vortex, using funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalwindatlas.info.

TABLE 12: ENVIRONMENTAL, SOCIAL, AND TECHNICAL CONSTRAINTS THAT ARE CONSIDERED PRECAUTIONARY EXCLUSION LAYERS FOR THE EARLY IDENTIFICATION OF SUITABLE OSW REGIONS.

Feature	Description	Source
Environmental and social exclusions		
Marine Protected Areas (MPAs) [119]	Areas protected in terms of Section 9 of the National Environmental Management: Protected Areas Act (NEM: PAA).[120]	Department of Environment, Forestry and Fisheries
Critical Biodiversity Areas (CBAs) [121]	Natural or near-natural areas are required to contribute to meeting biodiversity conservation targets and ensure that a viable, representative sample of biodiversity can persist.[122]	Nelson Mandela University, Institute for Coastal and Marine Research
Marine Important Bird Areas (MIBAs) [123]	Core bird habitat for African penguin, Cape gannet, and Cape cormorant. Data was obtained directly from Birdlife South Africa.	Birdlife South Africa, Seabird Conservation Programme
Distance within 10 km of the coastline [124]	10 km buffer from the coast generated. Consideration is included to ameliorate potential visual impact and conflicts with other nearshore marine activities. (by virtue, this entailed that **estuaries** [125], **Ramsar sites** [126], **mangroves** [127], nearshore **coral reefs** and **coastal heritage** were also excluded).	Digital Earth Africa
Underwater heritage [128]	Recorded heritage resources mainly consisting of shipwrecks and shell middens fish traps.	South African Heritage Resources Agency
Shipping lanes [129]	Estimated from MarineTraffic.com. density maps. We have assumed that shipping will be better organised and constricted as other offshore development and activities (e.g. OSW development) are introduced to the South African EEZ. Therefore, the exclusion zones are smaller than the routes currently used for shipping.	Marinetraffic.com
Technical exclusions		
Wind speed	Modelled wind speed of less than 8 m/s is generally considered less viable for OSW development.[130]	Global Wind Atlas
Water depth [131]	A maximum modelled depth of 1,300 m was included, considering the capabilities of current and possible future technological advancements.	General Bathymetric Chart of the Oceans
Distance to port	A buffer distance of 250 km was generated around the locations of South African ports (including the proposed Port of Boegoebaai in the Northern Cape province). 250 km was selected as a maximum distance reasonable for construction and maintenance vessels to travel.	Transnet Ports Authority

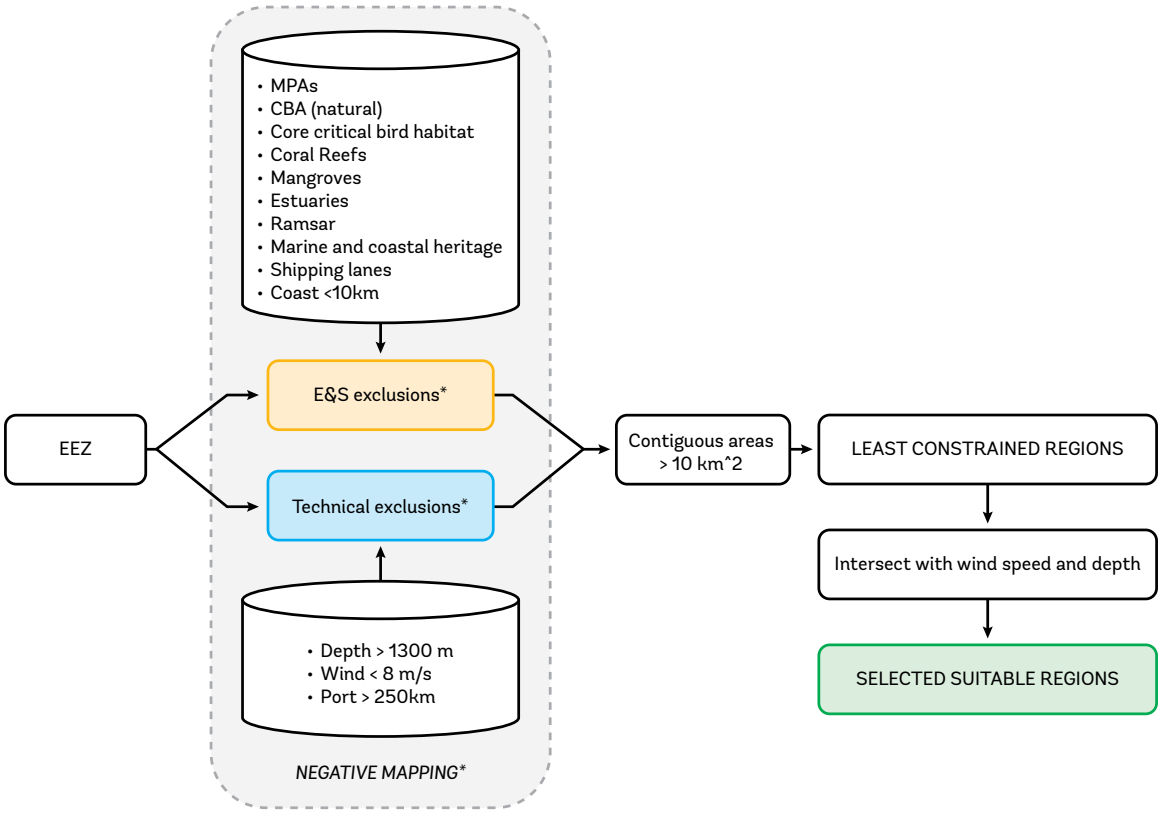
Other important environmental and social features that need to be considered in planning for OSW development were assigned an Amber rating and are presented and discussed in Chapter 5: Environmental and social constraints.

6.2.3. Identification of most suitable OSW development regions

A negative mapping approach using GIS software was used to identify relatively more suitable regions for OSW development in the South African EEZ. Environmental, social and technical exclusion areas were discarded from the EEZ area, and small disjunct areas were removed. The result shows the least constrained regions in the South African EEZ. Finally, considering relative wind speed and water depth, a total of seven most suitable areas for OSW development were selected for the study.

The area (km^2) of the selected regions was calculated, and a potential MW capacity was estimated, assuming a power density of 3 MW per square kilometre.

FIGURE 19: SUMMARY OF IDENTIFYING AND SELECTING SUITABLE OSW DEVELOPMENT REGIONS.



The identified OSW development areas are based on existing and freely available spatial data and a specific set of environmental, social and technical constraint criteria discussed in Section 5.0. It does not aim to present a "go/no-go" answer for development, but provides a point of departure to identify broadly feasible regions for early strategic OSW development planning and marine spatial planning processes. These constraints may change over time, for example, if additional ports are developed, social and environmental constraints change, or due to the availability of new and more detailed data. This analysis is, therefore, indicative only and subject to change. (Chapter 5: Environmental and social constraints).

6.2.4. Levelised cost of energy (LCOE)

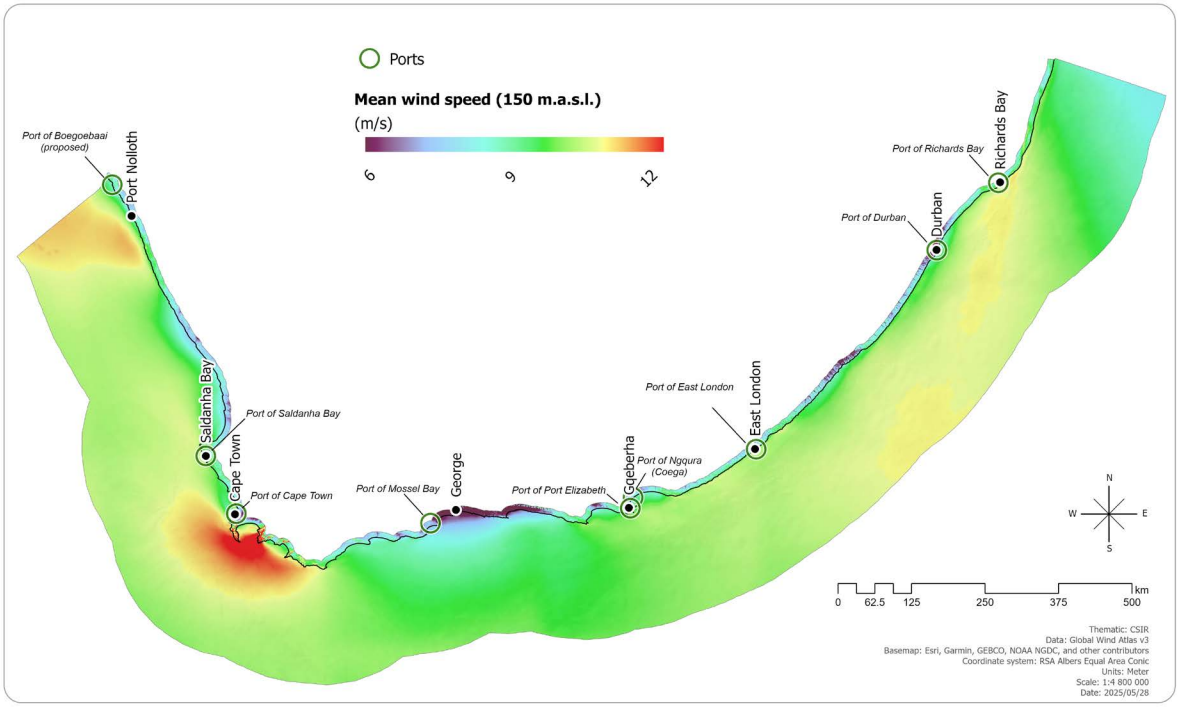
A grid of points at 10 km intervals was generated for the least constrained regions. For each of the points, the mean wind speed (m/s) at 150 m hub height, water depth (m), distance to coast (km), and distance to closest port (km) were extracted in the GIS. This information, in addition to other cost elements, such as water depth and distance from shore, was used to calculate the LCOE for each point (see Chapter 8: Levelised cost of energy). The calculated LCOE values were returned to the GIS to visually display variance in LCOE across the least constrained and selected suitable regions.

6.3 RESULTS AND DISCUSSION

6.3.1. Technical potential

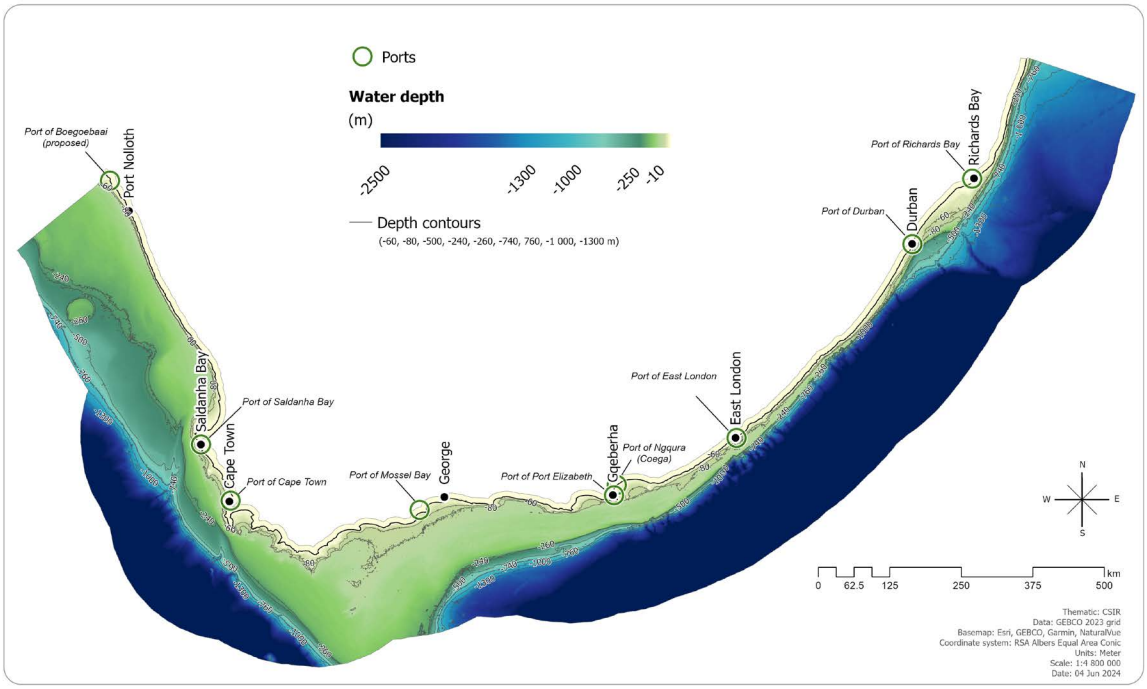
South Africa has excellent wind potential across its entire EEZ. Wind speeds of up to 11 m/s can be expected in Port Nolloth, Cape Town and Richards Bay. There is only one stretch of the EEZ, around the Port of Mossel Bay/George, where mean wind speeds are lower than 7 m/s.

FIGURE 20: MEAN WIND SPEED (M/S) AT 150 M HUB HEIGHT.



The bathymetry of the South African EEZ is distinctly characterised by the continental shelf. On the West Coast, the shelf is relatively wide and deep but tapers off to a shallow and extremely narrow shelf on the East Coast.[132]

FIGURE 21: WATER DEPTH (M).

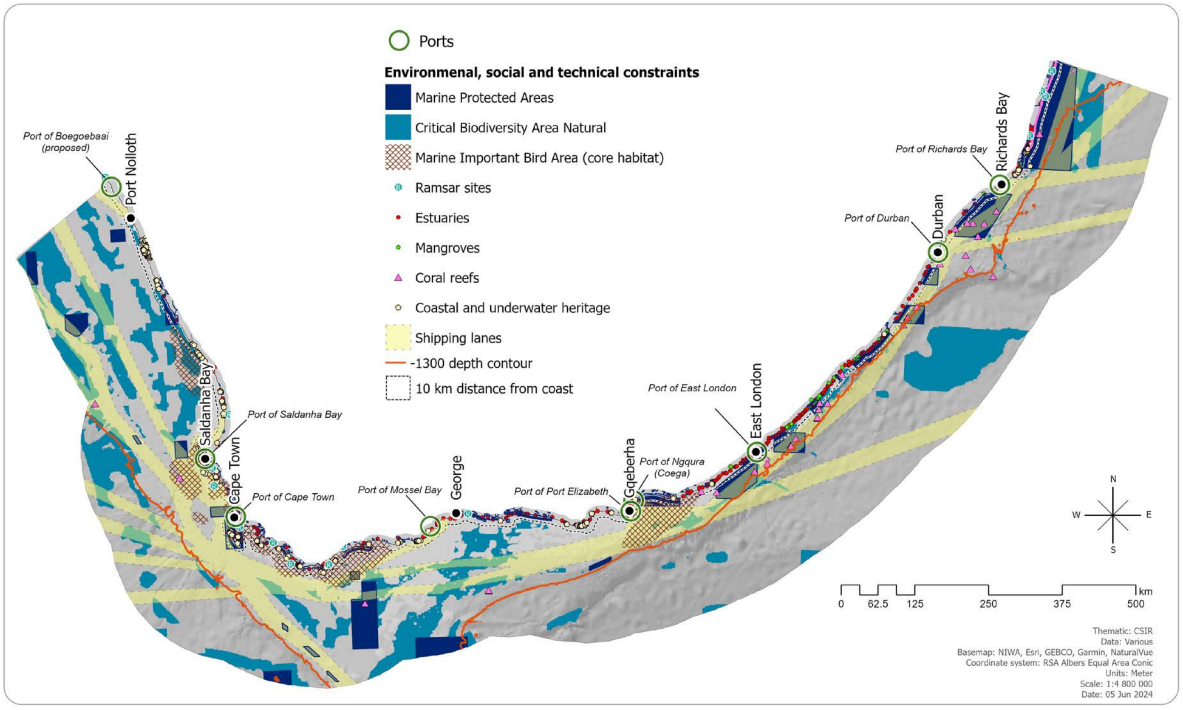


6.3.2. Environmental, social and technical constraints

The primary constraint to OSW development in South African waters is depth, especially on the east coast between East London and Durban, where depths exceed 1,300 m within 10–30 km of the coast. A distance of 10 km from the coast is considered an exclusion area as the most sensitive nearshore and coastal ecosystems (estuaries, mangroves) and heritage resources are on or within 10 km of the coast. MPAs and CBAs are distributed across the EEZ, although they are more prolific on the West Coast. The areas between Saldanha Bay and George are identified as MIBAs.

Existing shipping routes across the EEZ are largely dispersed and uncoordinated (as observed on MarineTraffic.com) owing to a relative absence of competing offshore activities. In this analysis, shipping lanes have been centralised to arterial routes (on the assumption that constriction is possible and will occur as other offshore development and activities are introduced.

FIGURE 22: ENVIRONMENTAL, SOCIAL AND TECHNICAL CONSTRAINTS.



6.3.3. Identification of the most suitable regions for OSW development

For this study, and taking into account both technical potential and environmental, social and technical constraints, the seven most suitable 'case study' regions were manually selected from the least constrained areas based on the most favourable wind speeds and water depth.

It is important to note that environmental, social, and technical constraints or barriers to OSW development will still exist within these regions. Similarly, opportunities for OSW development outside the areas identified are possible, especially off the southern coast between the Ports of Mossel Bay and Gqeberha (Port Elizabeth), where wind speeds are still relatively favourable.

The best wind speeds are expected around Cape Point, while the average depth at the Durban-Richards Bay region can present a challenge to offshore development.

TABLE 13: AVERAGE WIND SPEED, DEPTH, AND DISTANCE TO PORT AND COAST FOR THE SELECTED OSW DEVELOPMENT REGIONS.

Selected region	Wind speed (m/s at 150 m.a.s.l)			Water depth (m)			Distance to closest port (km)			Distance to coast (km)		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Boegoebaai — West Coast (BB-WC)	8.88	9.93	9.51	-256	-96	-172	31	248	137	10	98	53
Saldanha Bay — West Coast (SB-WC)	8.13	9.52	9.05	-282	-53	-172	35	223	127	10	104	54
Cape Point West (CPW)	9.63	10.17	9.88	-278	-170	-212	38	70	55	24	58	41
Cape Point South (CPS)	10.26	10.90	10.57	-146	-80	-111	53	100	75	11	28	18
Coega West (CW)	8.68	9.03	8.88	-123	-70	-103	32	76	51	11	33	19
Coega East (CE)	9.20	9.29	9.24	-86	-70	-79	98	116	110	14	24	18
Durban — Richards Bay (DRB-RB)	9.16	9.66	9.50	-1296	-170	-852	31	94	61	21	90	51

FIGURE 23: SELECTED MOST SUITABLE REGIONS FOR OSW DEVELOPMENT, CONSIDERING THE EXCLUSION OF KEY ENVIRONMENTAL, SOCIAL AND TECHNICAL CONSTRAINTS.

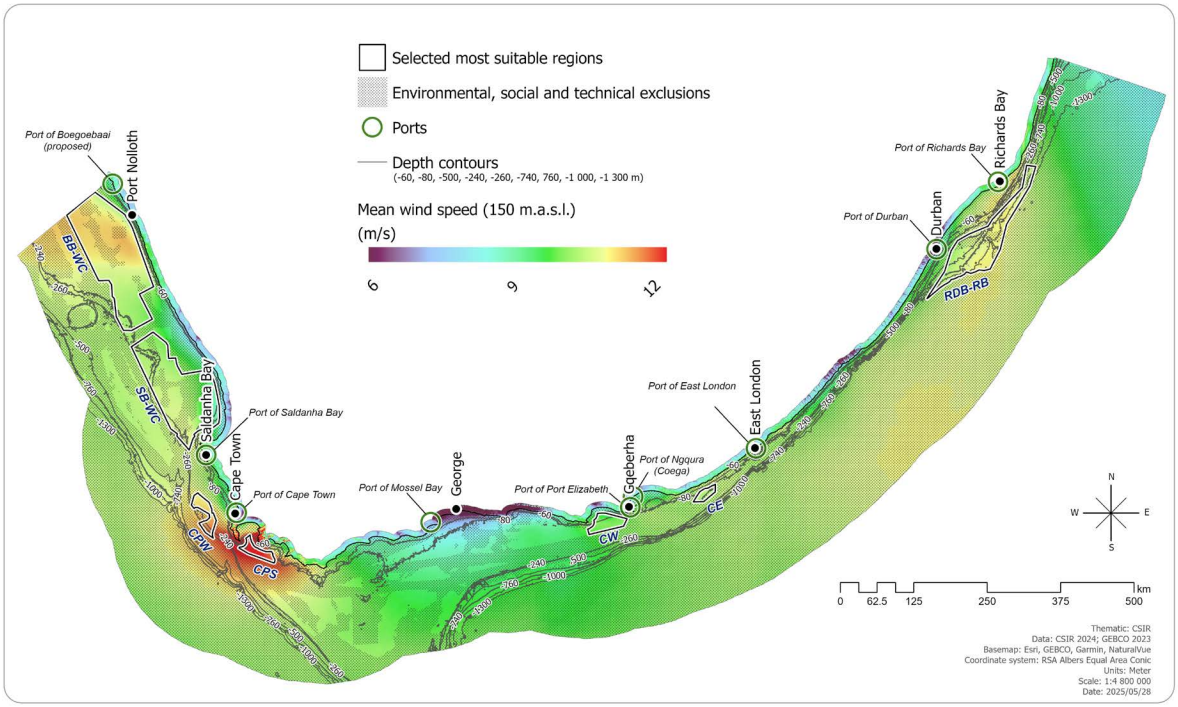
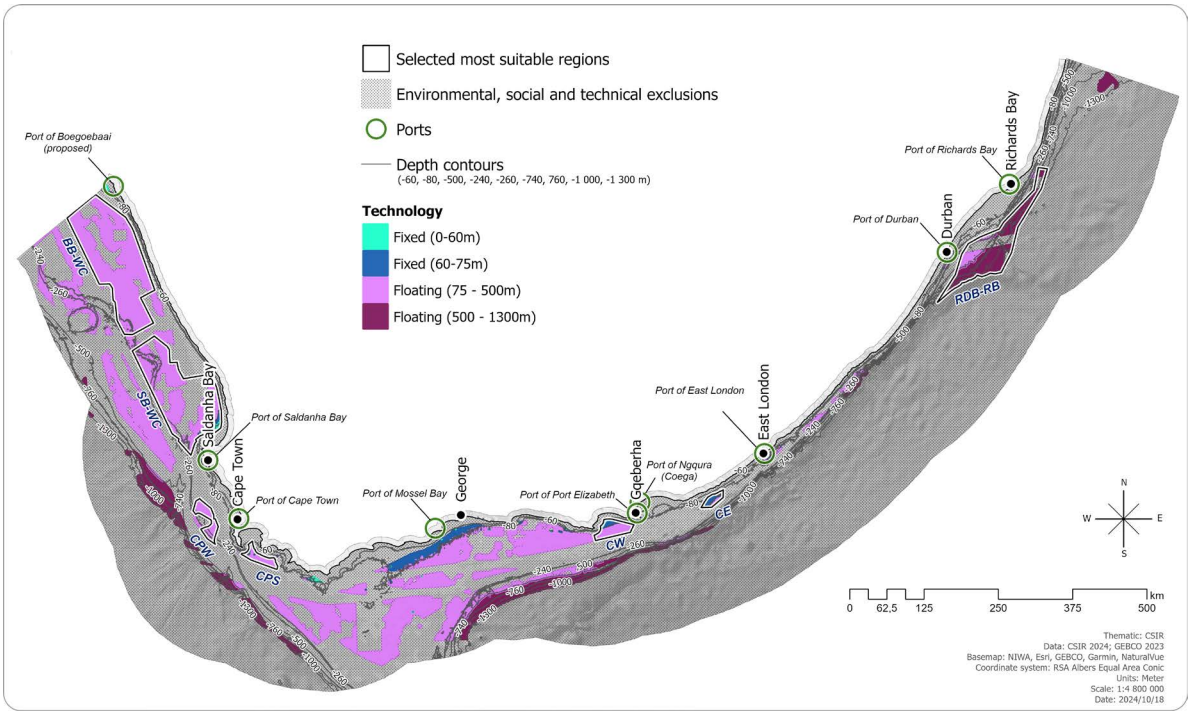
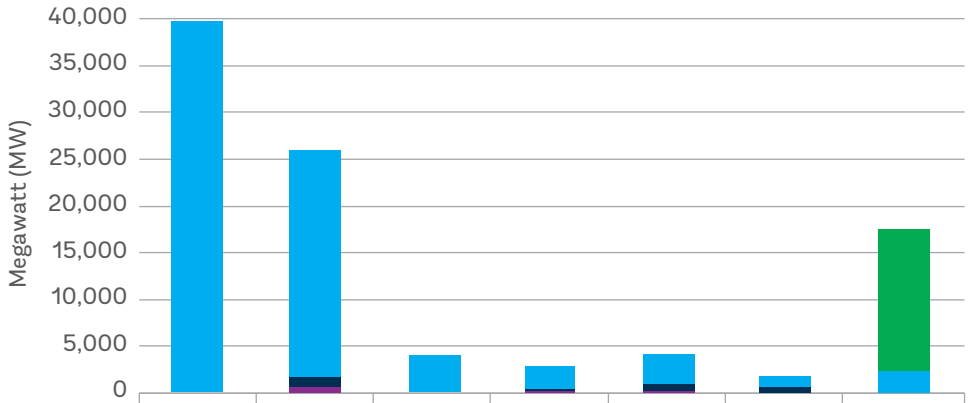


FIGURE 24: LEAST CONSTRAINED AND SELECTED SUITABLE SITES IN RELATION TO WATER DEPTHS FOR FIXED AND FLOATING OSW (CURRENT AND FUTURE).



Due to nearshore environmental and social constraints, as well as rapid increases in water depth proximal to the shore, the majority of the South African OSW development opportunity is floating OSW at 75–500 m depths. Opportunities for fixed OSW development are relatively limited.

FIGURE 25: ESTIMATED MW CAPACITY PER SELECTED REGION (ASSUMING 3 MW / KM^2).



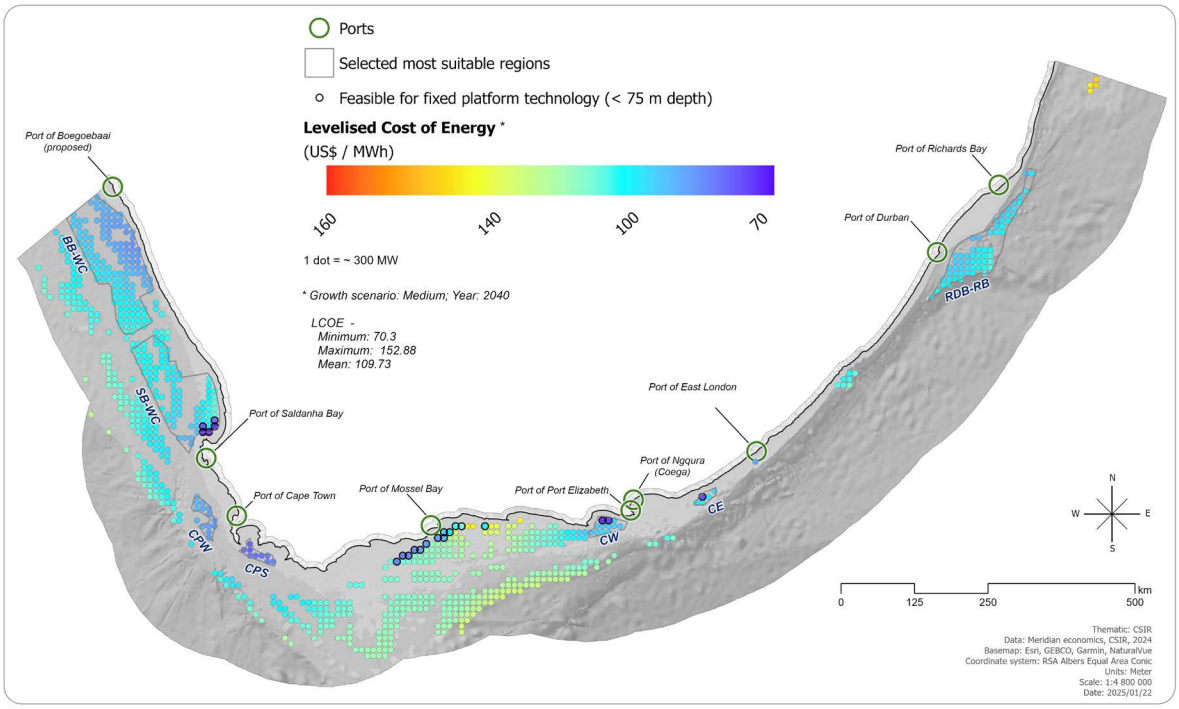
	BB-WC	SB-WC	CPW	CPS	CW	CE	DRB-RB
Floating (500 - 1300m)	0	-	-	-	-	-	15,207
Floating (75 - 500m)	39,675	24,374	3,846	2,643	3,334	1,053	2,186
Fixed (60-75m)	-	873	-	95	653	557	-
Fixed (0-60m)	-	584	-	57	107	-	-

BB-WC: Boegoebaai (proposed) - West Coast; SBWC: Saldanha Bay - West Coast; CPW: Cape Point West; CPS: Cape Point South; CW: Coega West; CE: Coega East: DRB-RB: Durban - Richards Bay.

6.3.4. Levelised cost of energy

The spatial pattern of the LCOE highlights how much cost is driven by water depth and proximity to ports. The Durban-Richards Bay area is expected to have a relatively higher LCOE, while more favourable LCOEs may characterise the regions around Cape Town (Cape Point West and South).

FIGURE 26: LEVELISED COST OF ENERGY FOR OFFSHORE DEVELOPMENT IN THE LEAST CONSTRAINED AND SELECTED SUITABLE REGIONS.



6.3.5. Conclusion

South Africa has highly favourable OSW resources, with much of the EEZ experiencing mean wind speeds above 8 m/s large areas above 9 m/s. Based on critical technical, environmental, and social constraints, seven regions have been identified as the most suitable for OSW development under the *Strategic Framework for Offshore Wind Development in South Africa.* Collectively, these regions offer a potential capacity of up to 95 GW, assuming a density of 3 MW/km², with 80% of this potential located in areas with water depths between 75 m and 500 m.

Technical constraints, especially bathymetry (water depth), significantly shape OSW development potential, particularly along the east coast. Beyond technical limitations, priority environmental and social concerns — including MPAs, CBAs, MIBAs, and shipping lanes — must also be considered. Currently, shipping in South Africa's EEZ is dispersed and lacks coordinated management. Moreover, the coast is home to unique and sensitive ecosystems like estuaries, which should be factored into decisions regarding where OSW cables come ashore.

At the project level, finer resolution assessments will be necessary. Developers must use high-quality, up-to-date data to assess whether to pursue specific projects. This is discussed in further detail in Chapter 19: Bankability considerations.

The mitigation hierarchy (Avoid, Minimise, Restore, Offset) [133] should guide all planning and development efforts. While the strategic-level study has already designated several critical environmental and social features as 'exclusion' areas to help identify broadly suitable regions for OSW, a wealth of additional data (existing, modelled, or collected in situ) should be reviewed during site-specific project planning.

As the OSW sector grows, marine conservation and spatial planning should integrate the most recent evidence regarding the potential risks and benefits of OSW development on the South African EEZ's environmental and social features. Opportunities for co-existence, biodiversity enhancement [134] and mutual benefits between OSW and other marine activities should be actively explored. For example, when co-located, OSW facilities could potentially enhance the conservation potential of MPAs by serving as refuges for marine biodiversity.

6.4. RECOMMENDATIONS

Development decisions must be based on fine-scale investigation, ground-truthing, assessment and stakeholder engagement to maximise potential benefits and minimise adverse impacts and conflict between OSW development and other marine activities. The following recommendations are made based on this analysis to guide regulators and developers to support harmonious planning for OSW:

- **GEO1 / E&S2.** Key government departments, like DEE and DFFE, should engage with the International Maritime Organisation, the South African Department of Transport (DoT) and the South African Maritime Safety Authority (SAMSA) to improve the coordination and structure of shipping movements (shipping lanes) alongside MSP. A desktop study of shipping and offshore wind interaction in South Africa should be leveraged as a supportive precursor to this engagement.
- **GEO2.** In addition to collecting more comprehensive wind and metocean data (MET1) a desktop appraisal of seabed conditions, building on existing geological and physical process knowledge, should be carried out and incorporated into any future constraints analysis.
- **GEO3.** Research institutions, relevant authorities and representative bodies should conduct further analysis to explore the potential benefits and impacts of OSW development on South Africa's unique ecosystems and existing marine activities. This research should aim to identify opportunities for coexistence or co-benefits alongside OSW development, such as protecting fish spawning areas.
- **GEO4 – MED-HIGH.** Building on REG5 and with consideration of REG9, the DEE and DFFE should work together, alongside other relevant departments and agencies, to identify future floating OSW development areas by comparing projected LCOE to the cost of grid upgrades to further understand investment trade-off, using this to inform future leasing rounds.

7. OFFSHORE WIND GROWTH SCENARIOS

7.1. PURPOSE

The costs, supply chain requirements and infrastructure needs in South Africa will be impacted by the scale and speed at which OSW is developed in the country. This chapter outlines three potential growth scenarios for OSW development, which are the basis for determining the associated costs, benefits, supply chain and infrastructure requirements.

7.2. METHOD

7.2.1. Development of growth scenarios

Dating back to 2010, South Africa has developed various IRPs, which formed the basis for public procurement of new generation capacity. The methodology underpinning these IRP studies includes optimisation modelling to determine the least cost energy system under different assumptions and constraints. To date, OSW has not been explicitly included as a technology option in the IRP optimisation modelling. Three scenarios are explored in this report, *A Strategic Framework for Offshore Wind Development in South Africa*, for the potential growth of the South African OSW market.

Much like the IRP, the scenarios explored in this report, *A Strategic Framework for Offshore Wind Development in South Africa*, have sought to align with the country's socio-economic objectives for economic growth, employment creation, energy security and decarbonisation, and consider how the introduction of OSW could affect the price of electricity. Rather than setting targets for deployment, these scenarios aim to explore the impact of different growth trajectories. Given that the timeframes for OSW development are typically significantly longer than for onshore wind projects, 2035 is considered the first year that OSW projects would be operational across all scenarios. It is assumed that all suitable fixed OSW is developed prior to floating OSW, given the more favourable economics, except in the case of the high growth scenario. Actual deployment will therefore vary in both quanta, timing and the extent to which fixed bottom and floating OSW is deployed.

Under all scenarios, we expect there to be an initial period of scale up from pathfinder projects to commercial development. The World Bank uses the term "pathfinder projects" to describe the first projects developed in a new market that can help pave the way for future commercial development. Although pathfinder projects in South Africa may be smaller than commercial projects in established markets, these would still help establish an understanding of local challenges and risks, as well as opportunities.

7.2.2. Estimation of electricity emissions reduction

The carbon emissions reduction associated with each OSW growth scenario was estimated. This analysis assumes OSW will replace either coal or OCGT on this electricity system. Installed capacity data relates to the IRP reference case as presented by Meridian Economics in "Review of the IRP 2023". [135] Capacity factors for generation technologies have been acquired from the same report.

Demand is kept constant across all three deployment scenarios. The estimate of emission reduction does not consider demand trajectory growth in the high growth scenario. However, this analysis does consider and account for offshore wind generation for P2X use cases in the high growth deployment scenario. We have apportioned approximately one third of OSW generation to provide P2X applications. This is calculated following the replacement of coal and some gas on the system, whilst still ensuring security of supply. It is assumed that when OSW is used for P2X application it does not contribute to system emissions reduction in South Africa.

7.3. RESULTS AND DISCUSSION

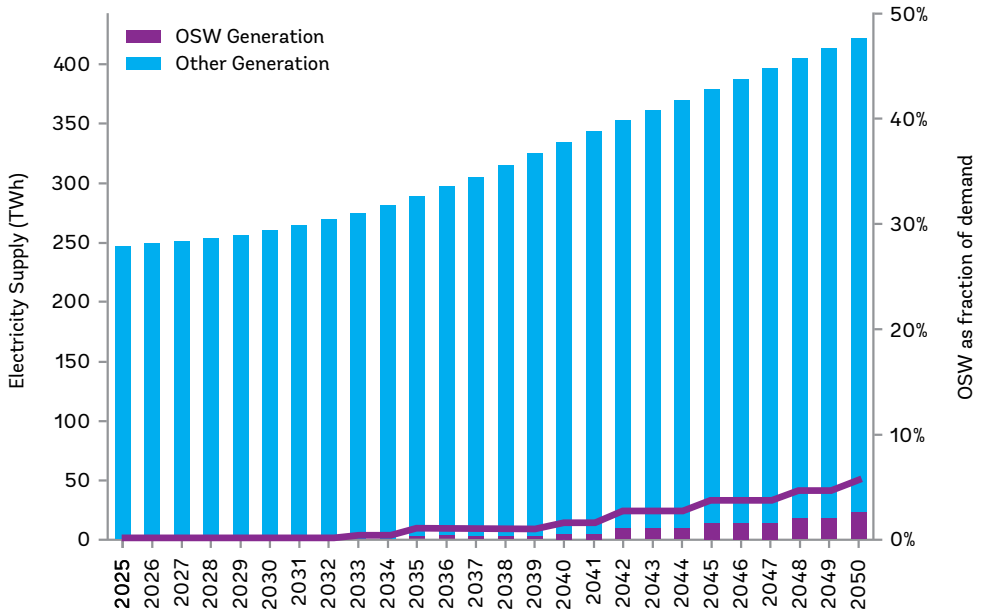
7.3.1. Low growth scenario

The low growth scenario envisages a gradual growth in OSW capacity in South Africa. Under this scenario, there is an initial deployment of 500 MW by 2035, increasing to 1 GW by 2040 and reaching a total of installed capacity 5 GW by 2050.

The geospatial analysis presented in this report has determined a potential capacity of 2.7 GW of fixed OSW capacity in the areas that were identified as most favourable, combined with 92 GW of floating OSW potential. The low growth scenario assumes that all fixed OSW sites will be developed to the full identified potential by 2045, combined with a limited further deployment of 2.3 GW of floating OSW. The identified suitable regions for fixed OSW include Saldanha Bay — West Coast and Coega (East and West).

The electricity demand profile of the draft IRP 2023 is assumed in the low scenario. This trajectory assumes accelerating growth in electricity demand post 2030, reaching 422 TWh by 2050 (from 243 TWh in 2023). This demand profile is assumed for both the low and medium growth scenarios. The average blended capacity factors calculated for the fixed and floating OSW regions identified in this report for the low scenario are 47% and 57% respectively, excluding any additional external curtailment. Under these assumptions OSW generates 6% of the national energy demand by 2050 (see Figure 27).

FIGURE 27: ELECTRICITY MIX FOR THE LOW GROWTH SCENARIO.



7.3.2. Medium growth scenario

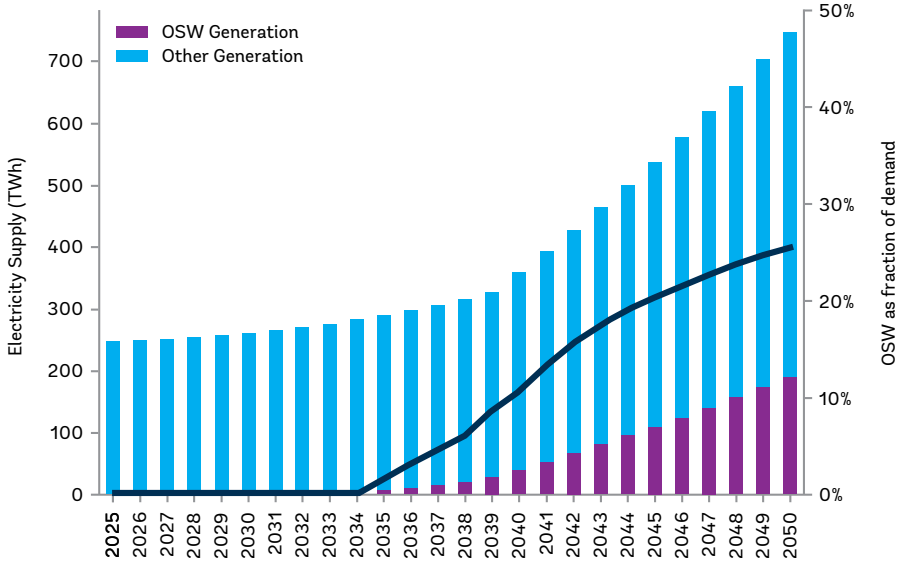
The medium growth scenario assumes there is a strong and consistent growth in OSW deployments. Candidate fixed OSW sites are assumed to be fully utilised by the late 2030s (2.7 GW), resulting in a subsequent shift to floating OSW deployment. It is assumed that scaling up of supply chains and reducing costs lead to increasing rates of floating OSW (1 GW/yr post 2037). Under the medium growth scenario, the cumulative installed capacity increases to 5 GW by 2040 and 15 GW by 2050. The calculated blended capacity factor for the 12.3 GW floating OSW capacity required by 2050 is 55%, as additional lower resource sites are required to meet the capacity targets. Under the medium scenario assumptions OSW contributes 17% to the national energy mix by 2050, excluding curtailment impacts.

7.3.3. High growth scenario

The IRP 2023 demand projections exclude the additional demand for green hydrogen production. South Africa's Green Hydrogen Commercialisation Strategy estimates that the country has an export potential of between 1.9 and 8 Mt/y of green hydrogen equivalent by 2050.[136] Therefore, significant potential exists to increase the demand for new renewable energy generation. Assuming a 75% electrolyser efficiency, this will increase the demand for renewable electricity by between 95 and 400 TWh. Assuming an additional 300 TWh of demand materialises from a combination of green hydrogen export projects, and local electrification of process heat and transportation, the electricity demand could reach 722 TWh by 2050. This rapidly increasing demand for renewable electricity is a key enabler for further scaling up OSW development in the country.

Therefore, the high growth scenario assumes that there is a rapid and consistent growth in demand for OSW projects, reaching an expansion rate of 3.5 GW/yr by the late 2040s, and a total installed capacity of 40 GW by 2050. Figure 28 shows that under this assumed demand trajectory, the high growth scenario would meet 26% of demand (excluding curtailment).

FIGURE 28: ELECTRICITY MIX FOR THE HIGH GROWTH SCENARIO ASSUMING SIGNIFICANT GROWTH DUE TO SECTOR COUPLING OF ELECTRICITY TO HYDROGEN, HEAT AND TRANSPORTATION.



7.3.4 Summary of volumes and timing

A summary of the volumes and timing of new OSW capacity is provided in Figure 29. The medium growth scenario can be achieved through a consistent deployment of 1 GW/y between 2037 and 2050. Achieving the high growth scenario will require a rapid scaling up of the local supply chains in order to support the deployment of between 2-3.5 GW/y between 2040 and 2050.

FIGURE 29: VOLUME AND TIMING OF OSW CAPACITY UNDER EACH GROWTH SCENARIO.

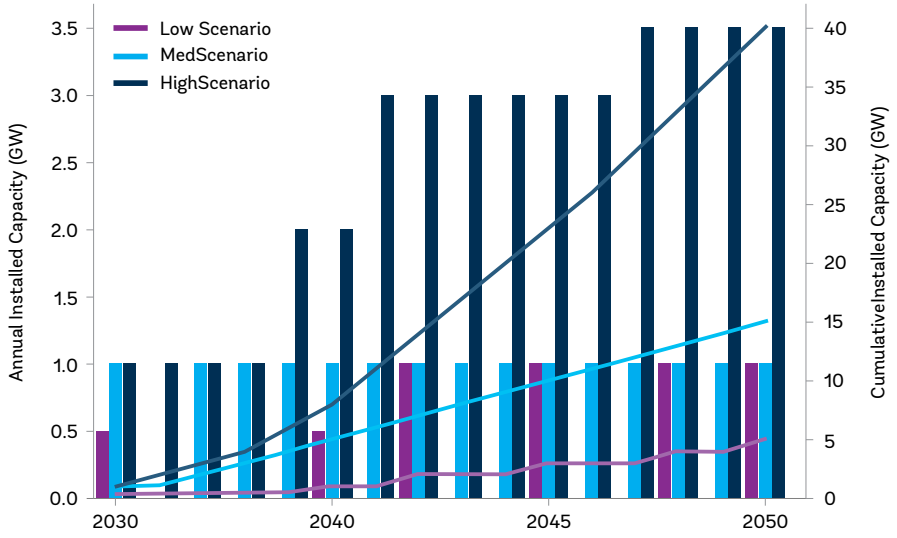


TABLE 14: CUMULATIVE VOLUME OF OSW CAPACITY UNDER EACH GROWTH SCENARIO IN 2035, 2040 AND 2050.

Scenario / Year	2035	2040	2050
Low growth	500 MW	1 GW	5 GW
fixed OSW	500 MW	1 GW	2.7 GW
floating OSW	0 MW	0 GW	2.3 GW
Medium growth	**1 GW**	**5 GW**	**15 GW**
fixed OSW	1 GW	2.7 GW	2.7 GW
floating OSW	0 GW	2.3 GW	12.3 GW
High growth	**1 GW**	**8 GW**	**40 GW**
fixed OSW	1 GW	2.7 GW	2.7 GW
floating OSW	0 GW	5.3 GW	37.3 GW

7.3.5. Emissions reduction potential

Across the range of deployment scenarios, OSW can contribute to electricity generation emissions reduction of up to 15 $MtCO_2$ by 2035, 96 $MtCO_2$ by 2040, and 530 $MtCO_2$ by 2050.

TABLE 15: CUMULATIVE ELECTRICITY GENERATION EMISSIONS REDUCTION ASSOCIATED WITH OSW IN THE LOW, MEDIUM AND HIGH GROWTH SCENARIOS IN 2035, 2040 AND 2050.

	2035 (cumulative)		2040 (cumulative)		2050 (cumulative)	
	Installed Capacity (GW)	Emissions Offset ($MtCO_2$)	Installed Capacity (GW)	Emissions Offset ($MtCO_2$)	Installed Capacity (GW)	Emissions Offset ($MtCO_2$)
Low growth deployment	0.5	7.58	1	29.41	5	141.53
Medium growth deployment	1	15.15	5	66.21	15	362.30
High growth deployment	1	15.15	8	96.06	40	530.34

7.4. RECOMMENDATIONS

- **SCEN1** – The DEE should carry out a time-series analysis, comparing the temporal profile of OSW, onshore wind and solar PV to identify synergies in their outputs and to inform target-setting (REG1) and wider energy system planning.

8. LEVELISED COST OF ENERGY

8.1. PURPOSE

The rate of deployment of OSW in South Africa will be dependent on how its costs and benefits evolve relative to an existing onshore renewables market, and the dominant fossil fuelled generation. Although LCOE is an incomplete metric because it doesn't include wider economic benefits such as investment and job creation, it is useful to compare generation technologies with a wide range of different characteristics. It is often used, alongside other metrics, to understand a technologies potential role and impact on the wider energy system. LCoE should not be reviewed in isolation but alongside the wider factors such as environmental, economic and energy system impacts.

This chapter describes how the LCOE of OSW is expected to change between 2035 and 2050 under different scenarios of local deployment in South Africa.

8.2. METHOD

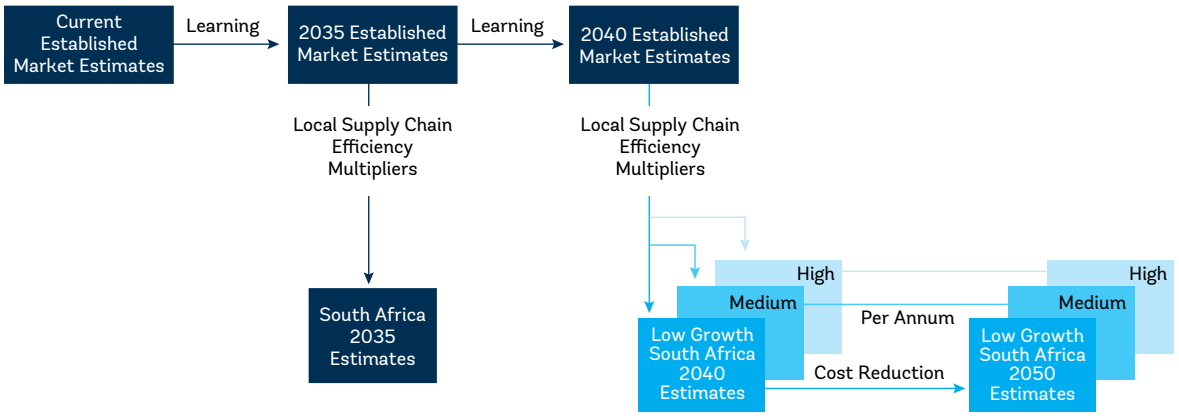
8.2.1. Overview of LCOE modelling approach

Bottom-up cost modelling was used to determine the LCOE for both fixed and floating OSW projects, including capital costs (CapEx) and operating costs (OpEx), Annual Energy Production (AEP), lifetime and discount rate. CapEx and OpEx were disaggregated into the following individual categories:

- Development expenditure
- Turbine
- Foundation
- Array cables
- Installation of generating assets
- Offshore substation
- Installation of transmission assets
- Operation and planned maintenance
- Unplanned service

An overview of the modelling approach is presented in Figure 30 below.

FIGURE 30: SCHEMATIC ILLUSTRATING CONVERSION FROM ESTABLISHED TO SOUTH AFRICAN MARKET CONDITIONS.



8.2.2. Baseline cost assumptions

CapEx values

We have assumed that major components could be imported from two major markets: Europe and China. We used baseline fixed and floating cost information from established markets, including Europe and China. We assumed European baseline costs for all elements assumed to be manufactured locally or imported from Europe, based on data published by The Crown Estate.[137] [138] As turbines could feasibly be imported from China as opposed to Europe, Chinese baseline CapEx costs were assumed for turbines in all scenarios, and foundations when they are assumed to be imported rather than locally manufactured.

All cost data introduce unique challenges and caveats. The best available European baseline cost data from both 2019 and 2023 were used to generate CapEx inputs for the LCOE modelling. Although cost figures were compared and adjusted, some data comes from a period of unusually high inflation. Detailed cost data for China, the largest OSW market, are not published, but the International Renewable Energy Agency (IRENA)'s Renewable Power Generation report indicated that CapEx costs for China were about 28% lower than CapEx costs for Europe in 2022.[139] In the absence of detailed, bottom-up costs, we assume that Chinese CapEx costs are 28% less than European costs.

CapEx spend profile

The capital expenditure is not captured at a single point but spread out over the project development phase (assumed to be 4 years) and construction phase (assumed to be 3 years), which together are assumed to take 7 years.

Decommissioning and contingency

Additional factors contributing to the LCOE are:

- Decommissioning costs, which have been estimated at 2% of the total CapEx and account for the removal of the wind farm infrastructure at the end of its operational life; and
- Contingency costs, which address any unforeseen increases in project development expenditure, and have been assumed to be 5% of project development CapEx.

Weighted average cost of capital

All currencies used in this section are real 2023 US$.[8] The LCOE is calculated on a pre-tax basis and assumes the capital structure remains constant throughout the lifetime of the project. Given the high upfront investment costs of OSW, the cost of financing greatly impacts the LCOE. In this work, a real weighted average cost of capital (WACC) was used to account for the cost of financing OSW projects, considering both debt and equity capital. In the low growth scenario, a higher WACC of 7.5% is assumed, which is slightly lower than the real post-tax WACC (8.2%) used by the South African Treasury in evaluating the cost of energy. In the high growth scenario, the WACC is assumed to decrease due to potential access to concessional financing, which could incentivise OSW development.

8.2.3. Projected cost reductions for established markets

Global trends in technological innovation are projected to drive CapEx and OpEx cost reductions in the established market through to 2040. Potential advancements include:

- Larger, more efficient wind turbines;
- Advancements in foundations for floating OSW;
- Supply chain efficiency improvements as more capacity is deployed;
- Improvements across operation and maintenance regimes.

Projecting costs multiple decades in the future is filled with uncertainty. Therefore, it is critical to consider a range of potential future costs. There are a limited number of studies that consider how the different cost components an OSW farm will decline over time. One of the more comprehensive studies by InnoEnergy [140] identified 57 potential innovations that will decrease the CapEx and OpEx for OSW projects between 2020 and 2033. This data was used as a baseline and extrapolated to 2035 and 2040. As this reference study is based on fixed OSW development, which is more mature than floating OSW development, additional cost reductions have been applied to the relevant floating OSW components that are less mature. Using this approach, the overall CapEx in US$/MW is similar to other established market projections for fixed and floating OSW, such as the NREL Annual Technology Baseline.[141]

8 While every effort has been made to ensure consistency in the analysis presented here, this chapter uses 2023 USD in real terms. Variations in the base year or currency adjustments across other sections may exist. Readers are advised to interpret cross-chapter comparisons with caution.

The projected cost reduction resulting from these innovations was applied to the Established Market LCOE (see 'learning' in Figure 30. Schematic illustrating conversion from established to South African market conditions.), which subsequently informed South Africa cost estimates along with local content multipliers.

8.2.4. Local supply chain

As South Africa is a new market, using established market costs would present an overly optimistic LCOE. To account for this discrepancy, local factors have been incorporated to determine South African costs for 2035 and 2040. These local considerations include changes in new market efficiencies, cost base and site conditions, described below.

Typical changes in productivity in a new market: considers the learning curve effect in a new market. Projects installed in 2035 would have lower productivity compared to the established market and would therefore have higher energy costs. However, as the market and local offshore industry gains experience and expertise, productivity is assumed to increase, leading to cost reductions over time.

Typical changes in the cost base: accounts for differences in cost between South Africa and the established market. Costs considered here are labour cost and equipment cost for categories that are assumed to have a high likelihood of localisation as the market evolves. These factors are based on the analysis outlined in Chapter 12: Supply Chain Analysis.

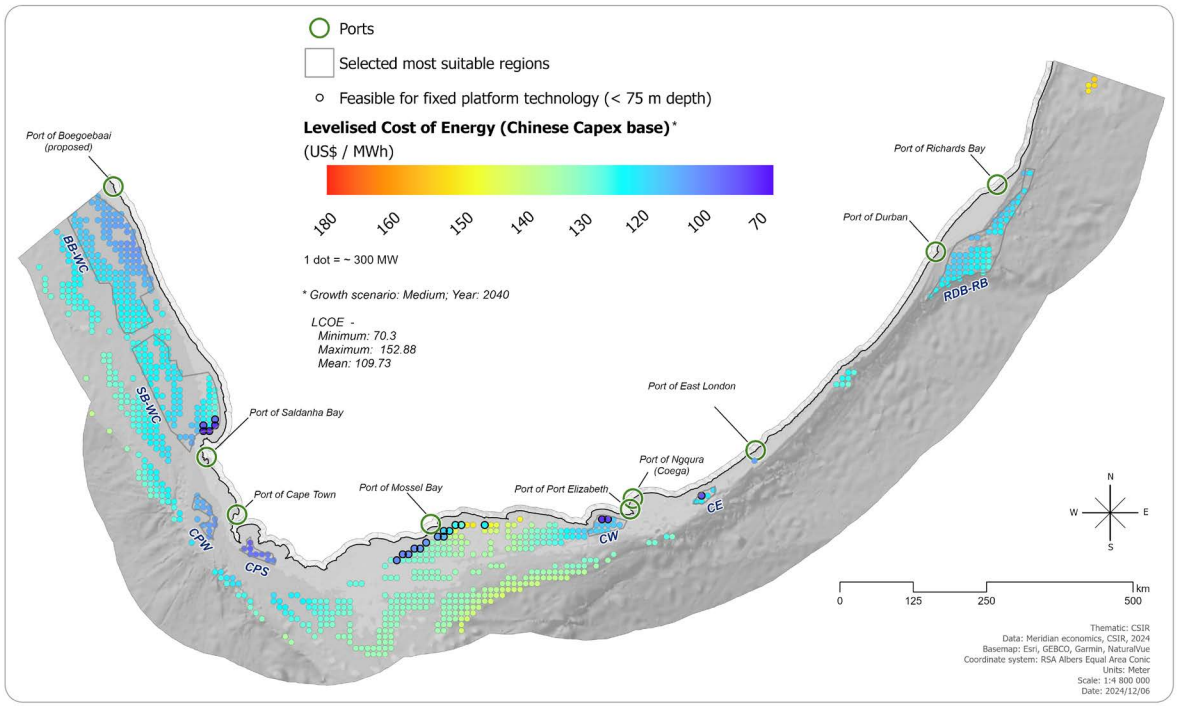
Typical changes in site conditions: considers South African project site conditions such as wind speed, water depth and distance from the coast.

The scaling from established market to the South African market has been carried out using a bottom-up approach, where each of the individual cost inputs are considered based on the supply chain analysis conducted in this study.

Appendix 5 summarises the differences in South Africa and established market costs at an aggregate CapEx and OpEx level based on changes in efficiency, cost base and site conditions.

South Africa benefits from relatively low local labour costs. Initially, the lack of established local supply chains will contribute to a higher cost of deploying OSW in South Africa relative to established markets. South Africa is geographically removed from established OSW markets and would not initially benefit as much from the economies of scale available in mature markets. No regional OSW specific supply chain exists, and any localisation would have to be led by South Africa. However, local labour costs are significantly lower than in some established markets such as Europe, so accelerating the localisation of supply chain will not only reduce costs but also help support the local economy and job creation. As more capacity is deployed in South Africa over time the supply chain efficiency multipliers will improve and reduce the costs further.

FIGURE 31: CALCULATED LCOE IN 2040 UNDER A MEDIUM GROWTH SCENARIO, BASED ON SITE SPECIFIC PARAMETERS.



8.2.5. Mapping the LCOE across potential regions

LCOE was calculated across a total of 823 locations along the South African coastline using combined European and Chinese CapEx costs as described previously. At each location input data on wind speed, water depth, distance from port and distance to the transmission network was used to determine a site specific LCOE. This was completed for the years 2035, 2040 and 2050 under each growth scenario. At each location, the water depth metric was used to determine if fixed or floating OSW is applicable. Figure 31 shows the distribution of calculated LCOEs for 2040. Each dot represents an area with the potential of ~300 MW. In general, the lowest LCOEs are found in proximity to the coastline and progressively increase as the water depth and distance to shore increases. The analysis also highlights a wide range of potential LCOEs in 2040.

8.2.6. Representative projects by region

Whilst the spatial mapping of LCOE illustrates the range in projected costs across various potential sites, it is also useful to consider representative projects in each of the 7 broad regions identified in Chapter 6: Geospatial Analysis.

This analysis can be used to investigate how the potential costs could evolve over the coming decades. The four largest areas (Boegoebaai West Coast, Saldanha Bay West Coast, and Durban-Richards Bay), were subdivided into smaller areas to capture more variation (see Figure 32).

In each case, average values for several site characteristics were calculated for each potential OSW development area. These values were then use as inputs for the LCOE projections. A summary of the typical site characteristics under each region for candidate fixed and floating OSW sites is presented in Table 16 and Table 17 respectively.

FIGURE 32: DIVISION OF LARGER OSW POTENTIAL AREAS INTO SMALLER SUB-AREAS FOR THE LCOE ANALYSIS.

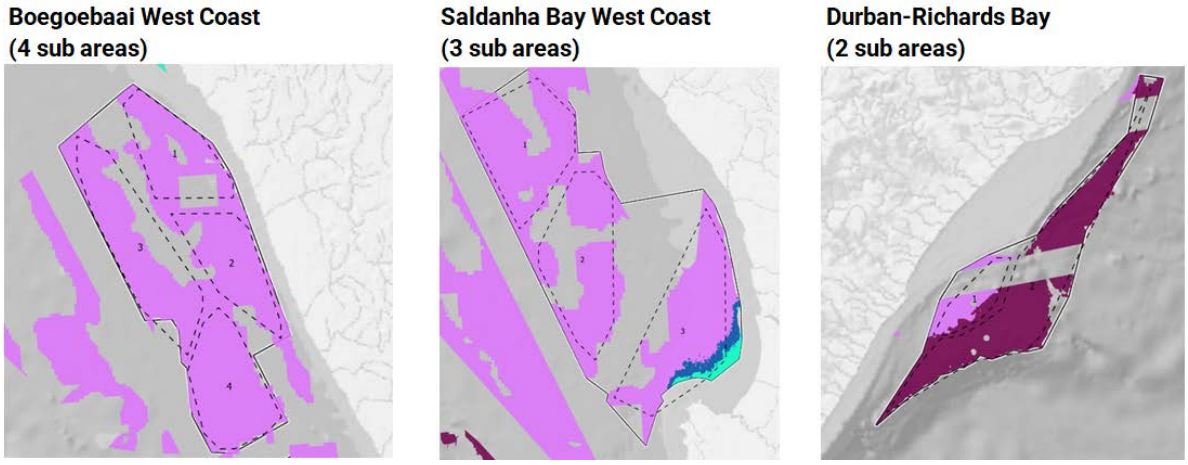


TABLE 16: TYPICAL SITE CONDITIONS FOR FIXED OSW INSTALLATIONS IN SOUTH AFRICA BY YEAR OF FIRST OPERATION FOR CANDIDATE FIXED OSW SUB-AREAS.

Development area	Potential capacity (MW)	Water depth (m)	Mean wind speed at 100m (m/s)	Capacity factor (%)	Distance from port (km)	Distance to Transmission (km)
Saldanha Bay (3s)	584	54.0	8.57	45.9%	48.5	33.4
Saldanha Bay (3d)	873	73.5	8.48	45.3%	60.3	37.7
Coega East	557	70.0	9.24	50.6%	116.4	91.0
Coega West	653	72.5	8.69	46.8%	45.9	22.7

[*]Saldanha Bay (3) has both shallow and deep areas considered as (3s) and (3d) respectively

TABLE 17: TYPICAL SITE CONDITIONS FOR FLOATING OSW INSTALLATIONS IN SOUTH AFRICA BY YEAR OF FIRST OPERATION FOR CANDIDATE FLOATING OSW SUB-AREAS.

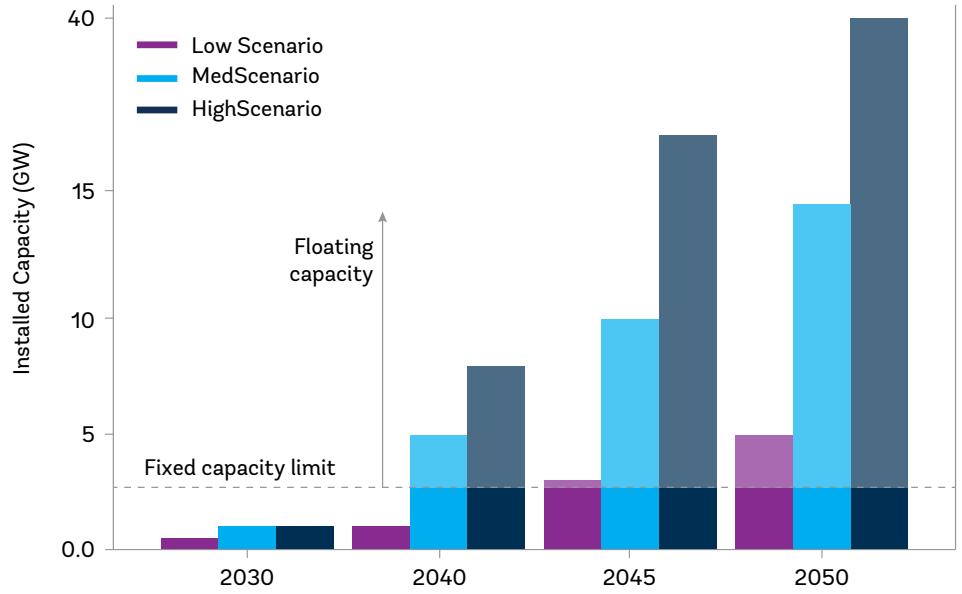
Development area	Potential capacity (MW)	Water depth (m)	Mean wind speed at 100m (m/s)	Capacity factor (%)	Distance from port (km)	Distance to Transmission (km)
Boegoebaai (1)	7 967	135.0	9.59	52.9%	60.3	46.8
Boegoebaai (2)	9 073	141.5	9.69	53.5%	131.3	41.9
Boegoebaai (3)	11 605	183.7	9.64	53.2%	125.9	94.5
Boegoebaai (4)	11 029	211.1	9.18	50.3%	210.3	69.3
Cape Point South	2 643	111.0	10.57	58.1%	75.9	37.1
Cape Point West	3 846	211.8	9.88	54.6%	56.0	56.6
Coega East	1 053	82.0	9.24	50.7%	108.5	87.0
Coega West	3 334	109.9	8.92	48.6%	52.7	32.5
Durban — Richards Bay (1s)*	2 156	389.4	9.36	51.5%	48.9	48.1
Saldanha Bay (1)	8 178	237.9	9.17	50.2%	192.1	82.5
Saldanha Bay (2)	7 982	178.0	9.35	51.4%	123.0	88.5
Saldanha Bay (3)	8 214	126.3	8.74	47.2%	79.5	42.5
Durban — Richards Bay (1d)*	954	582.0	9.43	51.9%	49.4	53.8
Durban — Richards Bay (2)	14 253	951.9	9.53	52.5%	64.7	63.0

**Durban – Richards Bay (1) has both shallow and deep areas considered as (1s) and (1d) respectively*

8.3. RESULTS AND DISCUSSION

As described previously, the LCOE of South African OSW projects will be a function of the technology cost reductions that are achieved over the coming decades (global learning) and the rate and scale which local projects are developed (local learning). For the sake of simplicity, is assumed that fixed OSW sites will be developed first followed by floating OSW sites under the low, medium and high growth scenarios, even though this may not occur in practice. Given the estimated fixed OSW potential is 2.7 GW, there is no requirement for floating OSW development in 2035. Similarly in the medium and high growth scenarios, all fixed OSW sites are fully utilised by 2040, and by 2045 in the low scenario. Therefore, no additional fixed OSW capacity is considered in 2050 in all scenarios. Figure 33 shows a comparison of when fixed and floating OSW capacity is considered in the LCOE analysis under each growth scenario.

FIGURE 33: FIXED VS FLOATING OSW CAPACITY ACROSS THE GROWTH SCENARIOS.



The LCOE for fixed OSW under each scenario is presented in (Table 18). Given the uncertainty around the timing of regions that could be developed for fixed and floating OSW, we calculate an LCOE for each region at each time period, assuming that all regions would benefit equally from the assumed learning rates and present all data. However, not all LCOEs would be applicable. For example, under all the growth scenarios fixed OSW capacity is expected to be exhausted by 2040-2045, and therefore a 2050 LCOE is not congruent with the assumptions. We include the 2050 numbers for completeness.

Each of the identified regions has a maximum possible installed capacity. The green highlighted values show how many regions would be needed to reach the required installed capacity under each scenario if regions were to be developed in order from the least to highest LCOE.

The high growth scenario assumes a lower financing cost as early as 2035, resulting in a lower LCOE than the low and medium scenarios, even in 2035. By 2040 the LCOE will reduce to between US$ 60-81/MWh. This range is primarily driven by the scale of deployment leading to improvements in the local supply chain, which lead to significant cost reductions, especially in the high growth scenario.

Note that the analysis below focuses only on LCOE and as mentioned above, this does not include wider system or connection costs. These additional costs and considerations are likely to influence the actual build-out presented on the next page.

TABLE 18: RANGE OF LCOE FOR CANDIDATE FIXED OSW REGIONS.

Development area	Potential capacity (MW)	2035 South Africa LCOE (US$/MWh)			2040 South Africa LCOE (US$/MWh)			2050 South Africa LCOE (US$/MWh)		
		Low Growth	Med Growth	High Growth	Low Growth	Med Growth	High Growth	Low Growth	Med Growth	High Growth
Saldanha Bay (3s)	584	88	88	80	81	72	60	66	56	45
Coega West	653	90	90	82	83	75	62	68	58	46
Coega East	557	98	98	88	91	78	65	75	61	48
Saldanha Bay (3d)	873	97	97	88	90	81	67	74	63	49

**Areas that are not expected to be developed in a specific year, are greyed out. Saldanha Bay (3) has both shallow and deep areas considered as (3s) and (3d) respectively.*

Overall, Table 18 and Table 19 shows that the cost premium associated with developing floating OSW over fixed OSW decreases substantially between 2035 and 2050 as the technology matures. Under the growth scenarios, floating OSW is not expected to be developed in 2035, and by 2040 the required capacity for floating OSW ranges between 1.3-5.3 GW in the medium and high scenarios. This capacity could be developed within the Cape Point region alone, which has the lowest 2040 LCOE of between US$ 63-84/MWh. Of course, this capacity could also be developed in other regions which have similar costs or for other strategic reasons such as proximity to hydrogen development. In a similar fashion, should areas like the Cape Point South Region not be available for development due to environmental and social reasons, Table 17 shows that there is a large area of capacity available at a moderate increase in LCOE (US$ 70-121/MWh) that can be used as a replacement.

Costs for floating OSW continue to decrease post 2040, especially in the high demand scenario, which results in an achievable LCOE below US$ 47/MWh by 2050. This is in sharp contrast to the low growth scenario where the LCOE remains elevated US$ 76-98/MWh. This underscores the economies of scale realised in the high growth scenario. One consideration with the high growth scenario is that to reach the required installed capacity, an increasing number of sites must be developed with less favourable conditions. However, the analysis shows that the premium to develop capacity in Boegoebaai (3) is ~8% compared to Cape Point, but the LCOE remains significantly lower than in the low and medium growth scenarios (US$ 57/MWh vs US$ 78-93/MWh).

TABLE 19: RANGE OF LCOE FOR CANDIDATE FLOATING OSW REGIONS.

Development area	Potential capacity (MW)	2035 South Africa LCOE (US$/MWh)			2040 South Africa LCOE (US$/MWh)			2050 South Africa LCOE (US$/MWh)		
		Low Growth	Med Growth	High Growth	Low Growth	Med Growth	High Growth	Low Growth	Med Growth	High Growth
Cape Point South	2 643	97	97	88	93	84	63	76	65	47
Cape Point West	3 846	108	108	97	104	92	70	85	72	51
Boegoebaai (2)	9 073	108	108	97	103	93	70	84	72	52
Boegoebaai (1)	7 967	109	109	98	104	93	70	85	72	52
Durban — Rich. Bay (1)	2 156	115	115	103	110	98	74	90	76	55
Coega West	3 334	115	115	103	110	99	75	89	77	55
Boegoebaai (3)	11 605	118	118	106	113	101	77	93	78	57
Durban — Rich. Bay (1d)	954	117	117	105	112	100	76	92	78	56
Saldanha Bay (2)	7 982	122	122	109	116	104	79	95	81	58
Saldanha Bay (3)	8 214	121	121	109	116	104	78	95	81	58
Coega East	1 053	123	123	111	118	104	79	96	81	58
Durban — Rich. Bay (2)	14 253	122	122	110	117	104	79	96	81	58
Boegoebaai (4)	11 029	124	124	112	119	106	81	97	83	60
Saldanha Bay (1)	8 178	126	126	113	121	108	82	98	84	60

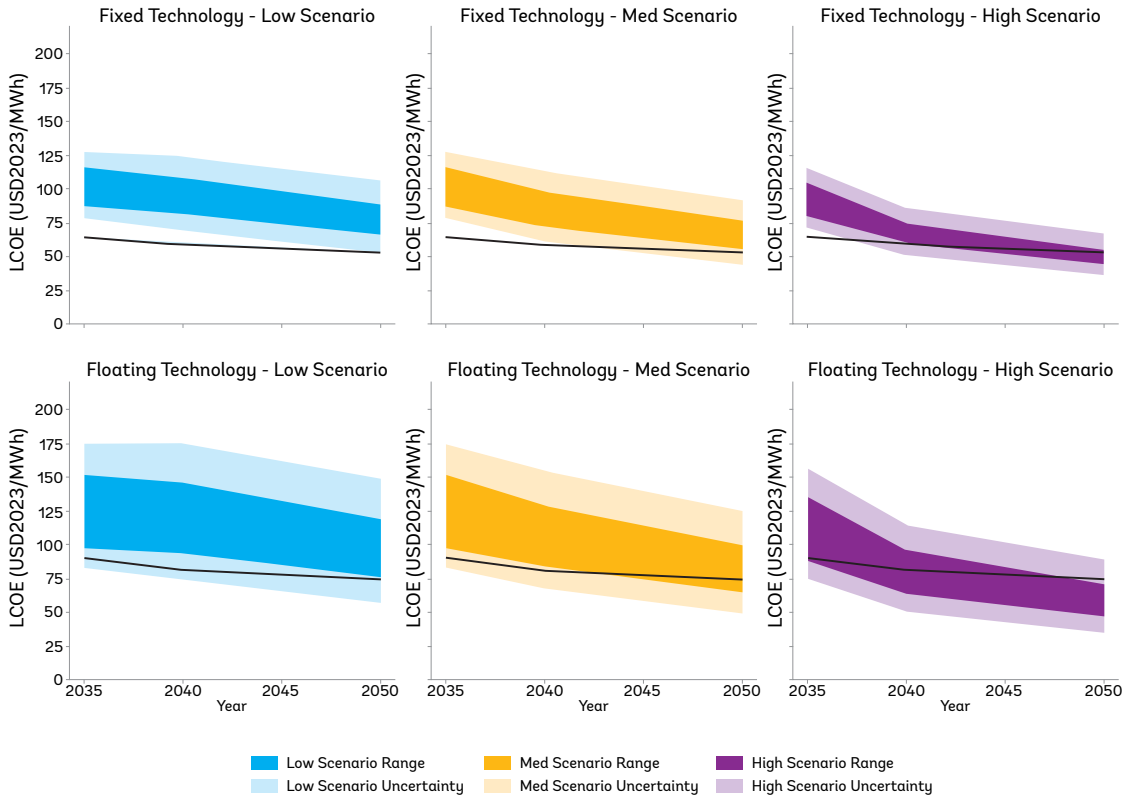
**Areas that are not expected to be developed in a specific year, are greyed out.*

It is worth noting that due to their size, these regions would likely be divided into multiple project sites.

8.3.1. LCOE reduces over time for all scenarios

Figure 34 below gives an overview of how LCOE evolves over time in each growth scenario. For clarity, we show the fixed and floating LCOEs separately. In the graphs a range of expected LCOEs is shown (the darker shaded regions), with corresponding uncertainties applied to those (as indicated by the lighter shaded regions). The upper bounds assume all European baseline CapEx and the regions with the highest LCOE, and the lower bounds assume a hybrid baseline CapEx (European baseline costs with Chinese costs for the turbines and imported foundations) and the regions with lowest LCOE. The solid black line represents European LCOE for comparison.

FIGURE 34: LCOE TRAJECTORY FOR FIXED AND FLOATING OSW IN SOUTH AFRICA COMPARED TO ESTABLISHED MARKET TRENDS.



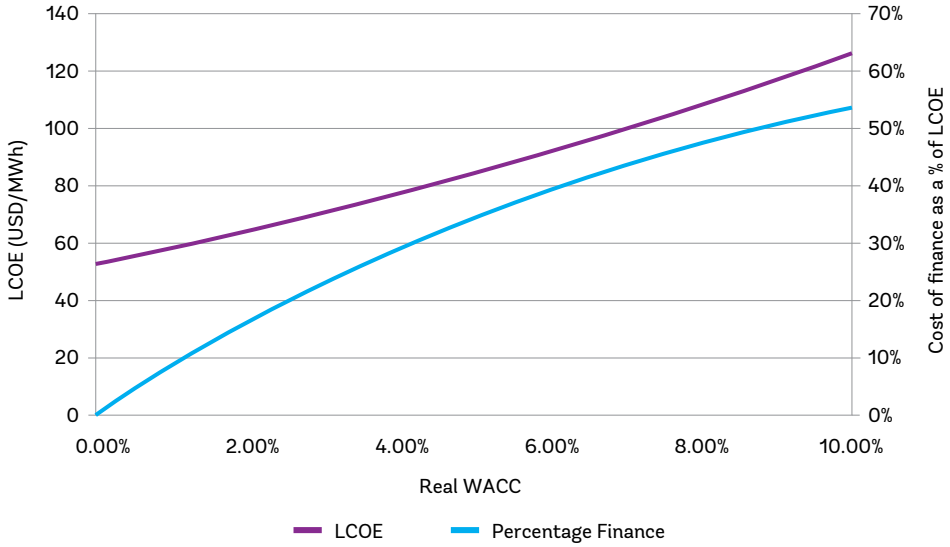
As shown above, LCOE decreases rapidly over time, and this cost reduction is most pronounced in the high growth scenario. This is mainly driven by the following factors:

- Lower capex costs due to efficiencies of scale;
- Establishment of a strong local supply chain being accelerated due to greater build-out;
- Lower local labour costs reducing LCOE through increased local supply chain;
- Lower WACC assumed for high growth scenario.

8.3.2. WACC is a key driver for LCOE

Reducing WACC has a significant impact on reducing LCOE. Figure 35 shows that reducing WACC from 7% to 4% would cause a roughly 20% reduction in overall LCOE. Therefore, the recommendations in Chapter 19: Bankability considerations should be prioritised, as they will also help reduce development risk, and therefore WACC and LCOE.

FIGURE 35: THE RELATIONSHIP OF LCOE TO WACC FOR FLOATING OSW ENERGY.



8.3.3. Importing technology from the cheapest markets reduces LCOE

Figure 36 and Figure 37 shows the breakdown of LCOE under two assumptions: first, importing components only from Europe; and second, importing turbines and floating OSW foundations from China (up until they are manufactured locally) and all other components from Europe (hybrid).

As shown in Figure 36, assuming hybrid CapEx reduces the LCOE for a representative fixed wind example from $87/MWh to $72/MWh — a significant reduction of around 18%. Figure 37 shows a similar impact of assuming a hybrid approach to procurement for floating offshore wind. The Europe-only import option results in an LCOE of $101/MWh, whereas assuming a hybrid import option results in an LCOE of $84/MWh — a 17% LCOE reduction overall.

As importing components from the lowest cost market can reduce LCOE up to 15-20%, this should be considered when developing South Africa's offshore wind market. However, there is a risk that importing from markets such as China could be seen as higher risk, as the track record for Chinese manufacturers is not fully established in the global market. This could have an adverse effect on WACC, and therefore would need to be assessed in detail by developers before any procurement strategy is finalised.

In either case, the lowest cost option for floating OSW foundations will eventually be through local supply. Therefore, local supply chain catalysation for large-scale manufacturing should be prioritised as a key enabler for LCOE reduction, as discussed further in Chapter 12: Supply Chain Analysis.

FIGURE 36: THE BREAKDOWN OF LCOE FOR FIXED OFFSHORE WIND; EUROPEAN (LEFT) VERSUS HYBRID CAPEX (RIGHT).

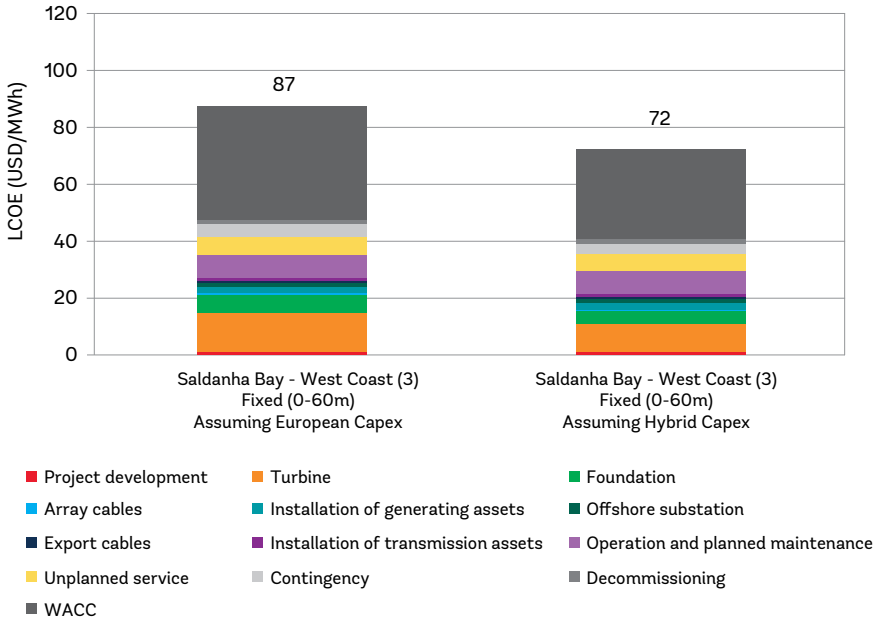
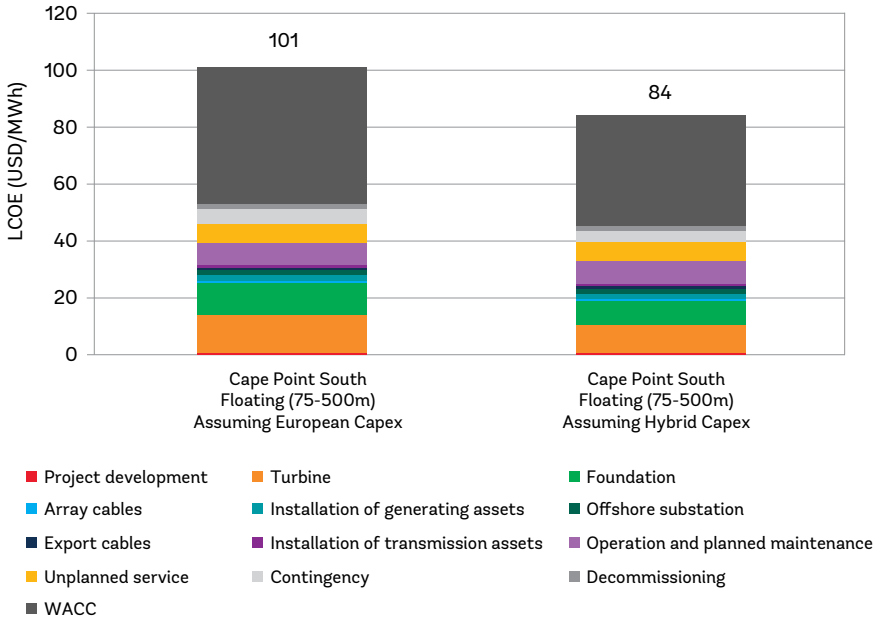


FIGURE 37: THE BREAKDOWN OF LCOE FOR FLOATING OFFSHORE WIND; EUROPEAN (LEFT) VERSUS HYBRID CAPEX (RIGHT).



8.3.4. Conclusion

A comprehensive bottom-up cost modelling exercise was completed for 823 locations in the identified suitable regions for fixed and floating OSW. Further analysis was conducted based on typical projects in each of the broad regions identified in this study for OSW development. In 2035 the anticipated LCOE of fixed OSW projects is in the region of US$ 88-116/MWh, which decreases to US$ 60-108/MWh, depending on the region and growth scenario assumed. Due to limited capacity for fixed OSW development of 2.7 GW, it is assumed that no further fixed OSW capacity will be developed after 2050.

Under all assumed growth scenarios there is sufficient fixed OSW capacity to meet anticipated deployment targets by 2035, and therefore floating OSW development in 2035 is not assumed. In 2040 the anticipated LCOE of floating OSW projects varies between US$ 63-148/MWh, reducing to US$ 47-118/MWh by 2050. The reason for such a wide variation is related to the scale of capacity deployed under the low and high growth scenarios. This analysis demonstrates that to reduce costs, an ambitious development of the local OSW industry is required. Overall South Africa has enough OSW potential to meet the high demand scenario of 40 GW by 2050, without having to pursue prohibitively expensive or otherwise challenging sites.

- The main factors that have a significant impact on LCOE are CapEx and WACC.
- CapEx costs can be brought down in all scenarios through:
- Investment in, and catalysation of, the supply chain, as discussed in Chapter 12: Supply Chain Analysis; and
- Adopting a hybrid approach to importing components, as turbines and foundations manufactured in China are cheaper than those manufactured in Europe.
- WACC also has a disproportionate impact on LCOE due to the high CapEx costs and long financing period of OSW development. Methodologies to reduce risk and cost are discussed in Chapter 19: Bankability considerations.

TABLE 20: SUMMARY OF LCOE IN US$/MWH FOR TYPICAL SOUTH AFRICAN SITES MODELLED.

Year of installation	South Africa fixed OSW low growth	South Africa fixed OSW medium growth	South Africa fixed OSW high growth	South Africa floating OSW low growth	South Africa floating OSW medium growth	South Africa floating OSW high growth
2035	88-116		80-105	No floating OSW development assumed		
2040	81-108	72-98	60-75	93-148	84-128	63-95
2050	No fixed OSW development assumed			76-118	65-99	47-70

9. GRID AND TRANSMISSION SYSTEM

9.1. PURPOSE

South Africa's electricity demand is concentrated in the northeast, aligning with the location of its coal resources and coal-fired power plants as the primary generation source. As the country shifts towards renewable energy, this geographic pattern will change. The best solar, onshore, and OSW resources are in the western and southwestern regions, where the grid is severely constrained. As with nearly all power markets, allowing more distributed generation at scale, including OSW, will require significant grid capacity and stability investment in these regions to efficiently transport power to demand centres. Addressing these grid constraints early is essential for OSW development, ensuring the necessary infrastructure is in place to support a cleaner energy mix.

This chapter assesses the current transmission capacity and the planned grid expansion and upgrades for transmission and grid connection in areas most suitable for OSW. It identifies where existing or planned grid could support OSW development, highlighting areas where OSW is well placed to meet existing demand, and those areas that will require upgrading beyond that accounted for in the current plans.

9.2. METHOD

9.2.1. Existing grid capacity compared to the identified OSW generation capacity at suitable sites

To establish a baseline, the analysis first considers the current available grid capacity and whether it is sufficient to develop the OSW capacity identified at suitable sites. The Generation Connection Capacity Assessment (GCCA) 2023 was used to analyse the grid capacity available for coastal areas. This assessment involved reviewing and assessing GCCA capacities with OSW potential in various suitable areas.

The GCCA 2023, published in October 2023, outlines the generation connection capacity of the planned transmission network, including all projects slated for commissioning by 2025. This publication follows the announcement of Bid Window Round 7 (BW7) under REIPPPP, with preferred bidders expected to be connected in 2025. The results encompass all preferred bidders from Bid Windows up to Round 6 (BW6) and include all budget quotations (BQs) issued or pending for private off-takers aiming to connect to the grid via bilateral power purchase agreements (PPAs), including wheeling agreements[9]. The GCCA assumes all planned projects are completed on time according to the 2022 TDP.

9 Wheeling is the delivery of energy from a generator to an end-user located in another area through the use of an existing distribution or transmission networks.

9.2.2. Future grid capacity under different OSW growth scenarios

The TDP is a requirement for Eskom and the NTCSA under their transmission licences, which originate from the Grid Code. The TDP aims to evaluate network needs and develop strategies to address load demand and generation integration anticipated over the next ten years. It details projects to expand or strengthen the transmission system, including those completed in the past year and those planned for the upcoming decade. The TDP 2023, used for this assessment, provides plans up to 2033.

An analysis was conducted to determine whether considering planned upgrades and assuming their completion, the transmission system can accommodate the OSW development outlined under different growth scenarios.

This study assumes that the first OSW farms will not be commissioned before 2035. Therefore, recommendations for additional possible upgrades have been made to enable longer-term connections to the grid.

9.3. RESULTS AND DISCUSSION

9.3.1. Analysis of existing grid capacity compared to the identified OSW generation capacity at suitable sites

Table 21 lists the identified OSW sites as per the Geospatial Analysis, their corresponding electricity supply areas, the available connection capacities of these areas, and the potential technical capacities within each identified area.

The comparison of the existing and planned grid capacity according to the GCCA 2023 against the potential generation capacity of OSW indicates that the only identified site with a supply area offering a reasonable amount of available connection capacity is the Durban-Richards Bay area. This supply area has a large available connection capacity of 5.78 GW. Since the first OSW farms are not projected to come online until 2035, the current grid capacity assessment may not accurately reflect future availability post-2035. Nevertheless, the large grid capacity currently available serves as a compelling incentive for advancing development in the Durban-Richards Bay region. As this region was identified as having a higher LCOE than others, this highlights the importance, discussed in Chapter 8: Levelised Cost of Energy, of taking wider impacts into account rather than focusing solely on LCOE. This is because, following a more detailed grid analysis, the region may present a lower system cost than others. Prioritising the most appropriate areas for development all round forms part of the marine spatial planning process.

Cape Point's (South and West) supply area has a limited available connection capacity of 0.2 GW, compared to a total identified technical potential of 6.7 GW (fixed and floating OSW).

The remaining OSW sites' supply areas do not have any currently available connection capacity. This grid capacity assessment in South Africa reflects those in all emerging offshore wind markets. This is principally due to the novel location and scale of OSW connection requirements.

TABLE 21: AVAILABLE CONNECTION CAPACITIES AT COASTAL REGIONS AND OSW TECHNICAL POTENTIAL BY 2025 (GCCA, 2023).

OSW Area	Supply Area	Available Connection Capacity (GW)	Technical OSW potential
Durban — Richards Bay	Pinetown	5.78	17.4GW floating
Coega (East and West)	Gqeberha	0	1.3 GW fixed 4.39 GW floating
Cape Point (South and West)	Peninsula	0.2	0.15 GW fixed 6.5 GW floating
Saldanha Bay — West Coast	West Coast	0	1.5 GW fixed 24 GW floating
Boegoebaai — West Coast	Namaqualand	0	39 GW floating

In January 2024, Eskom released an addendum to the GCCA 2025, highlighting new capacity available in the Eastern and Western Cape leveraging grid curtailment. The document states that by accepting a curtailment share of up to 10%, an additional 3,470 MW of wind power can be connected to the grid — 2,680 MW in the Western Cape and 790 MW in the Eastern Cape. It is likely that this additional available capacity will be taken up by onshore renewable energy development but it highlights the additional capacity that can be made available by using curtailment.

9.3.2. Analysis of future grid capacity for OSW under different growth scenarios

In this section, the installed capacity of OSW, as outlined in each growth scenario, is compared with the grid upgrades planned at relevant sites according to the TDP 2023 (which plans until 2033). Recommendations are provided regarding the feasibility of the mentioned growth scenario in light of the planned upgrades.

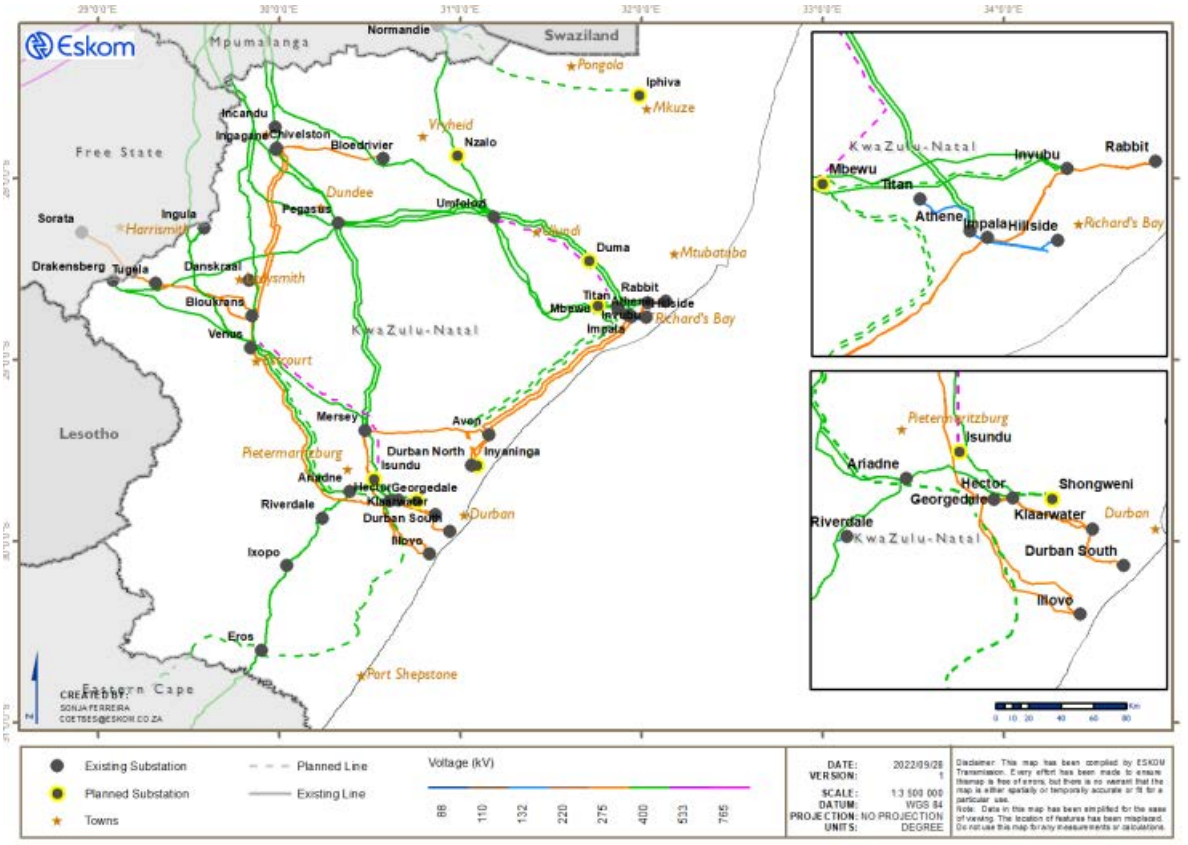
9.3.2.1. Future upgrades according to the TDP 2023 pertaining to the most suitable OSW sites

The main upgrades, as provided in the TDP 2023, which pertain to the suitable OSW sites and are summarised below.

Durban – Richards Bay

Installation of four 500 MVA 400/132 kV transformers (two at the Inyaninga substation in 2034 and two at the Shongweni substation in 2036). Additional 400 kV lines will be added between Inyaninga and Mbewu. A 765 kV reinforcement is planned between Mbewu and Isundu, with two 400 kV lines to be constructed in 2032, potentially increasing the power evacuation capacity from Mbewu. A new substation, Duma (160 MVA 400/88 kV), is planned for 2033, connecting to a network of substations near Richards Bay, which could provide additional capacity.

FIGURE 38: FUTURE KWAZULU NATAL TRANSMISSION NETWORK.

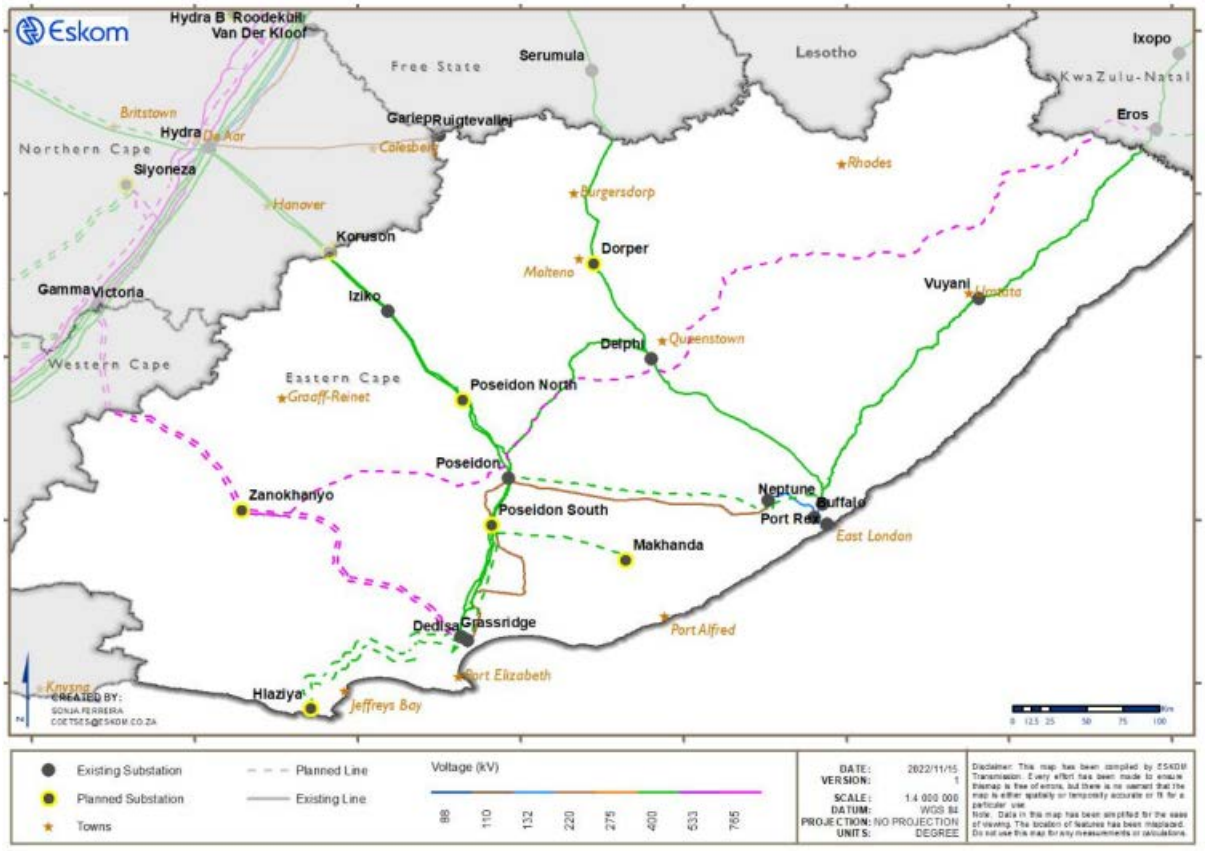


Coega (East and West)

In Coega East, the TDP plans to Install a 400 kV line from Neptune to Pembroke substation (with Neptune located near the coast), enhancing evacuation capacity. Additionally, the upgrades for Poseidon (see below) could facilitate more capacity being evacuated from Coega East, as it is interconnected with Dedisa, Neptune, and Grassridge.

In Coega West, there is the planned introduction of two 765 kV lines — one in 2029 and the other in 2031, transformer upgrades in 2027 and 2028 at Poseidon, and 2 x 400/132 kV 500 MVA transformers near the coast). Other upgrades include a 3rd 400/132 kV 500 MVA transformer in Grassridge and Dedisa, located along the coast and close to Coega West. Additional capacity in the EC is necessary to enable access to connect renewable energy by 2027. This capacity is intended to be through the first 400/132 kV 500 MVA transformer at Delphi (which is connected to Poseidon), a 4th 400/132 kV transformer at Grassridge and a 4th 400/132 kV 500 MVA transformer at Dedisa.

FIGURE 39: FUTURE EASTERN CAPE TRANSMISSION NETWORK.



Cape Point (South and West)

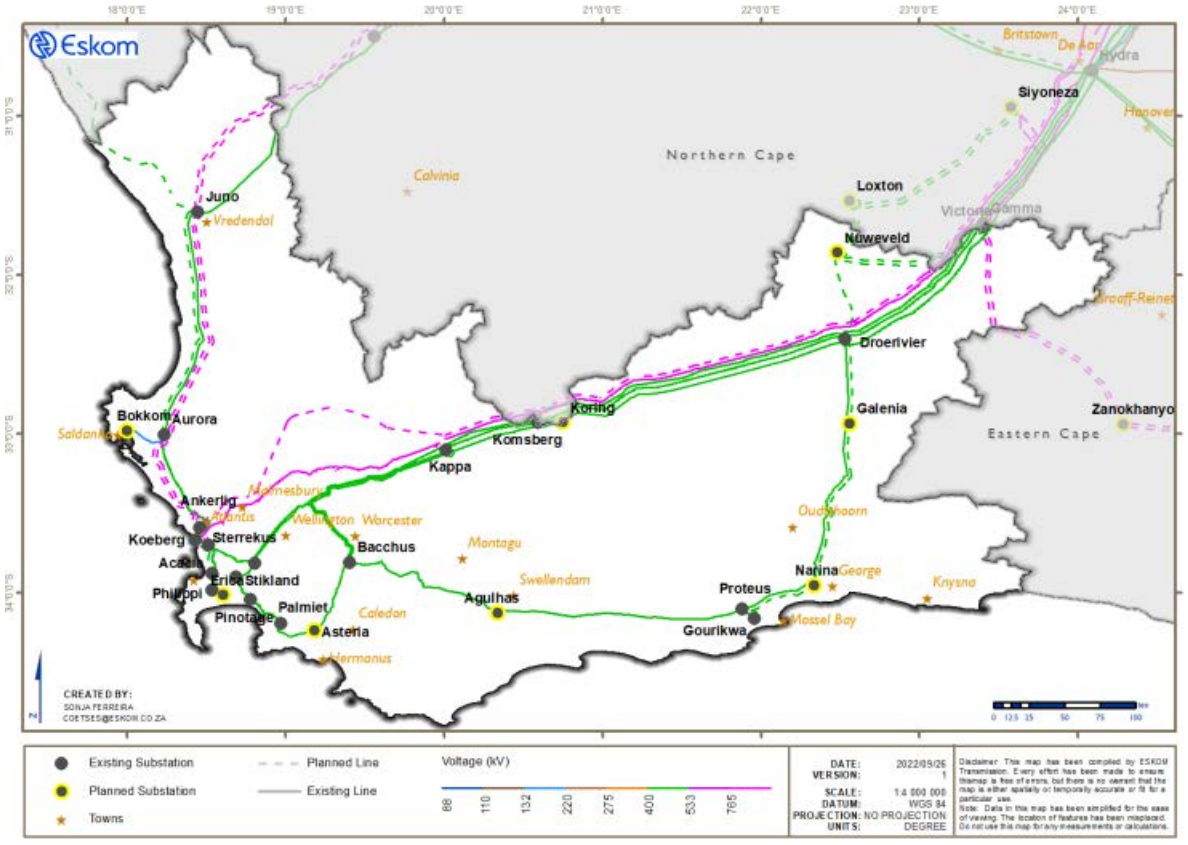
The main upgrades proposed near Cape Point South are three additional 400/132 kV 500 MVA transformers in 2028 (one at Phillipi and two at Erica substations), including one 400 kV Phillipi-Erica line. Two 400/132 kV transformers are proposed at the Asteria substation in 2026. There will be a loop-in-loop-out with Pinotage-Stikland substations and Erica and another 400 kV loop-in-loop-out of Asteria with Palmiet and Bacchus in 2026.

The main upgrade proposed near Cape Point West is a 765 kV line, which would increase the evacuation capacity.

Saldanha Bay — West Coast

In Saldanha Bay, Eskom plans the installation of four 500 MVA 400/132 kV transformers (2 x at the Inyaninga substation in 2034 and 2 x at the Shongweni substation in 2036). Additional 400 kV lines will be connected between Inyaninga-Mbewu. There is a planned 765 kV strengthening between Mbewu and Isundu, where two 400 kV lines will be constructed in 2032. This could increase the amount of power that can be evacuated from Mbewu. A 765 kV upgrade is planned between Mbewu and Isundu, with two 400 kV lines scheduled for 2032. This enhancement could increase Mbewu's power evacuation capacity. A new substation named Duma (160 MVA, 400/88 kV) is also planned for 2033. This substation will be connected to a network of substations near Richards Bay, potentially providing additional capacity.

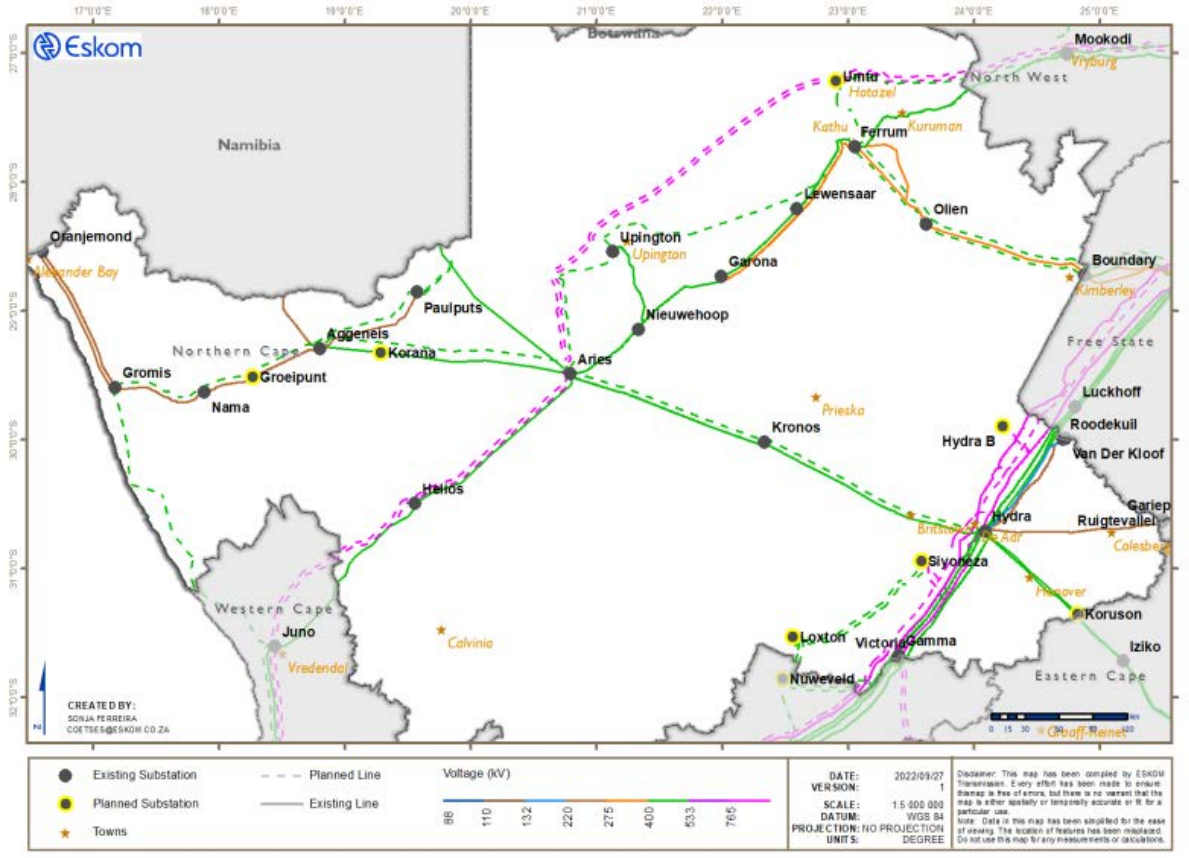
FIGURE 40: FUTURE TRANSMISSION NETWORK OF THE WESTERN CAPE.



Boegoebaai — West Coast

The main upgrades for Boegoebaai are the extension of a 400 kV network (Gromis to Oranjemund substations) to increase network reliability and capacity in 2029, the construction of a Juno-Gromis 400 kV line in 2024, and the strengthening of the Aries-Gromis corridor (400 kV line construction) 2029.

FIGURE 41: FUTURE NORTHERN CAPE TRANSMISSION NETWORK.



9.3.2.2. Available grid capacity for OSW under different growth scenarios by 2033

The analysis of the proposed upgrades within the TDP 2023 to determine whether sufficient grid capacity will be available for OSW under the low, medium, and high growth scenarios yielded the following results:

Fixed OSW capacity under the low growth scenario is feasible, given only the planned upgrades

The low growth scenario includes 2.7 GW of fixed OSW and 2.3 GW of floating OSW. Majority of the floating OSW capacity will only be developed between 2045-2050. Coega West, Coega East, Cape Point South, and Saldanha Bay are the identified resource sites for this growth scenario. The potential generation capacity for each site for fixed OSW are 760 MW, 557 MW, 152 MW and 584 MW, respectively. Considering the planned upgrades in the vicinities of the identified sites, Coega West should be able to accommodate 760 MW, given that several transformer and line

upgrades are included for this area. At Cape Point, fixed OSW (200 MW) should be accommodated with these upgrades. Saldanha Bay also has 500 MVA transformers and additional 400 kV lines, which could contribute to increased evacuation capacity. Accordingly, the fixed OSW capacity under the low growth scenario is feasible for the identified areas, considering the upgrades planned in the TDP by 2033.

The medium growth scenario requires further grid upgrades and additional connection capacity

The identified sites for this growth scenario are Coega West, Coega East, Cape Point South and Saldanha Bay. For Cape Point South, at least six 500 MVA transformers are included by 2028, an additional 2,000 MVA capacity. Fixed OSW (200 MW) should be accommodated with these upgrades and the initial pathfinder projects in these regions could potentially supply power to industrial sites in Special Economic Zone in each of these regions. Floating OSW is included in this scenario from 2040. Some of this capacity could be evacuated with the planned upgrades, but further upgrades will be required. The floating OSW capacity for Cape Point South is 2,643 MW, with similar amounts assumed for Coega West, Coega East and Saldanha Bay West for fixed and floating OSW. Accordingly, the medium growth scenario is only feasible for fixed OSW. Still, the planned upgrades are insufficient to accommodate all the capacity of the floating OSW. Further upgrades will therefore be required to enable OSW development of this scenario.

The high-growth scenario requires significant grid upgrades and additional connection capacity.

The identified sites for this growth scenario are Coega West, Coega East, Cape Point South, Durban-Richards Bay, Cape Point West, Boegoebaai and Saldanha Bay West. As with the medium growth scenarios, fixed OSW is likely to be accommodated at the various sites considering the planned upgrades, but the capacities of the floating OSW well surpass any upgrades that have been planned. Accordingly, as the most ambitious, the high growth scenario will require significant grid upgrades and additional connection capacity. The growth in electricity demand for green hydrogen production and electrification of industrial process heat and transportation, creates an opportunity for a high growth scenario in OSW to 40 GW by 2050, as such a portion of the capacity under the high growth scenario is assumed to be directly linked to supply an additional 300 TWh of demand from a combination of green hydrogen export projects, and local electrification of process heat and transportation.

9.3.2.3. Scale of investment required by TDP

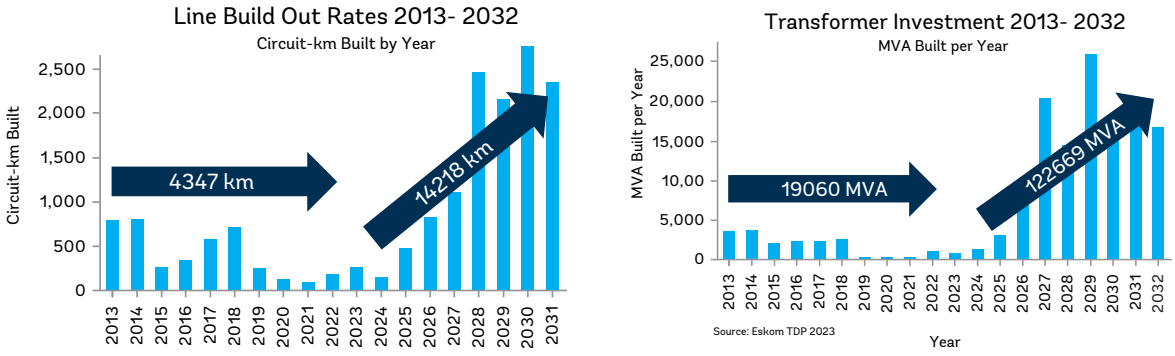
It should be noted that, given historical investment levels, the TDP contains ambitious investment and expansion plans (Figure 42).

- The plan aims to increase transmission infrastructure by 325% in the next ten years compared to the previous ten years.
- Transmission capacity will increase by 600% in the next ten years compared to previous years.

Given the ambitious nature of the investment, a realistic assessment of whether the planned upgrades are financially and technically feasible for Eskom or the NTCSA is recommended. Given the magnitude of the planned upgrades, alternative business models, such as private sector participation, should be investigated to assist in meeting investment targets.

FIGURE 42: GRAPHS SHOWING THE INCREASED PACE OF ASSET ROLLOUT IN THE TDP.

Left: circuit build out (km) per year. Right: Transformer deployment per year (MVA).



Source: Meridian Economics and TDP, 2023

9.3.3. Potential future upgrades to enable more connection

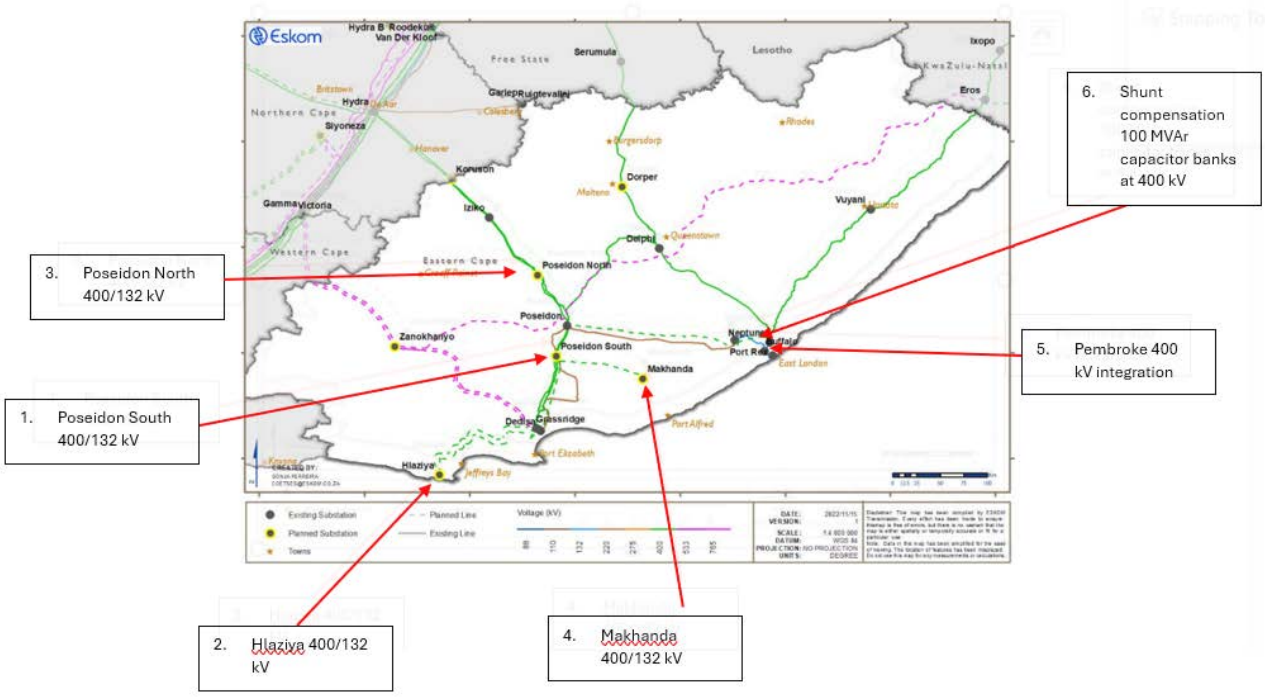
To accommodate additional renewable energy generation capacity on the transmission grid, the TDP includes several potential upgrades which are not yet planned. If implemented, these potential upgrades could increase capacity in coastal areas, as follows:

Eastern Cape

The following transmission network strengthening projects will be required to allow for more capacity in the province within the current TDP period (Figure 43):

1. Poseidon South 400/132 kV substation between Grassridge and Poseidon.
2. Introduce Hlazˌiya substation 400/132 kV substation.
3. Poseidon North 400/132 kV substation at Izˌiko series capacitor station.
4. Grahamstown (also known as Makhanda) 400/132 kV substation. The envisaged generation growth in the Port Elizˌabeth CLN in 2028 will result in under voltages at Pembroke substation, with some circuits out of service.
5. The construction of the Poseidon-Pembroke 400 kV line is expected to have increased generation evacuation through the Vuyani-Eros 400 kV line.
6. Shunt compensation projects that entail the installation of 100 MVar capacitor banks at 400 kV will be implemented for voltage support at Pembroke and Neptune.

FIGURE 43: POTENTIAL FUTURE UPGRADES TO ENABLE CONNECTION OF MORE CAPACITY IN EASTERN CAPE.

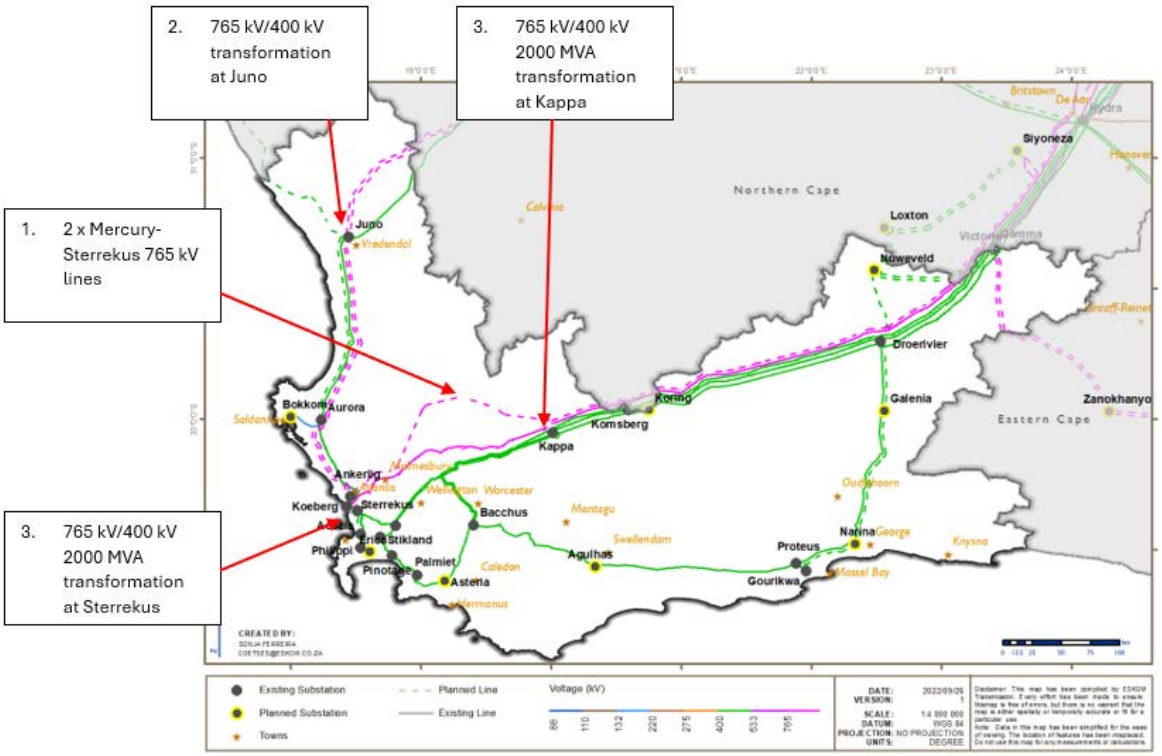


Western Cape

Additional infrastructure will be required to evacuate the excess power from the Western Cape. The required strengthening includes (Figure 44):

1. 2 x Mercury-Sterrekus 765 kV lines (via Umtu, Aries, and Juno substations), with series compensation between Umtu and Mercury substations
2. 765/400 kV transformation at Juno
3. An additional 765/400 kV 2 000 MVA transformers may be required at Kappa, and Sterrekus substations.

FIGURE 44: POTENTIAL FUTURE UPGRADES TO ENABLE CONNECTION OF MORE CAPACITY IN WESTERN CAPE.

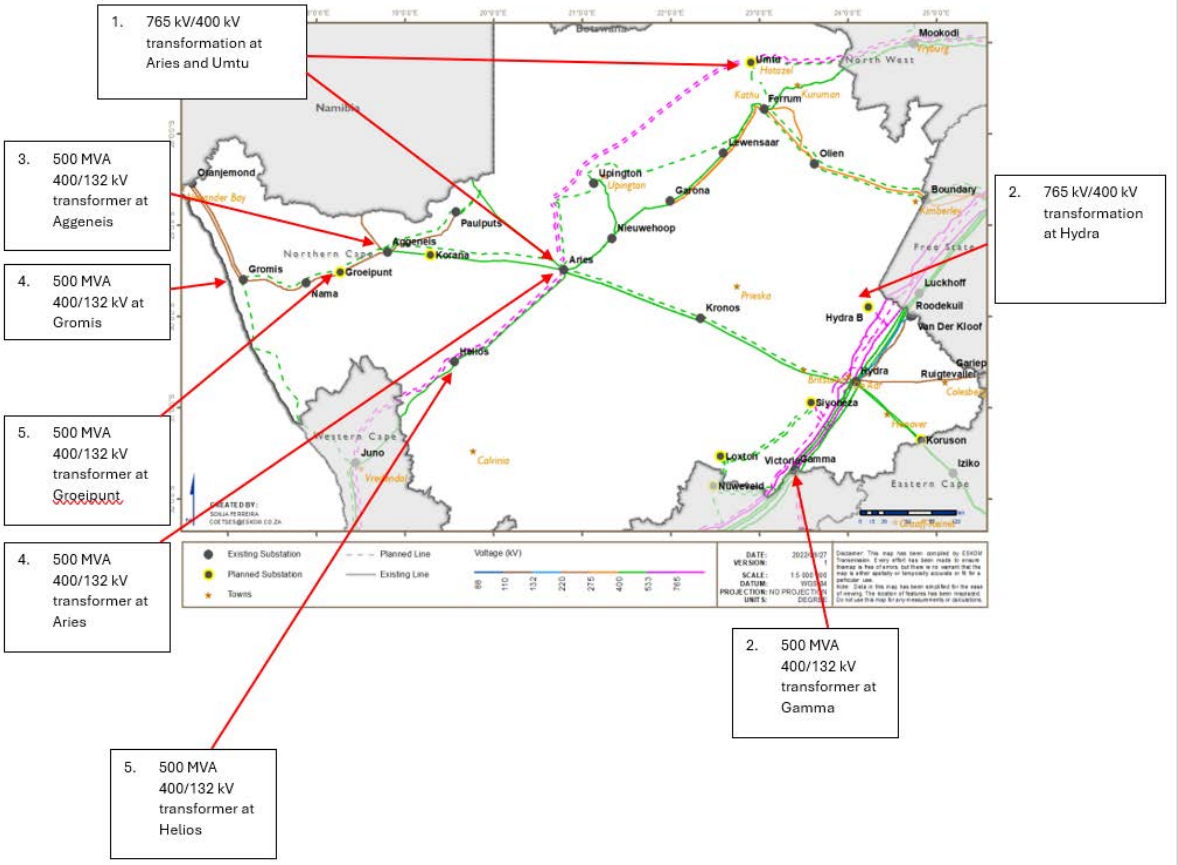


Northern Cape

The potential upgrades that could unlock greater capacity in the Northern Cape related to the Boegoebaai OSW site are detailed below. Several additional transformers at the substations in the Namaqualand supply area would enable increased capacity to be evacuated in the Northern Cape (Figure 45):

1. 1765/400 kV transformation at Aries and Umtu substations
2. 2765/400 kV transformation may also have to be introduced at Mercury and Gamma substations, and additional 765/400 kV 2 000 MVA transformers may be required at Zeus, Perseus and Hydra substations
3. Aggeneis substation 500 MVA 400/132 kV transformer
4. Aries substation 500 MVA 400/132 kV transformer
5. Groeipunt substation 500 MVA 400 132 kV transformer
6. Gromis substation 500 MVA 400 132 kV transformer
7. Helios substation 500 MVA 400 132 kV transformer

FIGURE 45: POTENTIAL FUTURE UPGRADES TO ENABLE CONNECTION OF MORE CAPACITY IN NORTHERN CAPE.



9.3.4. Conclusion

According to the GCCA 2023, most supply areas near the identified OSW sites are currently constrained, except for the Durban-Richards Bay OSW supply area, which has nearly 6 GW of connection capacity available. However, given that the first OSW farms are not expected to be operational until 2035, the current grid capacity indicator is a poor predictor of what will be available after 2035. Despite this, the considerable grid availability is a strong motivator for development in the Durban-Richards Bay area should capacity still be available in future.

Future grid upgrades based on TDP 2023 would be insufficient for all but fixed OSW capacity, and the grid availability is not always near the areas suitable for fixed OSW development. Deliberate planning for OSW is therefore essential in future iterations of the TDP. The assurance that necessary investments in transmission infrastructure will be made is critical for providing certainty to investors and developers in the OSW market and improving project bankability.

To accommodate additional renewable energy generation capacity on the transmission grid, the TDP outlines several potential upgrades in coastal areas, including various transformer and substation enhancements. While these upgrades are included in the TDP, they are not yet implemented and should be considered in future planning of the power system.

The first OSW capacity is assumed to be commissioned in 2035. Therefore, there is adequate opportunity to ensure that OSW targets are clearly articulated in critical policies such as the IRP, upgrades are included in the TDP, and the necessary budget is allocated to ensure adequate grid capacity. Given the magnitude of the investment required, immediate action would be needed to plan for future grid improvements to utilise the available time between now and when the first project development starts.

Given grid constraints, co-located Power-to-X applications can serve as an enabler of OSW in the short to medium term.

9.4. RECOMMENDATIONS

Ensuring sufficient grid connection capacity is critical for the development and bankability of OSW projects. The following recommendations are made to ensure that the required grid capacity is available to connect OSW farms:

- **GRD1.** The NTCSA should conduct a detailed grid study to determine the necessary upgrades to ensure sufficient grid capacity in the supply areas of identified OSW sites. This study should align with OSW targets set in planning policies, such as the IRP and include upgrade costs and timelines. This study should also assess the cost of grid upgrades against projected LCOE to better understand the trade-off between various floating OSW development areas, especially in the medium and high scenarios.
- **GRD2.** Based on this study and grid study in GRD1, the NTCSA should account for OSW development in upcoming TDP iterations and outline necessary upgrades.
- **GRD3 – MED-HIGH.** The NTCSA, in collaboration with relevant government departments, should assess the cost of grid upgrades against P2X costs and options, particularly with respect to OSW development around Saldanha Bay, Boegoebaai and Richards Bay.

10. POWER-TO-X: GREEN HYDROGEN AND DESALINATION

10.1. PURPOSE

GH_2 and its derivatives (Power-to-X, hereafter P2X) can provide solutions to decarbonise hard-to-abate sectors relevant to South Africa, particularly heavy-duty, long-distance transport and heavy industries based on chemical processes. This chapter describes a techno-economic analysis of the potential for OSW generation and GH_2 production at two sites, Saldanha Bay — West Coast and Durban — Richards Bay.

10.2. METHOD

10.2.1. Overview of LCOH modelling approach

Calculating the Levelised Cost of Hydrogen (LCOH) is analogous to calculating the Levelised Cost of Electricity (LCOE) discussed in Chapter 8, but with more input parameters and additional degrees of freedom.

There are two methods for the calculation of LCOE. The simpler method was published by the US Department of Energy's National Renewable Energy Laboratory (NREL), [142] while the more sophisticated model was published by the UK Government Department for Business, Energy and Industrial Strategy (formerly known as BEIS, now known as the Department for Energy Security and Net Zero).[143] Both methods could be (and sometimes are) modified to calculate LCOH, however, there are some difficulties with the NREL approach. Both electrolyser stacks and wind turbines degrade over time, so their production decreases every year. When the operating life of electrolyser stacks expire, the stacks must be replaced, incurring a one-off cost in the relevant year. This is not straightforward to implement in the NREL approach. For this analysis, the BEIS method is superior to that of NREL, since it can accommodate the fact that:

- The project will not have constant annual output due to an assumed annual deterioration rate of 0.1% per year for the wind plant;
- The expenses every year are not equal, due to the need to replace the electrolyser stacks when their allotted life is expended.

In this study, LCOH is therefore calculated using the BEIS method.

10.2.2. Input parameters

The following input values are used, as a function of site and year:

- The WACC: consistent with values used in Chapter 8: Levelised cost of energy;
- The CapEx, OpEx and plant life of equipment: for the OSW plant, assumptions were consistent with those outlined in Chapter 8: Levelised cost of energy;
- The electrolyser efficiency and stack life.

Additionally, the hourly wind capacity factor in the RMY was used to calculate, for each year: the amount of electricity generated, the amount of desalinated water and GH_2 produced, and the amount of electricity either curtailed or sold to the grid at the rate specified (in this case the LCOE). The sale of byproduct oxygen was not considered. The costs and revenues were used to calculate LCOH.

Aside from the OSW components, LCOH depends on the choice of feedstock water supply, electrolyser technology and construction timeline and grid connection design, among others. These are detailed below.

10.2.2.1. Single choice parameters

Feedstock water supply

All methods for producing hydrogen through electrolysis, including methods for producing GH_2, require water. Many regions in South Africa face current and future water stress, including the areas surrounding the proposed GH_2 plant sites analysed in this report (Figure 46):

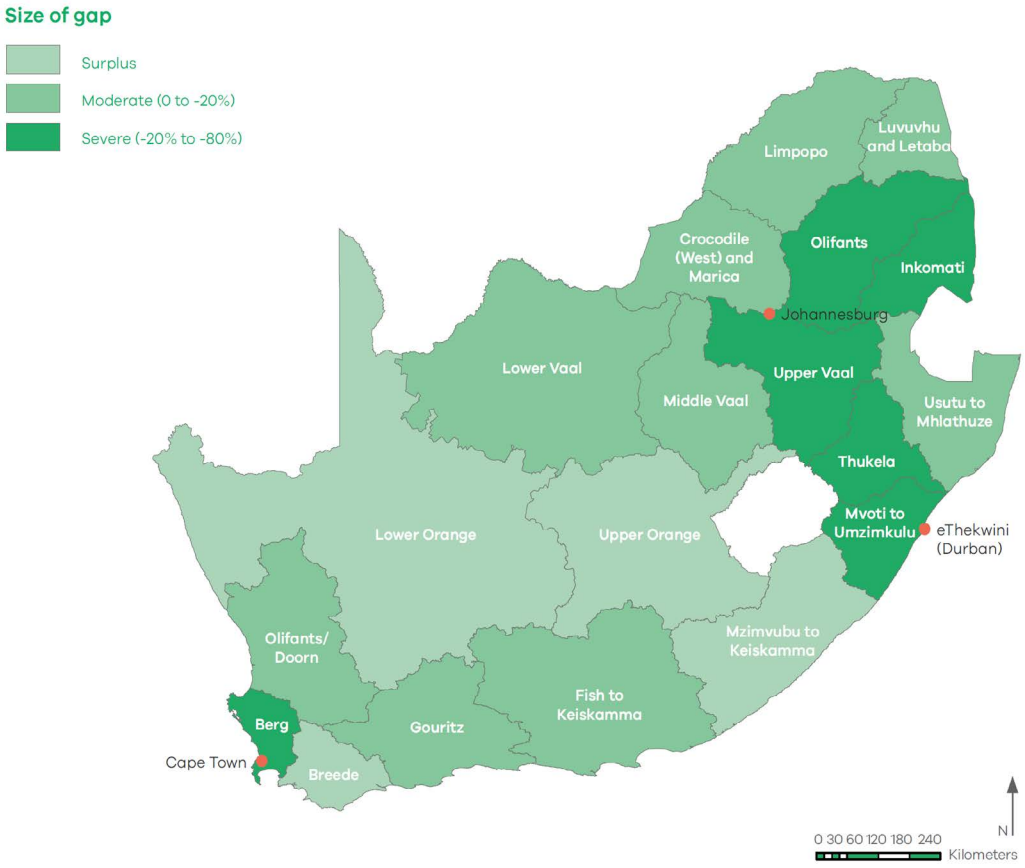
- Saldanha Bay: Severe water stress is expected in the Berg River catchment.
- Richards Bay: Moderate water stress is expected in the Usutu to Mhlatuze catchment.

The choice of feedstock water supply is therefore important. Theoretically, two possible options exist for the supply of feedstock water to the electrolyser:

- Wholesale: the water is purchased from the local water utility.
- Desalinated: the water is produced by a desalination plant, with seawater as feed.

Given the current and anticipated water stress conditions, it is not sustainable to use potable surface water for the generation of hydrogen. For this reason, this analysis only considers desalinated water as feedstock for GH_2 production. The use of desalinated water does not present a significant cost burden, however, adding only $\$0.02/kg_{H2}$ or less to the final hydrogen production cost, ranging between $\$3/kg_{H2}$ and $\$11/kg_{H2}$ (see Figure 53).

FIGURE 46. THE PROJECTED GAP BETWEEN WATER SUPPLY AND DEMAND BY 2030 IN SA CATCHMENT AREAS.[144] (GREENCAPE, 2019).



Electrolyser technology

The electrolyser technology options considered were:

- Alkaline: the advantages of this technology include technological maturity, widespread commercial availability, particularly in larger unit sizes, lower CapEx and longer stack lifetime.
- Proton exchange membrane (PEM): the advantage of this technology is its ability to achieve a higher capacity factor when driven by RE. The minimum electrical power setting at which the electrolyser will still operate is lower for PEM (5%) than alkaline (20%).

Alkaline was selected for this study, given its maturity, lower costs and longer life. The electrolyser units were assumed to be of 20 MW capacity, a scale at which alkaline electrolysers are already available.

Electrolyser scale

Electrolyser costs decrease with size, due to economies of scale. In all cases, the base electrolyser size chosen was 20 MW, to avoid overly high hydrogen costs due to a small electrolyser, and to capitalise on the fact that alkaline electrolyser units of 20 MW capacity are already commercially available.

Year of construction

The years of construction are important because several parameters change over time: the CapEx of wind turbines and electrolysers decrease, and the efficiency and stack life of electrolysers increase. Consistent with the LCOE analysis, only two years, being 2035 and 2040, are considered:

- Saldanha Bay — West Coast: GH_2 production from the fixed OSW capacity could begin in 2035**,** as this area is likely to be one of the first to be developed in South Africa and because there are already plans for GH_2 projects near the Port of Saldanha Bay.
- Richards Bay: GH_2 production from the floating OSW capacity in the Durban — Richards Bay area beginning in 2040, as the introduction around the Port of Richards Bay is expected to follow the successful introduction in the Saldanha Bay — West Coast area as per the deployment scenarios.

10.2.2.2. Multiple choice parameter: grid connection option

The grid connection options assessed were:

- Islanded grid: The OSW plant, electrolyser and desalination plant are electrically connected to each other but not to the national electricity grid.
- Connected grid: The OSW plant, electrolyser and desalination plant are electrically connected to the national electricity grid. This is not to import power from the grid for the electrolyser (since that would defeat sustainability requirements for GH_2 as the grid electricity is predominantly coal-based), but rather to export any electricity generated in excess of what is instantaneously required by the power-consuming components (electrolyser and desalination plant) to the grid to be sold. Operationally, this is only feasible if it can be proved (possibly by means of smart grid and power flow devices), that during normal operation, no power is imported from the grid, unless it is wheeled from offsite green electricity generators over the grid to maintain green credentials.

The advantage of an islanded grid is that it is easier to certify that the GH_2 produced is green. The disadvantage is that any electricity generated in excess of the demand of the electrolyser and desalination plant must be curtailed. Islanded grids may be suitable in areas with limited or expensive grid capacity connections, but these systems face a higher risk for the developer, lack flexibility, and must resort to curtailment.[145]

The advantages of a connected grid are that OSW infrastructure can be constructed first, and all the power generated can be sold to the grid. This generates positive cash flow and alleviates potential load shedding. The purchase and installation of the electrolyser may even be delayed. In the event of electrolyser failure, the plant can still generate revenue by selling the power produced while the equipment is being repaired or replaced. In the event of a failure in the OSW plant, electricity from the grid could be used for any safety-related power requirements. The CAPEX of the OSW infrastructure

is "amortised" not only over the sale of GH_2 but also over the sale of the excess electricity. This reduces the effective cost of the electricity generated, and therefore that of the GH_2. The OSW infrastructure can be oversized more than otherwise since these costs will be recouped. This allows the electrolyser (a high CapEx unit) to run for more hours of the year, resulting in cheaper GH_2 (as the electrolyser CapEx can be "amortised" over more GH_2). This excess electricity can assist in ensuring supply security, for example, by displacing demand from the grid or by recharging pumped-storage schemes. This can help generate buy-in from communities and public stakeholders.

Both islanded and connected (exporting excess power, not importing any power) were simulated in the analysis. In the case that the OSW plant is connected to the grid, this analysis assumes that the excess electricity is sold at cost.

10.2.2.3. Summary of input parameters used in the analysis

TABLE 22: PARAMETERS ANALYSED AT THE TWO SITES.

Parameter	Saldanha Bay	Richards Bay
Year of construction	**2035**	**2040**
RE		
Offshore wind technology	Fixed bottom	Floating
OSW CAPEX (USD/kW)	3328.06	4335.01
OSW OPEX (USD/kW/y)	79.50	63.01
Wind degradation (% per year)	0.1	0.1
Electrolyser		
Electrolyser technology	Alkaline	Alkaline
Electrolyser unit size (MW)	20	20
Electrolyser minimum load (%)	20	20
Electrolyser specific elec. consumption (kWh/kg_{H2})	45.61	44.29
Electrolyser base CAPEX (1MW) (USD/kW)	645.00	570
Electrolyser scaled CAPEX (USD/kW)	469.52	414.92
Electrolyser OPEX (% CAPEX/year)	2	2
Electrolyser stack fraction (%)	45	45
Electrolyser stack life (hrs)	102500	110000
Water requirement (incl. cooling) (L/kg_{H2})	25	25
Desalination		
Desalination plant CAPEX (US$/($m^3$/d)	1500	1500
Desalination plant CAPEX (% CAPEX/year)	2	2
Desal. specific elec. Consumption (kWh/m^3)	3.9	3.9
Overall plant		
Plant life (years)	27	28
WACC (%)	7.48	6.20
Grid		
Grid connection status:	Islanded	Islanded
	Connected	Connected

10.2.3. Generating of hourly traces

The LCOE values in Chapter 8 were calculated using annual capacity factor values. For the calculation of LCOH, however, hourly values of capacity factor are required.

Using the online database of the Climate Systems Analysis Group (CSAG) at the University of Cape Town, hourly traces of wind capacity factor were generated for a single representative turbine at the correct hub height. These values were subjected to Gaussian smoothing to represent the different behaviour of a wind farm compared to a single turbine.

The annual capacity factors were then calculated for the two sites examined for LCOH, Saldanha Bay and Richards Bay. The resultant annual capacity factor values thus obtained were lower than the single-point offshore wind capacity values. However, to maintain internal consistency for the study, the hourly values were scaled upwards until the cumulative annual values matched the original annual values. In scaling, some individual hourly capacity values were capped to prevent them from exceeding 100%.

Hourly traces have definite implications for hydrogen production by electrolysis. The electrolyser will shut down when the power supply drops below the electrolyser minimum power setting: 20% in the case of alkaline and 5% in the case of PEM.

10.2.4. Comparison with blended generation technology

This document explores the costs of generation of green hydrogen using OSW. The preceding section described the generation of hourly capacity factor traces. As will be shown in the results, wind capacity factor traces are site-specific and can vary noticeably by season and time of day.

Since the electrolyser is a high-CapEx item, it is desirable for the electrolyser to run for as many hours during the year as possible, to reduce the cost of the hydrogen produced. The opportunity was taken to explore whether the hourly OSW capacity factor distribution of the two sites may be complementary to the onshore single-axis tracking (SAT) solar PV plants (typically used for utility scale applications in SA). Complementary distributions occur when periods of low OSW availability correspond to periods of high solar availability and vice versa.

Complementary distributions would:

- ensure more continuous year-long hydrogen production, and
- further encourage uptake of OSW for general electricity supply.

Although an analysis of GH_2 production cost using both OSW and solar PV was not performed in this work, experience derived from prior Saldanha Bay studies [146] [147] using onshore wind and solar PV have shown lower production cost is achieved with a hybrid wind/solar PV installation than a purely solar PV or purely onshore wind installation. It is reasonable to expect that combining OSW and solar PV would also result in lower production costs.

10.3. RESULTS AND DISCUSSION

As described in Section 10.2.1, the LCOH was calculated for the following parameter permutations, which are laid out in Table 22. In all cases, the base electrolyser size is assumed to be 20 MW, as alkaline electrolyser units of this size are commercially available.

10.3.1. Seasonal variation in hourly capacity factors

10.3.1.1. Saldanha Bay hourly capacity factor distributions

The seasonal variation in the hourly capacity factors for OSW obtained for Saldanha Bay is shown in Figure 47. Results are plotted for the months of January (summer), April (autumn), July (winter) and October (spring) as hourly distributions of three quartiles of production:

- 1st quartile, i.e. 25th percentile
- 2nd quartile, i.e. median or 50th percentile, and
- 3rd quartile, i.e. 75th percentile

The quartiles are shown to allow the reader to appreciate the distribution spread between the minimum and maximum values obtained for each hour of the day over the month concerned.

In winter (shown in green), OSW production throughout the 24h day period displays significant day-to day variability (see spread between 1st and 3rd quartiles), but the distribution of the 2nd quartile (median values), in a relatively narrow range between 15% and 35% capacity factor, shows that in the main, winter production is low.

For the remaining three seasons, OSW production is lowest in the morning at about 09:00 (2nd quartile less than 10%, with low variability). It increases steadily during the day, reaching a maximum in the afternoon and evening (with moderate day-to-day variability), whereafter it declines again steadily to the morning low.

FIGURE 47: COMPARISON OF HOURLY OSW CAPACITY FACTORS FOR SALDANHA BAY IN THE MONTHS OF JANUARY, APRIL, JULY AND OCTOBER.

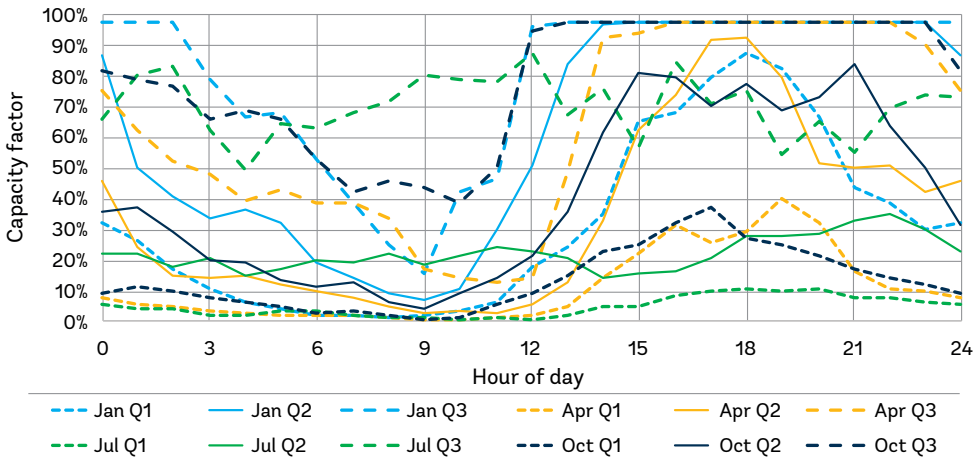


FIGURE 48: COMPARISON OF HOURLY CAPACITY FACTORS FOR UTILITY-SCALE SINGLE-AXIS TRACKING SOLAR PV IN SALDANHA BAY FOR THE MONTHS OF JANUARY, APRIL, JULY AND OCTOBER.

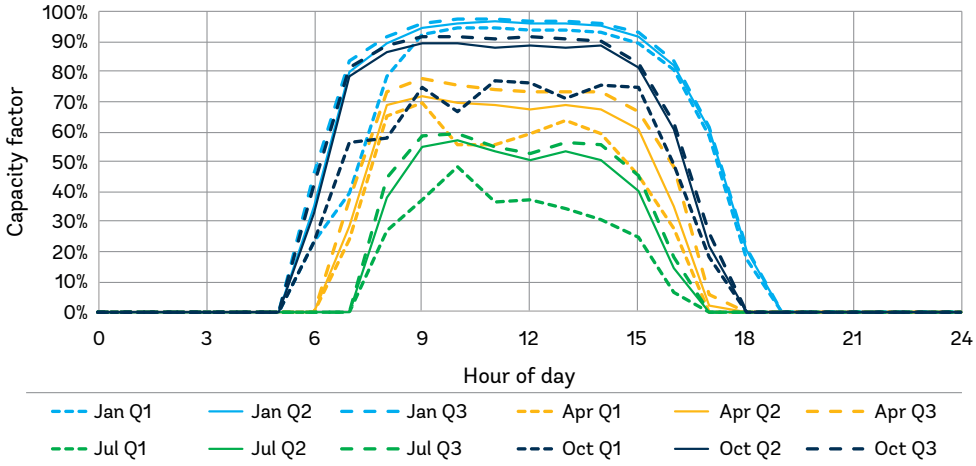


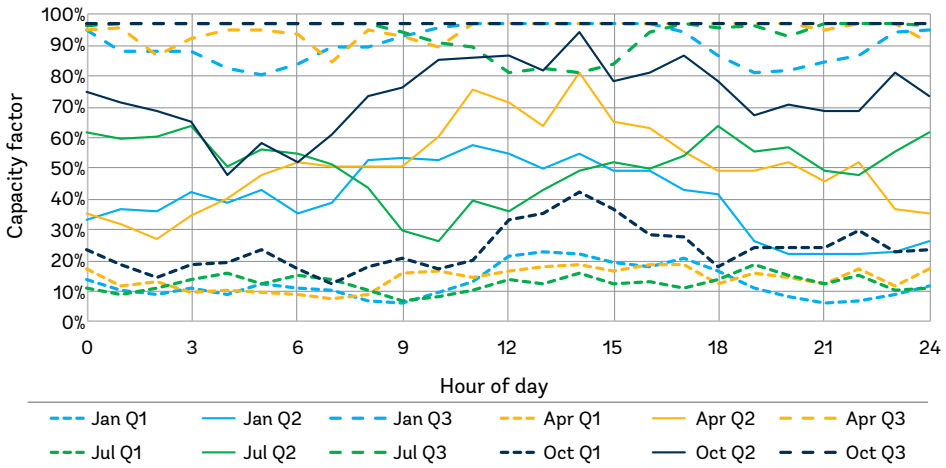
Figure 48 shows the seasonal variation in the hourly capacity factors for SAT PV in Saldanha Bay, in a similar manner to Figure 47 for OSW. Note the small gap between the 1st and 3rd quartile distributions (indicating low day-to-day variability), compared with the noticeably higher equivalent OSW gap in Figure 47. The variation in daytime median values across the seasons is significant, reflecting the fact that Saldanha Bay is a winter rainfall region: spring values reach (and summer values exceed) 90%, autumn values reach 70%, while maximum winter values lie between 50% and 60%.

By comparing Figure 47 and Figure 48, a strong complementarity may be seen between the capacity factor distributions of OSW (low in winter, and the other seasons low in the mornings, but high in the evenings and first half of the night) and SAT PV (high during daytime, but zero at night-time) in Saldanha Bay.

10.3.1.2. Richards Bay hourly capacity factor distributions

In comparison, the seasonal variation in the OSW hourly capacity factors obtained for Richards Bay is shown in Figure 49.

FIGURE 49: COMPARISON OF HOURLY OSW CAPACITY FACTORS FOR RICHARDS BAY IN THE MONTHS OF JANUARY, APRIL, JULY AND OCTOBER.



The patterns discernible in the 2nd quartile (median) for OSW Richards Bay are noticeably different from those present in the Saldanha Bay analysis. Firstly, the low morning / high afternoon trend observed in Saldanha Bay is not present. A more constant generation profile is evident, with relatively high daytime and low nighttime trend for spring, summer and autumn. In winter, the above pattern is inverted, with low production by day and high production by night. Secondly, the day-to-day variation (indicated by the spread between the 1st and 3rd quartiles) is very much larger than Saldanha Bay, extending from below 20% to above 80% throughout the day.

FIGURE 50: COMPARISON OF HOURLY CAPACITY FACTORS FOR UTILITY-SCALE SINGLE-AXIS TRACKING SOLAR PV IN RICHARDS BAY FOR THE MONTHS OF JANUARY, APRIL, JULY AND OCTOBER.

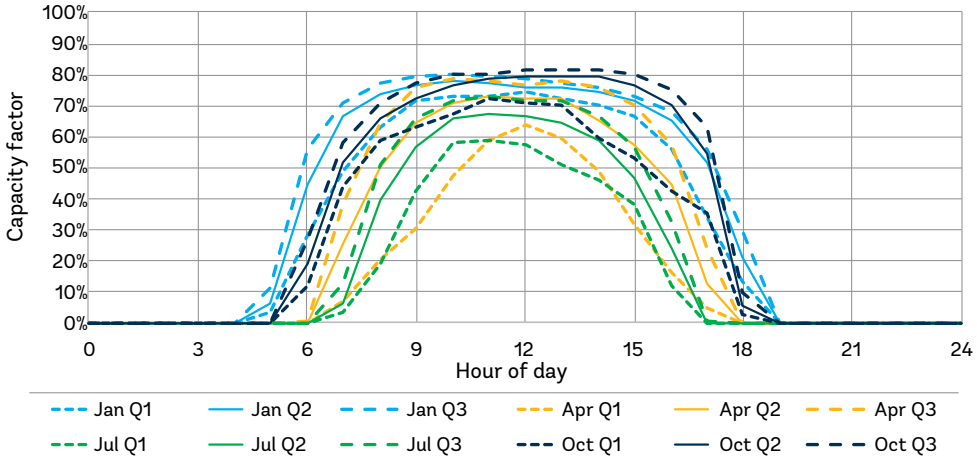


Figure 50 shows the seasonal variation in the hourly capacity factors for SAT PV in Richards Bay. As with Saldanha Bay, the gap between the 1st and 3rd quartile distributions is small. The seasonal variation in daytime median values is smaller than Saldanha Bay, reflecting its climate of a summer rainfall region with dry winters: spring and summer values lie between 70% and 80% (lower than Saldanha Bay), autumn just exceeding 70% (similar to Saldanha Bay), and winter between 60% and 70% (higher than Saldanha Bay).

While complementarity between OSW and solar PV appears to be lower than for Saldanha Bay based on time-of-day values, it may well be worthy of further investigation: the low day-to-day variation of solar may help offset the high day-to-day variation of OSW; and the higher solar availability in winter matching the decreased OSW availability in daytime in winter.

10.3.2. Saldanha Bay LCOH

Comparison between islanded and connected grid

The parameter power oversizing (PO) value, displayed on the x-axis in Figure 51, is defined as:

$$PO = \frac{P_{supply} - P_{demand}}{P_{demand}} = \frac{P_{OSW} - P_{electrolyser+desal}}{P_{electrolyser+desal}} = \frac{P_{OSW}}{P_{electrolyser+desal}} - 1$$

A PO value of 0.0 indicates the rated electrical capacity of the power supply installed (the OSW plant) is *equal to* that of the demand installed (the combined electrical rated capacities of the electrolyser and the desalination plant), i.e. there is no oversizing. By contrast, a power oversizing value of 1.0 indicates that the power supply capacity is *double* that of the rated power demand.

Figure 51 shows that the output of GH_2 powered by OSW increases non-linearly with PO, tending towards an asymptotic limit at or near 2500 t/y (as may be expected, there is no difference between islanded and connected grids regarding GH_2 production). Also, there is a clear impact on LCOH of both PO and grid configuration (islanded or connected). For connected grids, LCOH drops monotonically as PO is increased because:

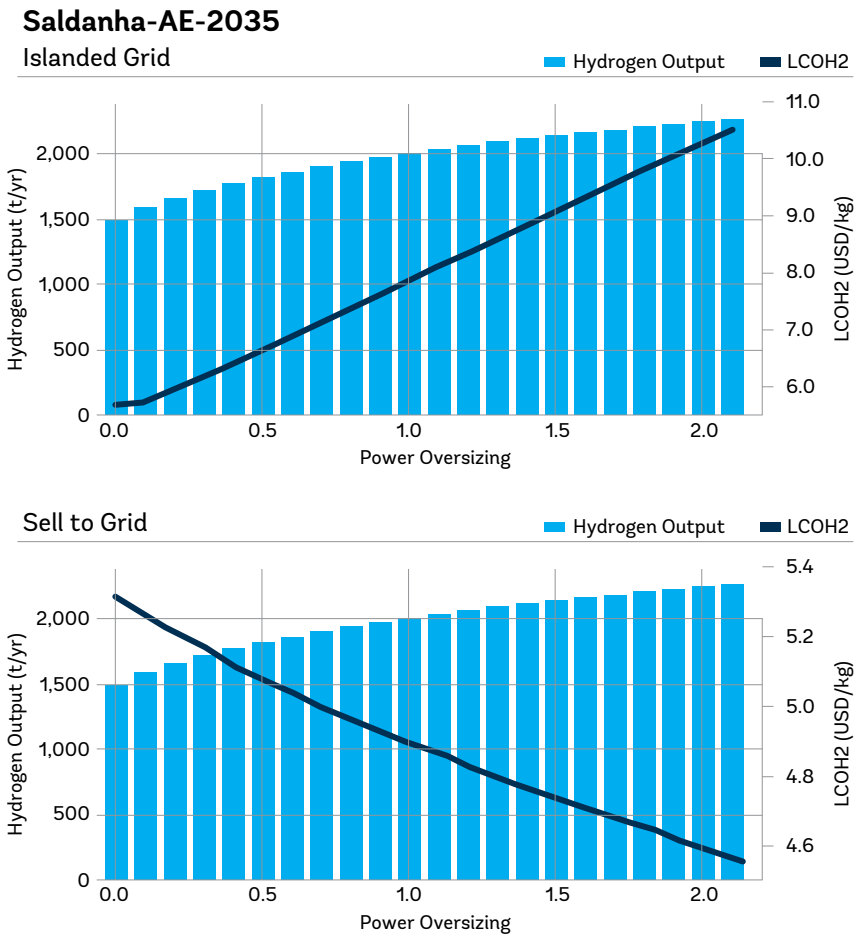
- No electricity is curtailed: any electricity not used in generating GH_2 is sold at the LCOE value. The OSW plant is "amortised" over the amount of electricity generated. The annual capacity factor does not change with PO, nor does the LCOE: the electricity-related costs remain fixed.
- The capacity factor of the electrolyser increases with PO, and more hydrogen is generated. The electrolyser and desalination plant costs are fixed with PO but are "amortised" over the amount of GH_2 generated, which increases with PO.

For islanded grids, LCOH climbs monotonically with PO because while the level of electricity generation capacity (input costs) increases linearly with PO, the GH_2 output (sales volume) increases progressively more slowly, reaching an asymptotic limit near 2500 t/y. The reason for the monotonic climb (rather than first passing through a local minimum) is explained by Figure 47. For several hours of the 3rd quartile, production is already at maximum capacity (13:00 to 23:00 in spring, 13:00 to 02:00 in summer, and 16:00 to 22:00 in autumn). If PO is 0.0, the electrolyser operates at a maximum capacity during these periods, and any oversizing of the RE capacity relative to the electrolyser will result in curtailment. Outside of these periods, additional electricity capacity will result in increased electrolyser production (up until the point where the electrolyser is at maximum capacity).

The LCOH values obtained for Saldanha Bay shown in Figure 51 ($5.5/kg–$10/kg for islanded grids, and $4.6/kg-$5.3/kg for connected grids) are high compared with the generally accepted international $2/kg–$3/kg target. Fortunately, hydrogen generation costs this high are not likely to occur in reality in Saldanha Bay, for the following reasons:

- Support for evening peak: The high OSW capacity factors for Saldanha Bay in the afternoon and evening coincide with the South African evening peak in electricity demand. OSW can, therefore, contribute to the general electricity supply at precisely the time that rooftop solar PV and utility solar PV plants stop generating power, particularly given the proximity of the Cape Town metropole. It is, thus, improbable that OSW for green hydrogen in Saldanha Bay will be constructed in an islanded mode but rather grid-connected, selling excess electricity to the grid (or even decreasing green hydrogen output in the evening to sell electricity at a higher price to the grid). This removes costs above $5.3/kg from further consideration.
- Hybridisation with solar PV: It is also highly unlikely that hydrogen generation in Saldanha Bay will be powered by OSW alone (despite the excellent capacity factors in the afternoon/evening), primarily because of the low OSW capacity factors in the morning. Instead, OSW will be used together with current and future single-axis tracking (SAT) solar PV plants in the area, either as a combined hybrid plant or wheeled over the grid by power purchase agreement (PPA).
- Internationally, the LCOE of solar PV is significantly lower than OSW. By "blending" the PV and OSW LCOE, a lower LCOH value and a higher electrolyser capacity factor may be obtained.

FIGURE 51: LCOH AND HYDROGEN OUTPUT FOR SALDANHA BAY POWERED BY OSW: TOP — ISLANDED GRID; BOTTOM — CONNECTED GRID.



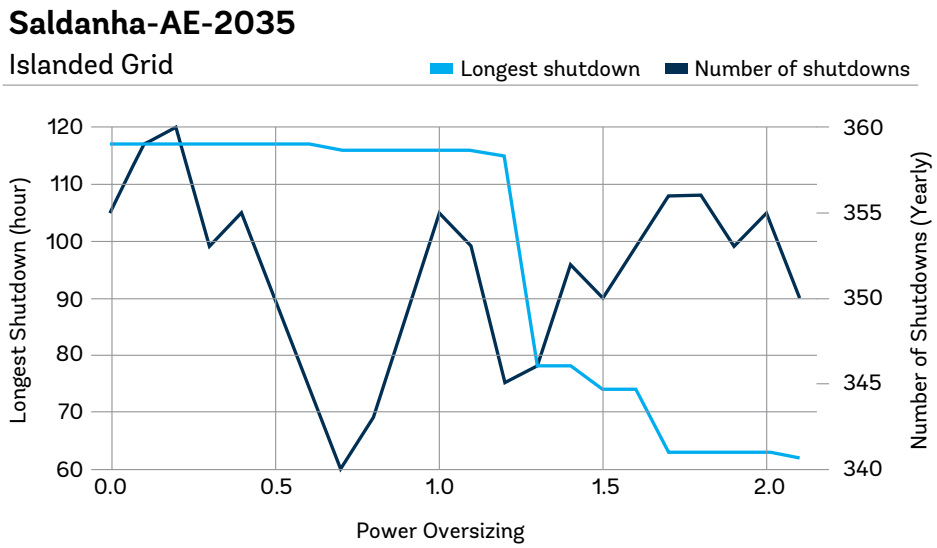
Combining OSW with solar PV would essentially be an alternative to the default current option for green hydrogen generation: generating GH_2 from onshore wind and solar PV. A comparison between these two options was not undertaken and is out of scope for this study, but is strongly recommended with the following considerations:

- Onshore wind site options in Saldanha Bay are finite. As installed onshore wind capacity increases over time, further expansion may face public opposition.
- While the LCOE of OSW is higher than onshore wind, the impact of this is reduced by the fact that OSW has a higher capacity factor than onshore wind: when combined with solar PV, the increased electrolyser capacity factor will offset the higher LCOE.

GH_2 is lower-cost when used on a connected grid, when excess electricity may be sold rather than curtailed.

Figure 52 shows that the electrolyser's annual shutdowns are independent of whether the grid is islanded or grid-connected and are not strongly dependent upon PO: they remain within a band of 340 to 360. By contrast, the longest annual shutdown is fairly constant at about 115 hours until PO exceeds 1.0, after which it drops to below 80. This longest shutdown is likely to drop to less than a full day if OSW is paired with solar PV.

FIGURE 52: NUMBER OF SHUTDOWNS PER YEAR AND DURATION OF LONGEST SHUTDOWN FOR SALDANHA BAY POWERED BY OSW: TOP — ISLANDED GRID; BOTTOM — CONNECTED GRID.



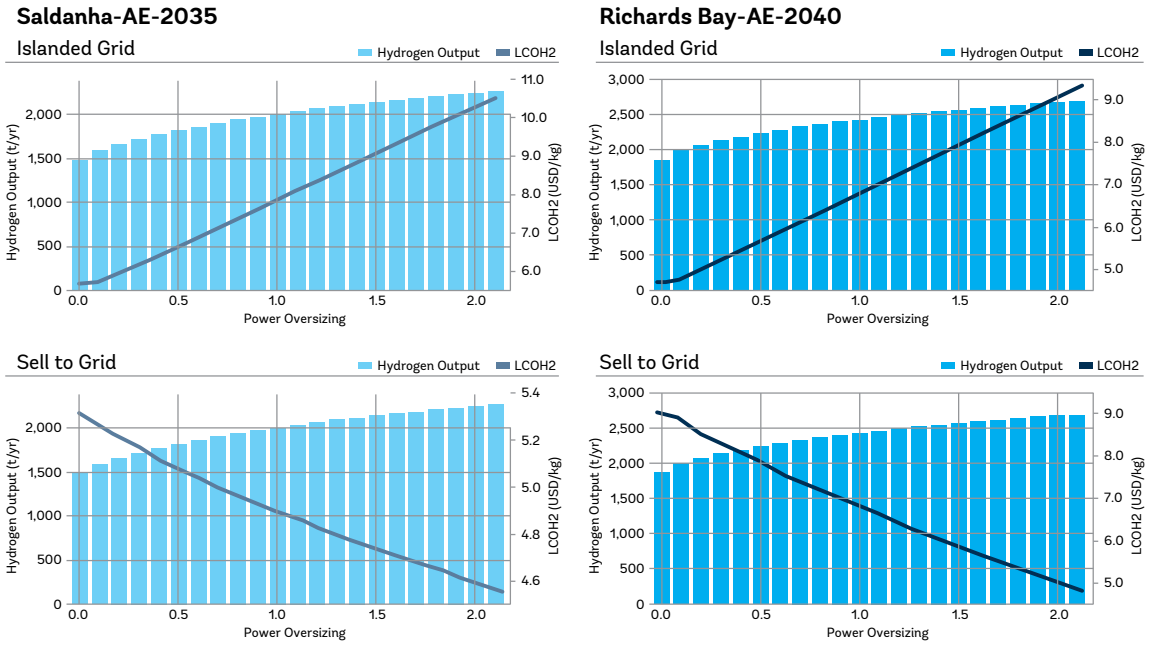
10.3.3. Richards Bay LCOH

Figure 53 shows that for Richards Bay (just as is the case with Saldanha Bay):

- the GH_2 output increases non-linearly with PO, in this case tending towards a higher asymptotic limit at or near 2750 t/y (with no difference between islanded and connected grids regarding GH_2 production).
- PO and grid configuration (islanded or connected) both have a direct impact on LCOH:
  - For connected grids, LCOH drops monotonically as PO is increased
  - For islanded grids, LCOH climbs monotonically with PO (without first passing through a local minimum). Just as with Figure 47 for Saldanha Bay, in Figure 49 for Richards Bay, production is already at maximum capacity for several hours of the 3rd quartile. Any oversizing of the RE capacity relative to the electrolyser will result in curtailment during these periods. The fact that there is excess electricity (to be either curtailed or sold) at all values of PO is visible in Figure 53 (difference between islanded and connected LCOH).

The LCOH of Richards Bay in 2040 is cheaper than for Saldanha Bay in 2035 by about $1/kg for islanded grids and about $0.30/kg for connected grids, despite the fact that Richards Bay has a higher LCOE. The reasons for the lower LCOH for Richards Bay are: a 10% increase in the electrolyser capacity factor, which represents an increase in green hydrogen (GH_2) output of approximately 500 tons per year, or one-third of Saldanha Bay's production at a plant output (PO) of 0; more favourable WACC (6.20% rather than 7.48%); use of a cheaper, more efficient electrolyser with longer lasting stacks (due to an extra 5 years); and, to a far lesser degree, a slightly longer plant life (28 years instead of 27 years).

FIGURE 53: LCOH AND H_2 OUTPUT: LEFT — SALDANHA BAY; RIGHT: RICHARDS BAY; TOP: ISLANDED; BOTTOM — CONNECTED.

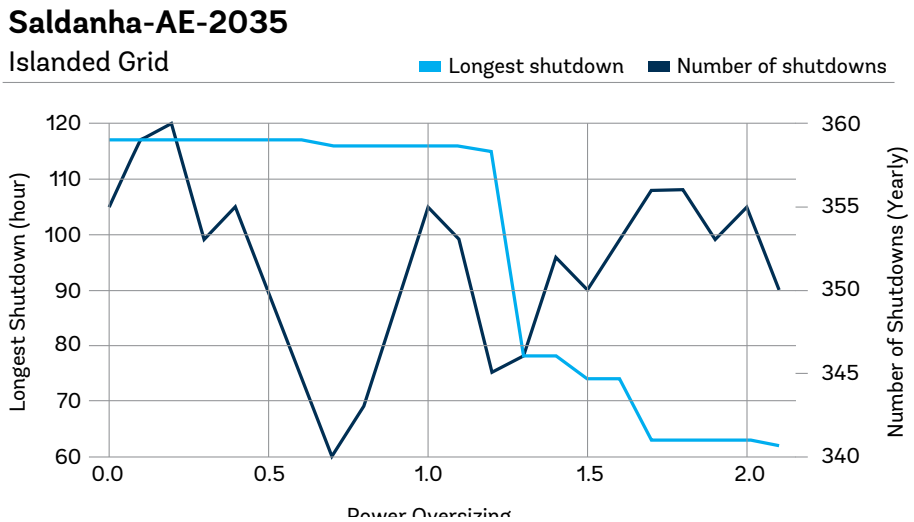


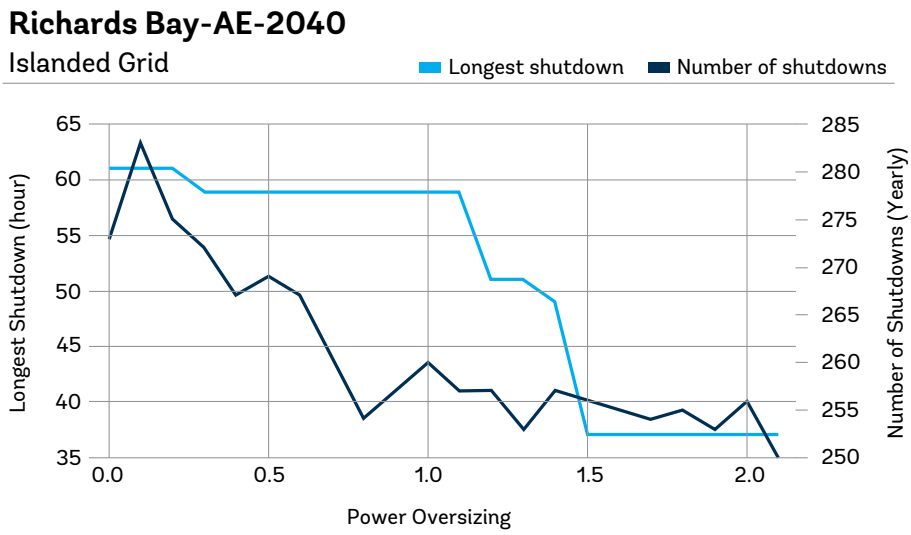
The resultant LCOH values shown in Figure 53 for Richards Bay ($4.8/kg–$9/kg for islanded grids, and $3.80/kg–$4.4/kg for connected grids) are lower than for Saldanha Bay, and although still higher than the target benchmark of $2-3/kg, the values for connected grids are still attractive. As with Saldanha Bay, however, the high cost values are not likely to materialise for the following reasons:

- Support for the morning and evening peak: Unlike the Saldanha Bay capacity factor distributions with low mornings and high evenings, the Richards Bay capacity factor distributions are more uniform. As a result, it makes sense to sell excess electricity to the grid to support both the morning and evening demand peaks, particularly given the proximity of the Durban metropole. In this case, constructing OSW for green hydrogen for Richards Bay in an islanded mode does not make sense, as excess electricity can only be sold to the grid using a connected grid. This removes costs above $4.4/kg from further consideration.
- While not quite as complimentary as for Saldanha Bay, the indicative quasi-sinusoidal hourly capacity factor of solar PV is still complimentary to the OSW hourly capacity factor at Richards Bay, as it exceeds the average OSW capacity factor values between 08:00 and 16:00 for all four seasons. Also, in Richards Bay the high day-to-day variability in OSW can be compensated for by the low day-to-day variability in solar PV, which reduces the risk of electrolyser shutdown due to insufficient power, relative to Saldanha Bay.
- Reducing the wind fraction below 100% will reduce curtailment at PO values above 0 in the case of islanded grids.

Richards Bay also performs better from a shutdown perspective, both in terms of number (between 250 and 284 compared with 340 to 360 for Saldanha Bay) and longest duration (constant at about 60 hours until PO exceeds 1.0, after which it drops to below 37; compared with constant at about 115 hours until PO exceeds 1.0, after which it drops to below 80 for Saldanha Bay).

FIGURE 54: NUMBER OF SHUTDOWNS PER YEAR AND DURATION OF LONGEST SHUTDOWN: LEFT —ISLANDED GRID; RIGHT — CONNECTED GRID.





10.3.4. Discussion

This analysis shows that the LCOH ranges of GH_2 powered by OSW generation in South Africa overlaps with LCOH ranges of GH_2 from other renewable energy sources. The estimated LCOH ranges from purely OSW are, on average, higher than LCOH ranges for GH_2 produced from a combination of onshore wind and solar. However, it is expected that cost-competitiveness could be achieved through combining OSW with PV and through OSW cost reductions over the next decade. This finding, though indicative and dependent on the assumptions used here, is important, as it supports the assumption that OSW generation could power GH_2 used domestically and for international export under South Africa's high growth scenario.

The analysis shows that there are a number of considerations for reducing LCOH powered by OSW generation:

- Lower LCOH values are achievable for connected grids than islanded grids, as excess electricity is not curtailed but rather sold (in this model at cost);
- For connected grids, lower LCOH is achieved at higher levels of oversizing, due to higher electrolyser capacity factors;
- Richards Bay in 2040 is anticipated to achieve lower LCOH values than Saldanha Bay in 2035, by about $1/kg for islanded grids and about $0.30/kg for connected grids, primarily due to higher yields but to a lesser degree also due to more favourable WACC; cheaper, more efficient electrolyser with longer lasting stacks (due to an extra 5 years), and due to slightly longer plant life (28 years instead of 27 years);
- The range of LCOH values achieved from OSW generation is almost certain to be reduced if paired with solar PV in South Africa, since solar has a higher capacity factor during most daylight hours and lower costs than OSW. The LCOH from OSW and solar PV in South Africa may also be lower than LCOH from onshore wind and solar, since OSW has a higher capacity factor overall than onshore wind, and solar has a higher capacity factor during most daylight hours and lower costs.

The combination of OSW and solar PV will likely provide the required combination of low electricity cost and high-capacity factor. Green hydrogen production may well prove the catalyst required to kick-start a South African OSW journey. It is recommended that detailed analysis be performed to understand whether LCOH could be reduced by combining generation from OSW and solar PV.

Regardless, other factors contribute to interest in GH_2 production from OSW in South Africa. For example, grid transmission capacity is constrained in the Northern Cape, Western Cape and Eastern Cape provinces, affecting the ability to evacuate power from renewable-rich areas. Addressing this will take both time and investment. The twin requirements of decarbonising electricity supply and augmenting electricity supply may be thwarted by a lack of available renewable generation sites close to the load centres. They may also be affected by grid capacity constraints due to land availability, quality of renewable resources or public opposition to expansion of particularly onshore wind capacity in scenic areas. In this case, OSW production could provide relief for these regions. Lastly, while the discussion thus far has been related to green hydrogen as a stand-alone product, the reality is that for coastal regions, the majority of the hydrogen produced will be converted to hydrogen derivatives such as ammonia, methanol or Fischer-Tropsh products.[148] The earliest market for such products is for sustainable maritime bunker fuel: Member States of the International Maritime Organisation (IMO), such as South Africa, adopted the 2023 IMO GHG Strategy [149], requiring Net Zero emissions from shipping by 2050, with an intermediate target of 5% of the energy consumed in shipping to be Net Zero by 2030 (which is only 4 years away). Saldanha Bay and Richards Bay are both ports receiving heavy vessels (iron ore and coal ports, respectively), so will have to make significant volumes of sustainable maritime bunker fuel available for purchase.

10.4. RECOMMENDATIONS

OSW has significant potential to support the development of South Africa's green hydrogen (GH_2) industry, and the two sectors could mutually reinforce each other. To develop this potential, the following actions are recommended:

- **P2X1 – MED-HIGH.** Conduct further analysis to estimate the cost of producing green hydrogen using both OSW and solar PV as electricity sources assessing the cost competitiveness and synergy of these technologies.
- **P2X2 – MED-HIGH.** The DTIC should consider including provisions for OSW in the green hydrogen strategy and sector development plans.

11. PORT INFRASTRUCTURE

11.1. PURPOSE

Port infrastructure is pivotal in establishing the OSW sector. Oversized components of wind farms, such as turbines, foundations, and submarine cables, require ports for fabrication, marshalling and operations. South African ports possess considerable capacity and have been developed to handle a variety of cargo, including container cargo, coal and automobile exports, transhipment hubs, fresh produce, oil, and iron ore transportation.

This chapter assesses the readiness of South Africa's port infrastructure to support fixed and floating OSW development at a high level. It describes the upgrades needed to support the different growth scenarios. It also considers road and rail infrastructure.

11.2. METHOD

This chapter outlines the baseline port requirements for fixed and floating OSW and assesses the current port and wider infrastructure in South Africa. The current capabilities are then mapped against those required, with focus areas and recommendations for specific upgrade requirements made.

11.2.1. Port assessment methodology

To quantify the viability of South African ports, we employed a Red, Amber, Green (RAG) analysis, which provides a rating framework against which to assess each port's current and future capability in servicing OSW developments.

11.2.1.1. South African ports assessed

The Transnet Port Authority (TNPA) is a public, state-owned enterprise responsible for port master planning, investment, and management of the eight commercial seaports along South Africa's coastline: the Port of Richards Bay, Port of Durban, Port of East London, Port of Ngqura, Port of Port Elizabeth, Port of Cape Town, Port of Saldanha Bay, and Port of Mossel Bay. TNPA is also managing the development of the new Port of Boegoebaai. A total of seven of these South African ports were analysed. The ports selected for analysis were chosen based on geospatial analysis, which initially suggested them as viable options. Port Nolloth was not chosen for further investigation as this port is no longer suitable for commercial vessels due to silting [150] and its small size. Furthermore, the Port of Port Elizabeth (located in Gqeberha) was also not investigated due to the proximity of the newer Port of Ngqura, which offers significantly deeper waters. The Port of Boegoebaai, currently in the planning stages, was considered in this assessment but not scored against the port suitability criteria.

It is important to note that this assessment did not consider the environmental and social impacts of redeveloping port facilities for OSW projects. Such an assessment would require further analyses to determine the effect. It would be a future appraisal that should include more detailed financial analyses to determine the actual level of investment needed. From a procedural justice standpoint, ensuring inclusive decision-making processes in the planning, implementing, and operating of associated infrastructure projects is critical.

11.2.1.2. OSW port types and assessment criteria

Ports associated with the construction, and operation and maintenance (O&M) of OSW can broadly be divided into the following five typologies: floating OSW fabrication, fixed OSW fabrication, fixed OSW marshalling, Crew Transfer Vessel (CTV) O&M, and Service Operation Vessel (SOV) O&M. Each typology differs in its characteristics based on function.

The assessment criteria framework used is set out in Table 23, which, while including several assumptions, has been corroborated in stakeholder consultations. Each assessment criterion consists of a definition and values determined to be ideal requirements for each port type. Each criterion includes a RAG rating, categorising criterion values into three groups: red (values not acceptable for the required purpose), amber (acceptable values), and green (preferable values).

TABLE 23: ASSESSMENT CRITERIA FOR ALL PORT TYPOLOGIES WITH ASSIGNED RAG RATING.

			RAG assessment				
Port criteria	**Details**	**Units**	**Floating OSW fabrication port**	**Fixed OSW fabrication port**	**Fixed OSW marshalling port**	**CTV based O&M port**	**SOV based O&M port**
Air draft restriction	The presence of any barrier within the vertical distance measured from the vessel waterline to the highest point on the vessel	Metres (m)	Presence	<40	<120	<12	<30
				40-100	120-200	12-20	30-50
			0 / None	0 / None	0 / None	0 / None	0 / None
Cranes with lifting capacity	The equipment to handle wind turbine components	Metric tonnes (t)	<3500	<500	<500	N/A	N/A
				500	500		
			>3500	>500	>500		
Draft depth	The depth of water with which a ship or floating substructure can safely navigate	Metres (m)	<12	<3	<8	<3	<7
			12-20	3-12	8-12	2-3	7-8
			>20	>12	>12.5	>4	>8
Harbour entrance width	The width of a sheltered port area's entrance	Metres (m)	<150	<50	<200	<15	<20
				50-60	200-300	15-20	20-25
			>150	>60	>300	>20	>25

Port criteria	Details	Units	RAG assessment				
			Floating OSW fabrication port	Fixed OSW fabrication port	Fixed OSW marshalling port	CTV based O&M port	SOV based O&M port
Infrastructure access (road/ railway/airport)	The connectivity and transportation links that facilitate the smooth movement of personnel, equipment, and materials to and from the port facility	Presence/ absence	N/A	N/A	N/A	Absence	Absence
						Presence	Presence
Lock/gate presence	The physical restriction for entering and exiting the harbour	Presence/ absence	Presence	Presence	Presence	Presence	Presence
			Absence	Absence	Absence	Absence	Absence
Office facilities (storage, meeting rooms, changing rooms, etc.)	The dedicated spaces within the port infrastructure are designed to support the administrative and logistical needs of personnel engaged in the ongoing OW maintenance services.	Presence/ absence	N/A	N/A	N/A	Absence	Absence
						Presence	Presence
Quay length	The length of a hard wall that vessels are moored against	Metres (m)	<200	<200	<200	<30	<30
			200-500	200-400	200-400	30-40	30-40
			>500	400-500	400-500	>40	>40
Quay strength	The ability to uphold the shipment's weight of a hard wall that vessels are moored against	Metric tonnes per square metre (t/m^2)	<100	<10	<10	N/A	N/A
				10-20	10-20		
			>100	>20	>20		
Wet storage	A temporary storage area for floating wind turbines in suitable offshore areas before they are installed at their designated locations.	Hectares (ha)	<8	N/A	N/A	N/A	N/A
			8-16				
			>16				
Yard area	An area of land within a port where components are fabricated and stored before being floated into storage. The place comes with suitable covered facilities.	Hectares (ha)	<20	<4	<15	<0.75	0.75
			20-30	4-6	15-20	0.75-1.5	0.75-3
			>30	>6-12	>20	>1.5	>3

11.2.1.3. Applicability analysis

To assess and compare the selected South African ports for suitability for OSW development, publicly available data for each port was analysed against the assessment criteria and ideal values, and a value was assigned based on the RAG rating system. The definitions associated with the RAG rating can be seen in Table 24. Ports requiring fewer updates/upgrades receive a higher suitability score (green), while those with significant upgrade needs or those not considered suitable have a low suitability score (red).

TABLE 24: RAG USED TO ASSESS OVERALL PORT SUITABILITY.

Category	Description
	Suitable with no or minor upgrades.
	Potentially suitable with moderate upgrades.
	Not suitable or potentially suitable with significant upgrades.

For each port, the values were then consolidated to determine an overall score, indicating the port's level of suitability in its current or planned state. Once the suitability of each port was determined, the three most suitable ports were explored in Section 11.2.2 regarding additional associated infrastructure, including roads, air, and rail links.

The top three ports were further assessed to better determine their investment needs. This additional analysis was a qualitative assessment based on current data available for each port.

11.2.2. Assessment criteria of OSW ports

This section provides the characteristics of each OSW port type and the corresponding assessment criteria.

11.2.2.1. Assessment criteria for floating OSW fabrication ports

Fabrication ports are ports with the facilities to enable OSW farm fabrication rather than solely for transportation. Floating OSW has several specific characteristics, as floating OSW substructures differ from fixed OSW assets. Each floating OSW technology requires a different amount of space for fabrication and storage. Therefore, generic requirements for floating OSW fabrication ports have not yet been standardised.

Floating OSW foundations are manufactured and assembled on land (or via a floating dry dock) and have significant space requirements.[151] Foundations may be stored on land or in a sheltered wet storage area. In addition, turbine components such as nacelles, blades and towers require onshore storage facilities. In total, a floating OSW installation port can be expected to store between 25% and 50% of the components necessary for the entire wind farm. Mooring and fixing storage is also required for floating OSW fabrication ports; however, these do not have special associated storage needs. Electrical cables are usually loaded onto vessels at the point of fabrication and transported directly to the installation site. Therefore, the storage and fabrication are specific to their manufacturing location, which is not necessarily specific to floating OSW.

Floating OSW foundations require significant special storage, known as wet storage, to successfully integrate with installation processes. Spar-buoy and semi-submersible foundations, with their larger sizes, generally require more storage space than tension-leg platforms (TLPs). However, the specific storage capacity would depend on the individual platform's design, the wind turbine's requirements, and other equipment that needs to be supported.

11.2.2.2. Assessment criteria for fixed OSW fabrication ports

The specific requirements for fixed OSW fabrication ports are fewer than for floating OSW fabrication ports. However, several components for floating OSW could be constructed at a fixed OSW fabrication port. For example, floating and fixed OSW installations will use the same cable fabrication ports.

Fixed OSW fabrication ports require quayside storage for the main components of the turbine and tower, namely the nacelle, blades, tower and foundation. Fixed OSW foundations, i.e. jackets and monopiles, are much smaller than floating OSW substructures, so while they also require storage, they do not require wet storage, and the total area required is less.

Components must be moved from the quayside to the deck using quayside cranes or installation vessel cranes before transportation to the installation site.

11.2.2.3. Assessment criteria for fixed OSW marshalling ports

Marshalling ports are used as intermediary facilities while constructing a fixed OSW farm. They tend to be located relatively close to the OSW farm they are to serve and, therefore, store components closer to the site than the fabrication ports, therefore de-risking the transportation of parts. Due to their transient nature, it is expected that marshalling ports have a certain level of flexibility, especially concerning storage, since they are required to import, export and store many large components. Therefore, marshalling ports must have long, deep quaysides to accommodate the vessels needed to transport components.

OSW farms may use multiple marshalling ports or none at all, depending on the capability and location of nearby fabrication ports.

11.2.2.4. Assessment criteria for CTV-based O&M ports

Port requirements for O&M of OSW farms are far less demanding than those used for installation. Crew Transfer Vessels (CTVs) are support vessels used during OSW farms' operation and maintenance phases. They are also used during the construction phase. CTVs are used to reach wind farms that are relatively close to shore and for single-day trips, transporting personnel and small components or pieces of equipment out to the site, with the crew returning to shore at the end of the day. CTVs are small vessels with an overall length of 15-30 m and a shallow draft.

A CTV O&M port would be required to enable the daily running of CTVs between the installation site and port and allow the transfer of crew and components. Many CTVs use a deck crane to transfer cargo from quayside to deck, and therefore, quayside access and facilities are required for CTV ports. For wind farms served by CTVs, the O&M port is typically located under 100 km from the wind farm, and therefore, the distance to the wind farm is a vital characteristic of a CTV O&M port.

11.2.2.5. Assessment criteria for SOV-based O&M ports

Similarly to ports used for CTV O&M, ports used for Service Operations Vessels (SOV) O&M have fewer requirements than those used in installation and fabrication.

SOVs are support vessels used during OSW farms' construction, operation, and maintenance phases. They are used to reach wind farms further from shore. Therefore, SOVs are used for multi-day trips to transport personnel, components and pieces of equipment out to the site with the crew residing in the vessel's living quarters for the duration of the trip. SOVs are large vessels with crew lodging (for between 50 and 100 crew members for up to four weeks [152]), warehousing areas and with average overall lengths of between 50 and 80 m. Vertical clearance will vary but may be up to 30m (for an 80 m vessel), depending on the vessel's tower access type.

Ports used for SOV O&M are typically located within 200 km of the wind farm being served, and the closest available port is generally used. These ports must also be capable of large component exchanges and repairs.

11.2.3. Road and rail assessment methodology

The additional road and rail requirements will not be significant for OSW development. Therefore, the assessment is high-level only. We first defined the criteria for road and rail transport and then assessed the suitability of the current infrastructure to meet these needs. The requirements focussed only on component and personnel transport.

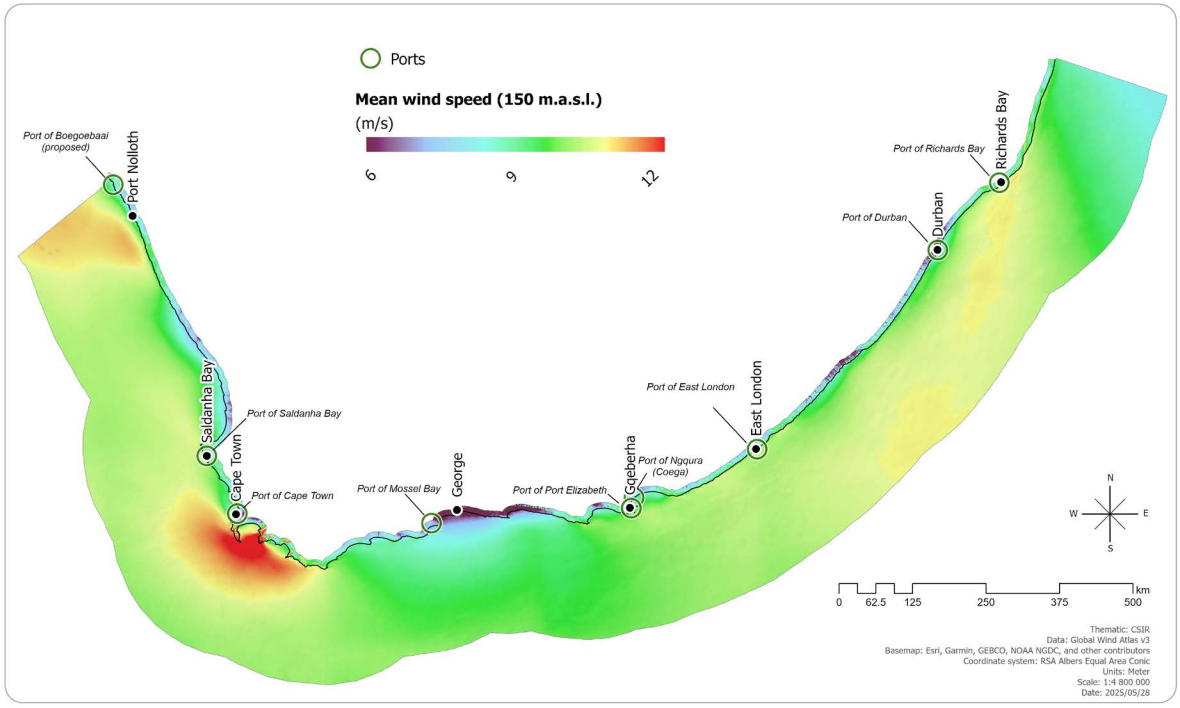
11.3. RESULTS AND DISCUSSION

This section will compare the individual ports selected for analysis and will compare these against all the criteria described and defined in Section 11.2. Following the assessment, the section will discuss the associated infrastructure of the highest-ranking ports.

11.3.1. Status in South Africa

South Africa has a coastline of roughly 2,800 km, with 24 ports and small harbours.[153] However, as described in Section 11.1, the country has eight commercial seaports (Figure 55) managed by the TNPA, which may be suitable for supporting an emerging OSW market. The TNPA provides and maintains the infrastructure for these commercial ports, organises marine-related services, and provides navigation aid and assistance to vessels manoeuvring along the coast and within port confines.[154]

FIGURE 55: GEOGRAPHICAL REPRESENTATION OF THE LOCATION OF PORTS INVESTIGATED RELATIVE TO THE PREFERRED LOCATIONS FOR OSW ENERGY DEVELOPMENTS.



11.3.2. Individual port analysis

In this section, we will compare the individual ports identified for assessment against the assessment criteria defined in Section 11.2.1.

11.3.2.1. Port of Richards Bay

The Port of Richards Bay is located on the East coast of South Africa, 160 km northeast of Durban. It has road connections to Eswatini and Mozambique. The port occupies 2,157 ha of land and 1,495 ha of water area but has the potential to expand, potentially making it one of the largest ports in the world. [155] The TNPA announced it will use funds from the Development Bank of Southern Africa (DBSA) to develop a common-use infrastructure facility needed for the Liquified Natural Gas (LNG) terminal and to create a gas transmission pipeline to handle LNG imports and bulk service infrastructure in Richards Bay. The port's current use includes minerals and commodities such as forest products, aluminium, granite, minimum containers, heavy lifts, ferroalloys, clay, potash, salt, sulphur and other chemical products.[156] The port is South Africa's leading port in terms of cargo volumes handled and port size. The layout of Richards Bay can be seen in Figure 56.

FIGURE 56: CURRENT LAYOUT OF THE PORT OF RICHARDS BAY.

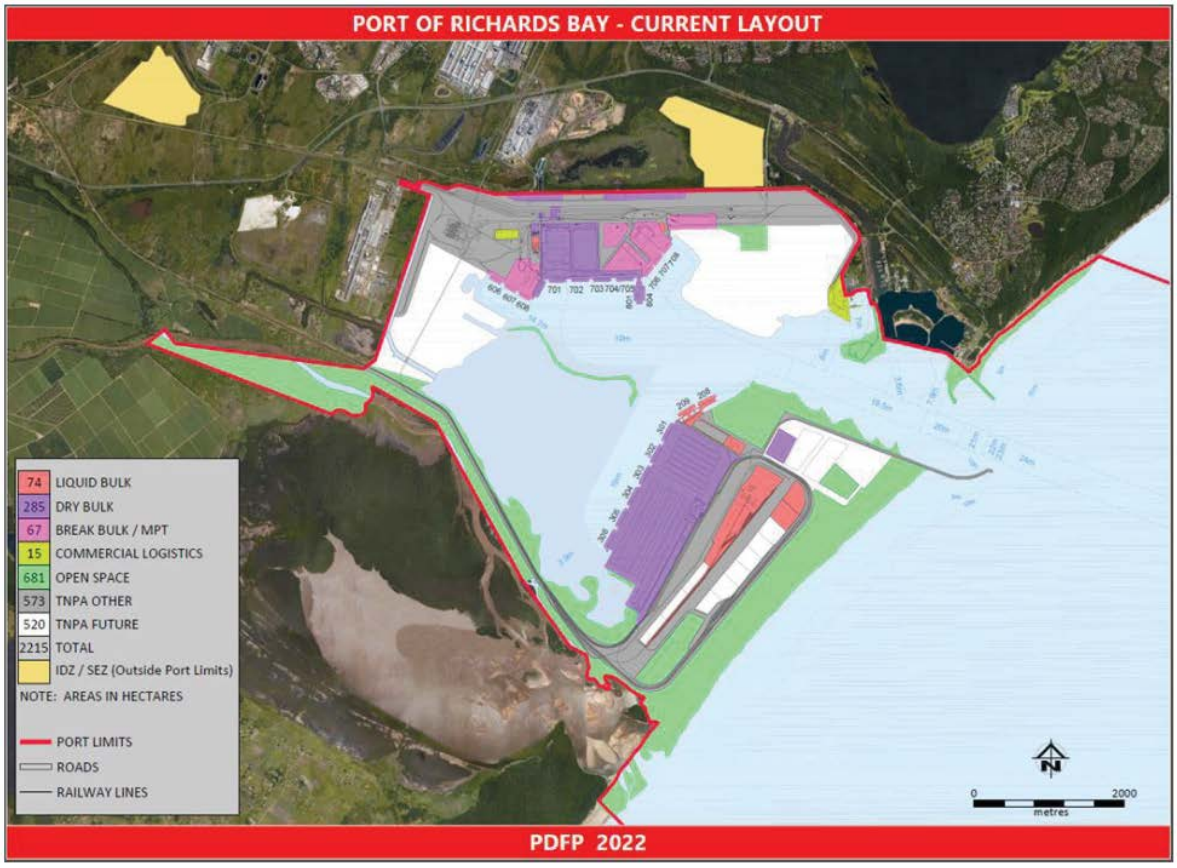


Table 25 shows the essential criterion for port types associated with OSW, by comparison with Port of Richards Bay characteristics. The Port of Richards Bay already has a lot of the required characteristics and is most suitable in its current state as a CTV or SOV O&M port, mainly due to the available quay length and depth. Fairly straightforward upgrades would be required for the site to be used as a fabrication or marshalling port. Therefore, suggested investment in this port would include quayside depth dredging, quay length expansion into available open space, and upgrading the available cranes.

TABLE 25: ASSESSMENT OF THE PORT OF RICHARDS BAY.[157]

Port criteria [158]	Details	RAG assessment				
		Floating OSW fabrication port	Fixed OSW fabrication port	Fixed OSW marshalling port	CTV based O&M port	SOV based O&M port
Yard area (Ha)	2,157 ha[10]					
Wet storage area (Ha)	1,495 ha[11]		N/A	N/A	N/A	N/A
Quayside draft depth (m)	Maximum permitted draught: 17.5 m[12]					
Air draft restriction (m)	None identified					
Harbour entrance width (m)	300 m [159]					
Lock/gate presence	No lock/ gate presence identified[13]					
Quay length (m)	300 m max berth length (single quay)					
Quay strength/ Load bearing capacity (metric tonnes/m²)	No information available				N/A	N/A
Cranes with lifting capacity (metric tonnes)	No information available				N/A	N/A
Office facilities (meeting rooms, changing rooms, etc.)	No information available	N/A	N/A	N/A		
Infrastructure access (road/railway/airport)	Rail access; road access; airport access; helicopter/ helipad access	N/A	N/A	N/A		

10 Land area: http://www.kzntransport.gov.za/public_trans/freight_databank/kzn/ports/Richards_Bay/index_xml.html#:-:text=Richards%20Bay%20Coal%20Terminal%20(RBCT)&text=Ships%20are%20handled%20at%20four,permissible%20draught%20of%2012.5m

11 Water area: http://www.kzntransport.gov.za/public_trans/freight_databank/kzn/ports/Richards_Bay/index_xml.html#:-:text=Richards%20Bay%20Coal%20Terminal%20(RBCT)&text=Ships%20are%20handled%20at%20four,permissible%20draught%20of%2012.5m

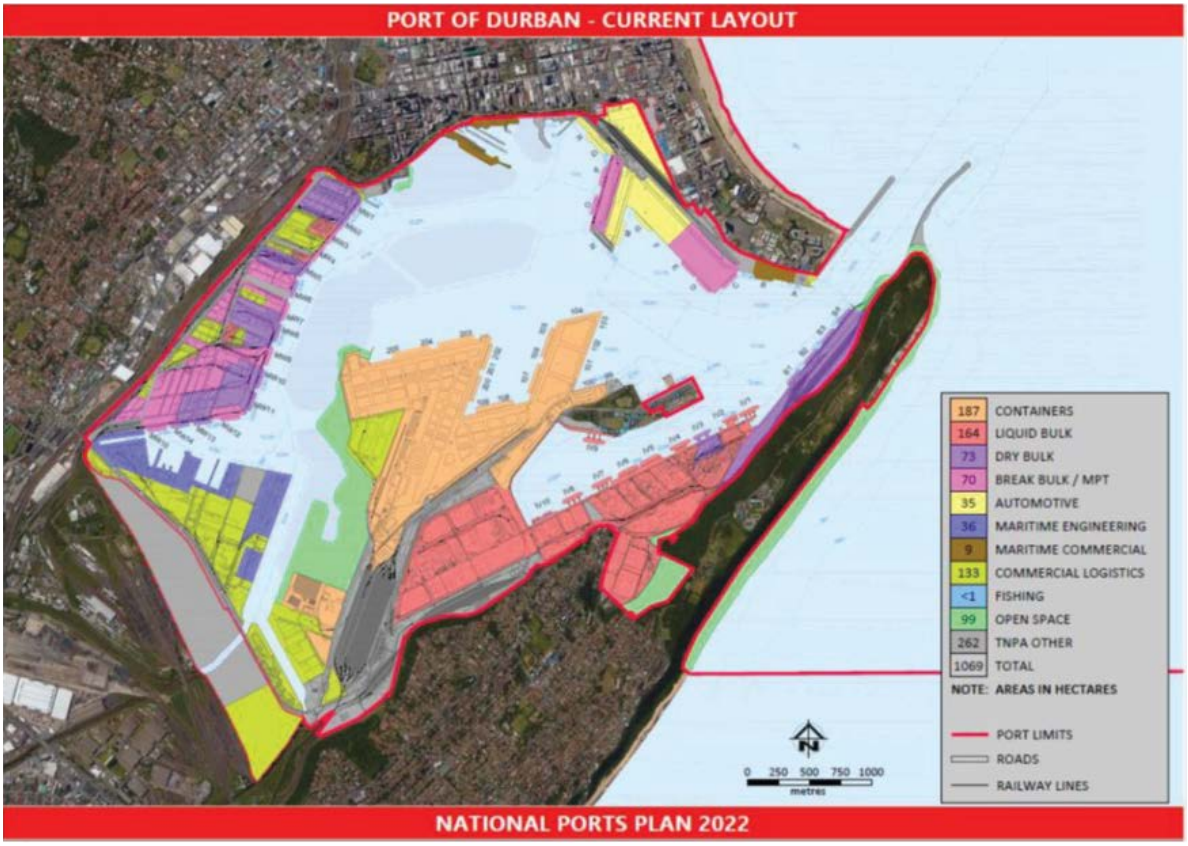
12 Vessels with a draft over 17.5 m are handled at the discretion of the Harbour Master.

13 Determined from map data on Google maps

11.3.2.2. Port of Durban

The Port of Durban, commonly called Durban Harbour, is the largest port facility in South Africa, with the highest vessel traffic in all of Africa. The port is located on the east coast of South Africa and is a central feature of the City of Durban. Currently, the Port of Durban is used for container, automotive and liquid bulk transport, as well as cruise ships.[160] To meet the rising demand and need for maritime capacity in the region, TNPA is seeking to expand the terminal capacity at this port from 3.6 m twenty-foot equivalent units (TEUs) to 4m TEU [161] through funding from the DBSA. Table 26 compares the essential criterion for port types associated with OSW against the Port of Durban's characteristics.

FIGURE 57: CURRENT LAYOUT OF THE PORT OF DURBAN.[162]



Based on the assessment criteria and the figures in Table 26, the Port of Durban would be suitable as a CTV and SOV-based O&M port. With investment in increasing quay length by a minimum of 34 m, the Port of Durban could be ideal for fixed OSW fabrication. An increase of quay length by at least 134 m and an increase in dredged quayside draft by 10 m would make the Port of Durban suitable as a floating OSW fabrication port. Physical and land use constraints may limit a quay length extension of this magnitude.

TABLE 26: PORT OF DURBAN.[163]

Port criteria	Details	RAG assessment				
		Floating OSW fabrication port	Fixed OSW fabrication port	Fixed OSW marshalling port	CTV based O&M port	SOV based O&M port
Yard area (ha)	Undercover storage: 0.838 ha Land area: 1850 ha [164]					
Wet storage area (ha)	679 ha (low tide) 892 ha (high tide)		N/A	N/A	N/A	N/A
Quayside draft depth (m)	Max: 12.2 m Min: 11.6 m					
Air draft restriction (m)	None Identified					
Harbour entrance width (m)	220 m[14]					
Lock/gate presence	No lock gate presence[15]					
Quay length (m)	366 m [165] maximum docking length					
Quay strength (metric tonnes/m²)	No information available				N/A	N/A
Cranes with lifting capacity (metric tonnes)	Dockside: 2 x 50 MT; 2 x 10 MT; Floating: 1 x 213 MT[16] at 10 m; 1 x 113 MT[17] at 24 m; 1 x 54 MT[18] at 6.1 m / 40.6 MT at 16.2 m [166]				N/A	N/A
Office facilities (meeting rooms, changing rooms, etc.)	No information available	N/A	N/A	N/A		
Infrastructure access (road/railway/airport)	Roadway systems; rail services [167]	N/A	N/A	N/A		

14 Once dredging has taken place by TNPA

15 Determined from map data on Google maps

16 Converted from tons, available at: https://dlca.logcluster.org/211-south-africa-port-durban#:~:text=The%20Port%20of%20Durban%20has,can%20easily%20enter%20the%20port

17 Converted from tons, available at: https://dlca.logcluster.org/211-south-africa-port-durban#:~:text=The%20Port%20of%20Durban%20has,can%20easily%20enter%20the%20port

18 Converted from tons, available at: https://dlca.logcluster.org/211-south-africa-port-durban#:~:text=The%20Port%20of%20Durban%20has,can%20easily%20enter%20the%20port

11.3.2.3. Port of East London

The Port of East London is South Africa's only river port, which sits on the mouth of the Buffalo River in the Eastern Cape province. The port is predominantly used for automotive, cargo, grain, fruit, mineral ore and wool, and the seaport currently houses the largest export grain elevator in South Africa.[168] It also has good road and rail connections with the hinterland. TNPA has announced a large portion of their 2025/26 budget to be allocated to the port, which is expected to be around R243 million.[169] The investment will go towards deepening and strengthening berths, replacing two cranes to enable the ship repair facility, and acquiring two tugboats.

FIGURE 58: CURRENT LAYOUT OF THE PORT OF EAST LONDON.[170]

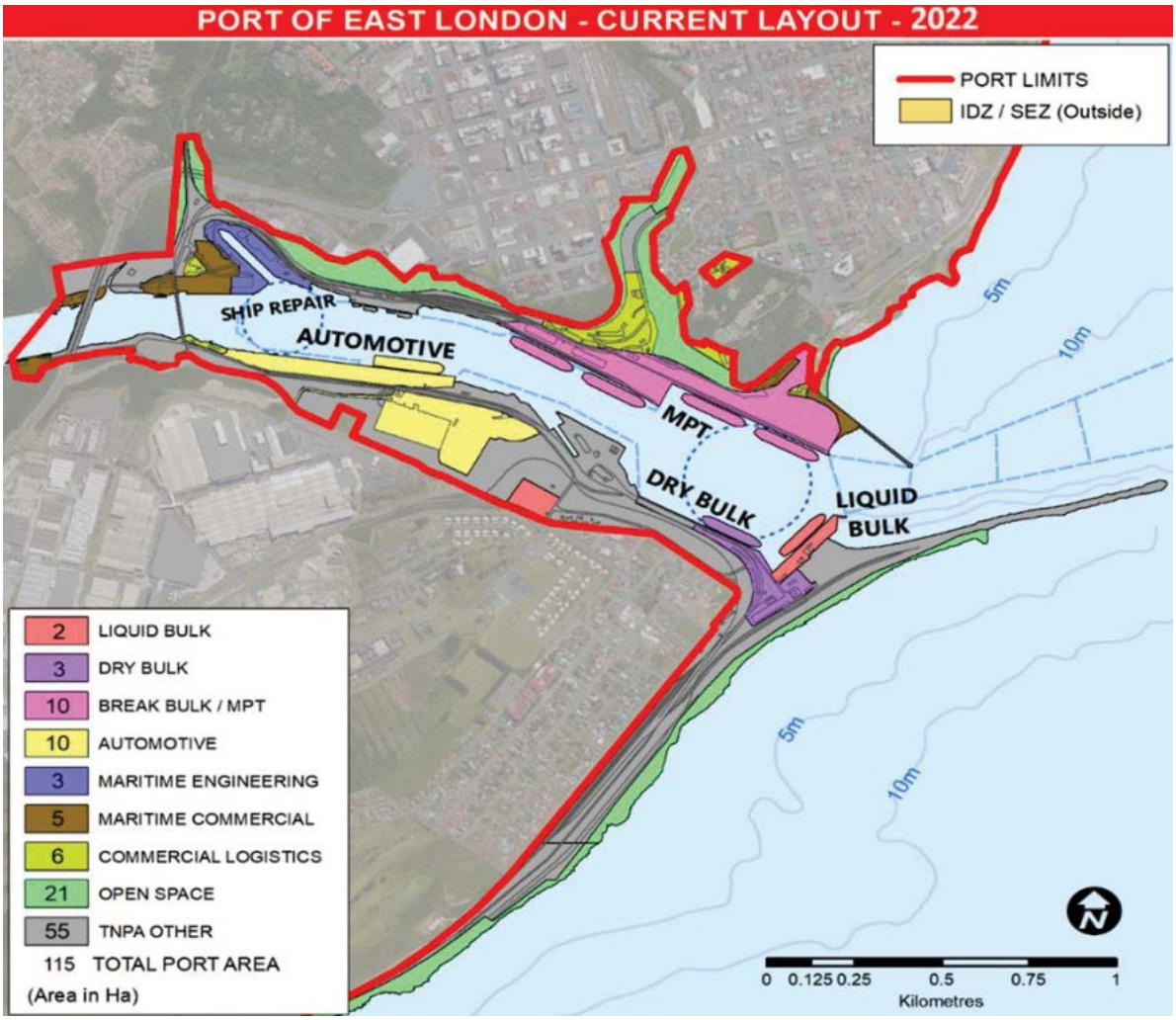


Table 27 compares the critical criterion for port types associated with OSW against the Port of East London's characteristics. The Port of East London is most suitable in its current state as a CTV O&M port. However, due to its nature as a river port, there is less space for expansion, so upgrading its main characteristics could be challenging.

TABLE 27: PORT OF EAST LONDON.[171]

Port criteria	Details	RAG assessment				
		Floating OSW fabrication port	Fixed OSW fabrication port	Fixed OSW marshalling port	CTV based O&M port	SOV based O&M port
Yard area (ha)	Undercover storage: 0.417 ha [172] Land area: 130 ha [173]					
Wet storage area (ha)	Approx. 1,760 ha[19]		N/A	N/A	N/A	N/A
Quayside draft depth (m)	Max at quayside: 10.4 m [174]					
Air draft restriction (m)	No maximum [175]					
Harbour entrance width (m)	170 m[20]					
Lock/gate presence	Lock/ gate only present on ship repair quay[21]					
Quay length (m)	250 m max berth length (single quay)					
Quay strength (metric tonnes/m²)	No information available				N/A	N/A
Cranes with lifting capacity (metric tonnes)	0-24 MT; 25-49 MT [176]				N/A	N/A
Office facilities (meeting rooms, changing rooms, etc.)	No information available	N/A	N/A	N/A		
Infrastructure access (road/ railway/airport)	There are rail and road connections with the hinterland and north and southwest to KZN and Port Elizabeth, respectively; the car terminal includes a four-storey parking facility connected by a dedicated road and East London airport. [177]	N/A	N/A	N/A		

19 Total land and water area provided is 1,890ha: https://www.lbhmozambique.com/wp-content/uploads/2020/07/LBH-SA_EastLondon_PortInfo.pdf

20 Width at narrowest point https://africaports.co.za/east-london/#:~:text=The%20entrance%20to%20the%20Port,vessels%20of%20up%20to%20245m.

21 Determined from map data on Google maps

11.3.2.4. Port of Ngqura

The Port of Ngqura, commonly called the Port of Coega, is located on the Southern coast of South Africa, close to the Port of Gqeberha (18 km). The port is a deepwater container transhipment hub and operates within an SEZ. The port is relatively new and is the deepest container port in South Africa, intended to complement the deepwater ports in Richards Bay and Saldanha Bay. Given the port's infrastructure, depth and marine services, it can accommodate abnormal cargo. It has handled imported wind turbines since 2013.[178]

The port's services are to be expanded to accommodate dry bulk, break bulk, and liquid bulk, and plans include increasing manganese ore exports and importing LNG.

FIGURE 59: CURRENT LAYOUT OF THE PORT OF NGQURA.[179]

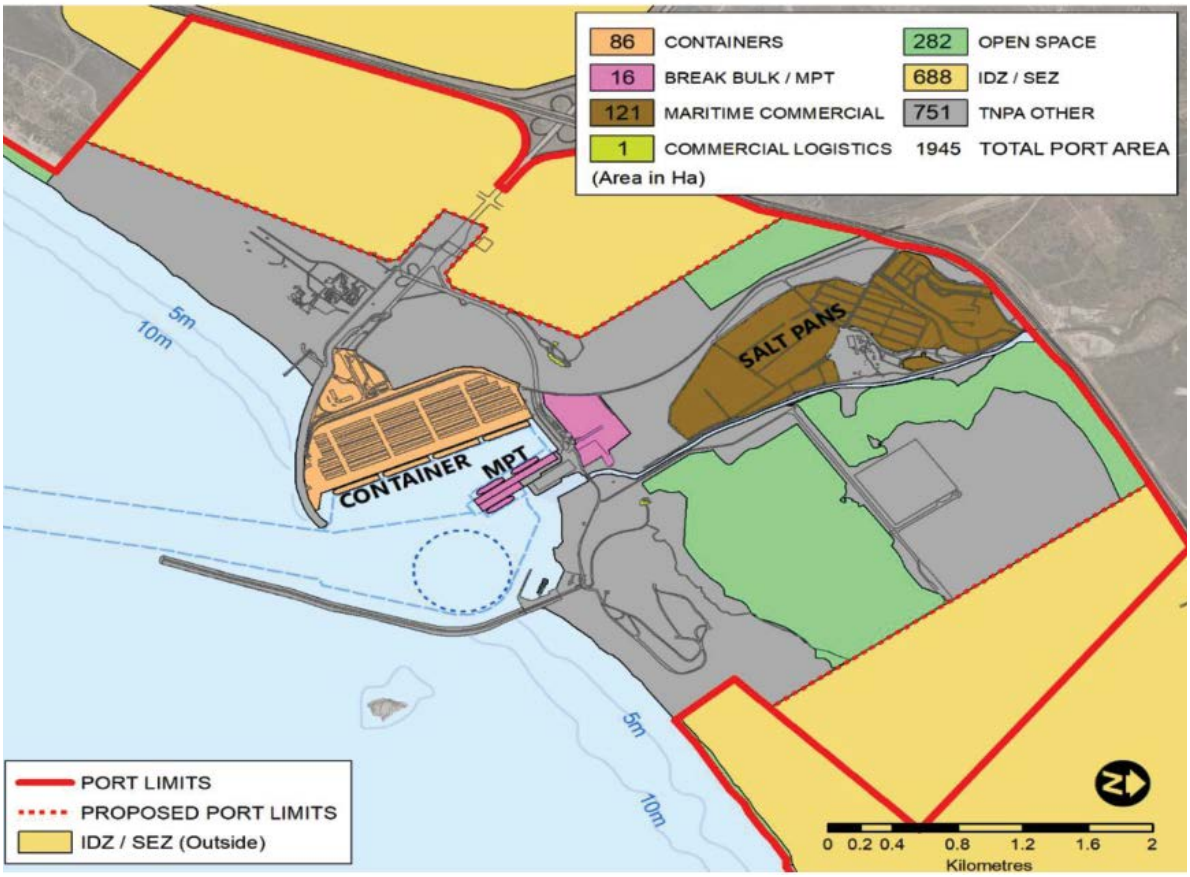


Table 28 compares the critical criterion for port types associated with OSW against the characteristics of the Port of Ngqura. The Port of Ngqura is most suitable in its current state as a CTV and SOV O&M port; however, compared to other ports, it is not the best-suited for development. This is predominantly due to its size and available area.

TABLE 28: PORT OF NGQURA.[180]

Port criteria	Details	RAG assessment				
		Floating OSW fabrication port	Fixed OSW fabrication port	Fixed OSW marshalling port	CTV based O&M port	SOV based O&M port
Yard area (ha)	Storage and operational area of container terminal: 83 ha [181]					
Wet storage area (ha)	No information available		N/A	N/A	N/A	N/A
Quayside draft depth (m)	Western basin: 15.5 m Eastern basin: 17.5 m					
Air draft restriction (m)	No information available					
Harbour entrance width (m)	300 m [182]					
Lock/gate presence	No lock/gate present[22]					
Quay length (m)	Max berth length: 318.5 m [183]					
Quay strength (metric tonnes/m²)	No information available				N/A	N/A
Cranes with lifting capacity (metric tonnes)	No information available				N/A	N/A
Office facilities (meeting rooms, changing rooms, etc.)	There is a port administration building ("eMendi") [184]	N/A	N/A	N/A		
Infrastructure access (road/ railway/airport)	Road access Rail access Air access	N/A	N/A	N/A		

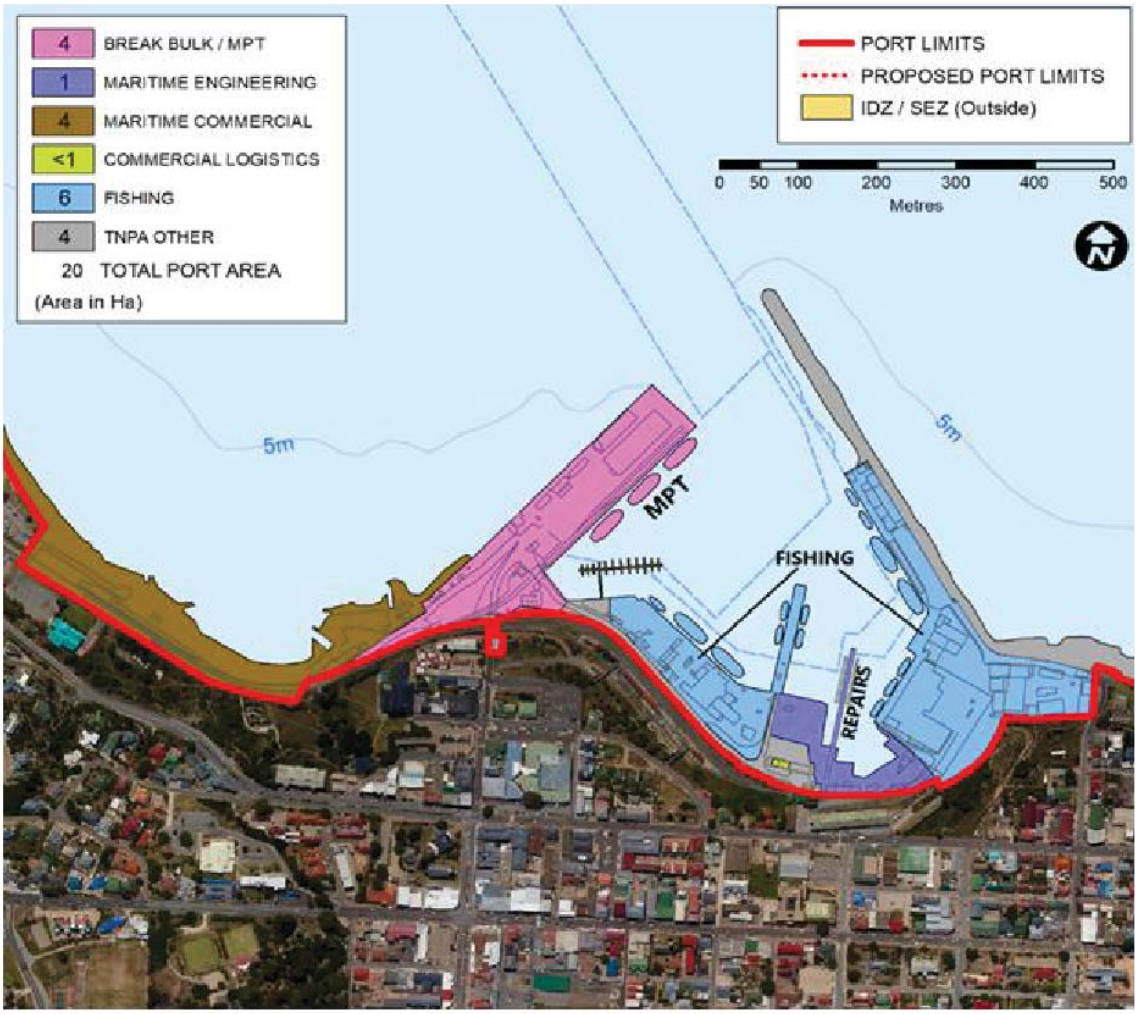
22 Determined from map data on Google maps

11.3.2.5. Port of Mossel Bay

The Port of Mossel Bay is situated halfway between Cape Town and Port Elizabeth on the Southern coast of South Africa. It is the smallest commercial port in South Africa and concentrates mainly on the oil, gas, and fishing industries. Notably, the port has two offshore mooring buoys used by feeder vessels from Durban and Cape Town. The N2 national road and rail connections connect the Port of Mossel Bay.

TNPA has announced an investment programme of R2.2 billion in the Port of Mossel Bay, specifically to prioritise key capital projects, including a slipway facility refurbishment and Quay 3 piling.

FIGURE 60: CURRENT LAYOUT OF THE PORT OF MOSSEL BAY.[185]



As can be seen by the scores shown in Table 29, Port of Mossel Bay is most suitable in its current state as a CTV or SOV O&M port. Due to its proximity to the Port of Cape Town, it would make most sense to consider any upgrades to support OSW development in tandem.

TABLE 29: PORT OF MOSSEL BAY.[186]

Port criteria	Details	RAG assessment				
		Floating OSW fabrication port	Fixed OSW fabrication port	Fixed OSW marshalling port	CTV based O&M port	SOV based O&M port
Yard area (ha)	Port area: 3,700 ha [187] Dry storage area: 0.4 ha (Quay 4 — possibly)					
Wet storage area (ha)	No information available		N/A	N/A	N/A	N/A
Quayside draft depth (m)	The harbour's maximum permissible draught is 7.5 m. At catenary buoy mooring, ships with a max draught of 12 m					
Air draft restriction (m)	No information available					
Harbour entrance width (m)	Breadth: 120 m					
Lock/gate presence	No lock/gate present 23					
Quay length (m)	Max quay length = 220 m Quay total = 686 m					
Quay strength (metric tonnes/m²)	Quay 4: 2.9 tons/m2 (approx. 28.4 KM/m2)				N/A	N/A
Cranes with lifting capacity (metric tonnes)	Slipway for ship repair				N/A	N/A
Office facilities (meeting rooms, changing rooms, etc.)	There is a port administration building [188]	N/A	N/A	N/A		
Infrastructure access (road/ railway /airport)	Accessible by road and railway networks; the closest airport is George (approx. 50km away) [189]	N/A	N/A	N/A		

23 From Map data on Google maps

11.3.2.6. Port of Cape Town

The Port of Cape Town is in Cape Town in the south-west of South Africa. The port is a critical hub in one of the world's busiest trade routes, and it predominantly handles fresh fruit and cargo containers. It is South Africa's second-largest container port. Recently, the TNPA has invested significantly in the port and sought a private partner for development. Additionally, the port has recently procured technical equipment to stabilise vessels during adverse weather and a helicopter piloting service to improve efficiency.[190] These investments aim to boost the port's productivity and eradicate backlogs, enhancing its role in South Africa's economy.

FIGURE 61: CURRENT LAYOUT OF THE PORT OF CAPE TOWN.[191]

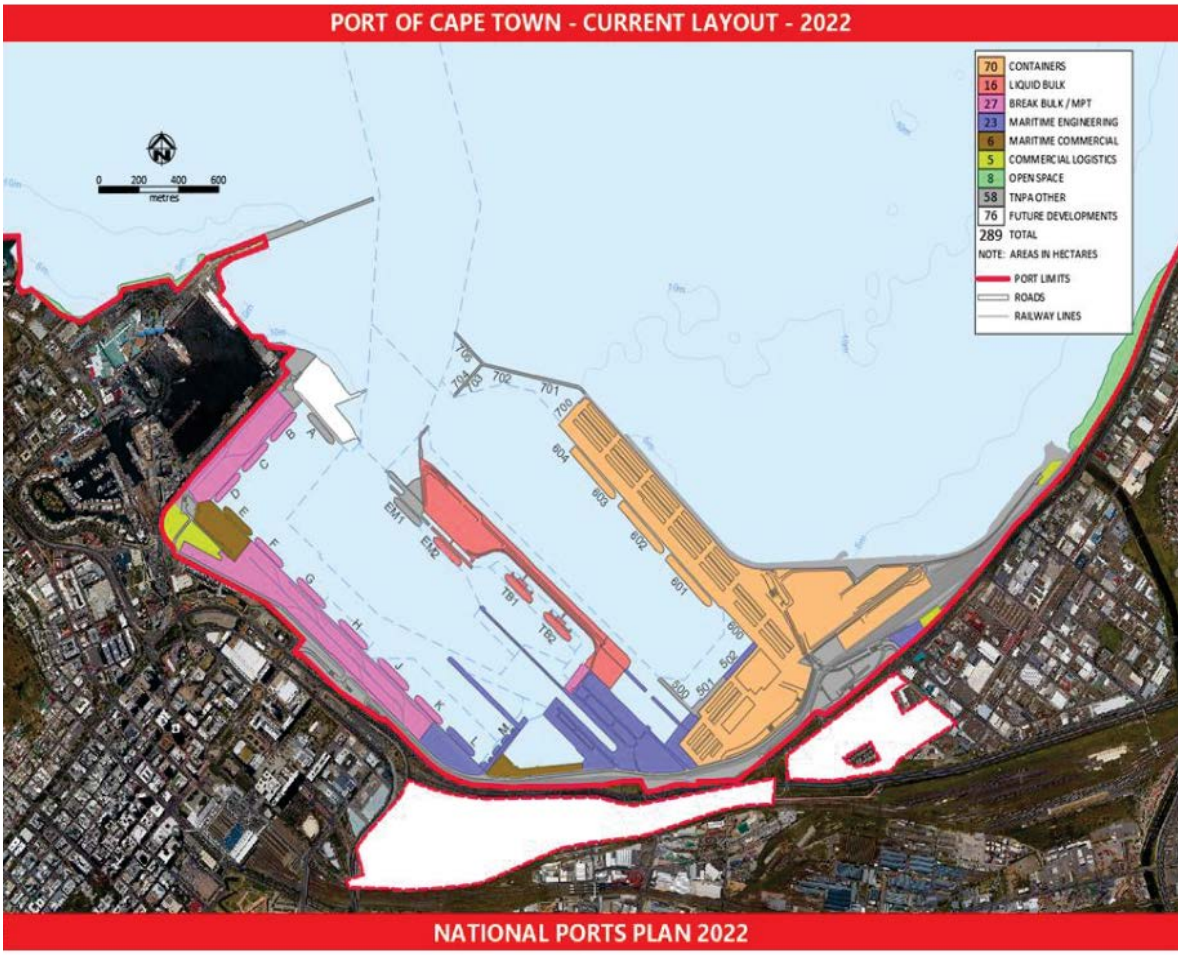


Table 30 compares the critical criterion for port types associated with OSW against the Port of Cape Town's characteristics. The Port of Cape Town is most suitable in its current state as a CTV and SOV O&M port; however, in comparison to other ports, it has multiple natural characteristics, which could make it suitable for fabrication and marshalling. Specifically, it has a long quayside length, which is hard to obtain. As such, upgrading this port to service OSW could be viable by improving other characteristics, such as crane lift capacity.

TABLE 30:PORT OF CAPE TOWN.[192]

Port criteria	Details	RAG assessment				
		Floating OSW fabrication port	Fixed OSW fabrication port	Fixed OSW marshalling port	CTV based O&M port	SOV based O&M port
Yard area (ha)	Warehousing facilities: 5.56 ha.[24] Land area = 253 ha. [193] There is no information on the open storage area.					
Wet storage area (ha)	No information available Water area = 9,163 ha [194]		N/A	N/A	N/A	N/A
Quayside draft depth (m)	Max draft (Duncan Dock) = 13.1 m[25] Max draft = 12.1 m					
Air draft restriction (m)	No information available					
Harbour entrance width (m)	180 m wide (Duncan Dock) [195]					
Lock/gate presence	No lock/gate present[26]					
Quay length (m)	Max quay length: 456 m (repair quay) [196] Total quay length: 1,137 m [197][27]					
Quay strength (metric tonnes/m²)	No information available				N/A	N/A
Cranes with lifting capacity (metric tonnes)	4-50 tonnes shore cranes ; 15 tonnes cranes; 5 tonne cranes ; 1,750 tonnes synchro lift [198]				N/A	N/A
Office facilities (meeting rooms, changing rooms, etc.)	The map indicates some presence of offices [199]	N/A	N/A	N/A		
Infrastructure access (road/ railway/airport)	Airport access [200] Good rail and road facilities [201]	N/A	N/A	N/A		

24 Size of the warehousing in 2 fresh produce terminals: https://dlca.logcluster.org/212-south-africa-port-cape-town#id-2.1.2SouthAfricaPortofCapeTown-PortOverview

25 Provided level of the tide is at least 0.9m above chart datum: https://dlca.logcluster.org/212-south-africa-port-cape-town#id-2.1.2SouthAfricaPortofCapeTown-PortOverview

26 Determined from map data on Google maps

27 Port scored against max quay length (single berth)

11.3.2.7. Port of Saldanha Bay

The Port of Saldanha Bay is located on the West coast of South Africa, roughly 105 km northwest of Cape Town. It is the largest and deepest natural port in the southern hemisphere.[202] The port handles the shipment of iron ore with a purpose-built rail link directly connected to a jetty bulk loading facility. The port also transports metals, heavy minerals, and crude oil.

Recently, the port has seen substantial investments, notably including an R3.5 billion investment to create the first Industrial Development Zone (IDZ) within a seaport with a Freeport or customs-controlled area regime.[203] The project will build a pier and jetty in the southwest precinct, a mobile hoist, a 220 m ship lift, and a lay-by jetty.

FIGURE 62: CURRENT LAYOUT OF THE PORT OF SALDANHA BAY.[204]

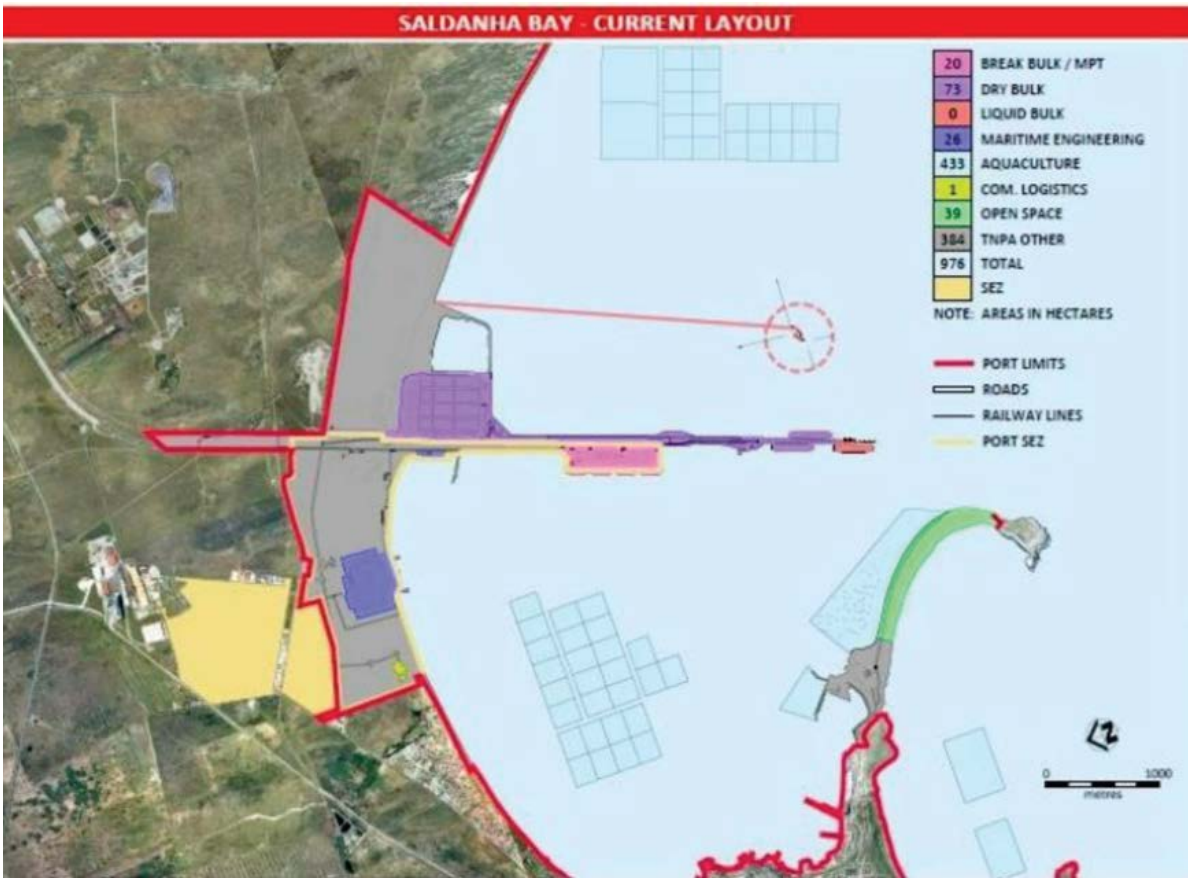


Table 31 compares the critical criterion for port types associated with OSW against the Port of Saldanha Bay's characteristics. As can be seen by the scores, the Port of Saldanha Bay is most suitable in its current state as a fixed OSW marshalling port. It also has considerable potential for use as a floating OSW fabrication port. As the most extensive and deepest port in the southern hemisphere, it is well suited for large vessel usage, and this natural characteristic should be considered when considering investment in OSW.

TABLE 31: PORT OF SALDANHA BAY. [205]

Port criteria	Details	RAG assessment				
		Floating OSW fabrication port	Fixed OSW fabrication port	Fixed OSW marshalling port	CTV based O&M port	SOV based O&M port
Yard area (ha)	Offshore fabrication yard area: 22 ha. [206] Land + sea surface = 19,300 ha. Land area = unknown					
Wet storage area (ha)	No information available		N/A	N/A	N/A	N/A
Quayside draft depth (m)	Up to 20.5 m, conditionally accepting 21.5 m [207]					
Air draft restriction (m)	No information available					
Harbour entrance width (m)	Entrance channel min width = 400 m					
Lock/gate presence	No lock/gate present[28]					
Quay length (m)	Max quay length: 874 m multipurpose quay					
Quay strength (metric tonnes/m²)	No information available				N/A	N/A
Cranes with lifting capacity (metric tonnes)	2 x 13.6 metric tonnes wharf cranes at the quay[29]				N/A	N/A
Office facilities (meeting rooms, changing rooms, etc.)	Offices, ablutions, lockers and change rooms are available in the offshore fabrication yard.[208]	N/A	N/A	N/A		
Infrastructure access (road/ railway/airport)	Local airports are about 15 km from the port; road and rail transport links connect Saldanha with Cape Town.[209]	N/A	N/A	N/A		

28 Determined from map data on Google maps

29 Converted from tons in: https://dlca.logcluster.org/212-south-africa-port-cape-town#id-2.1.2SouthAfricaPortofCapeTown-PortOverview

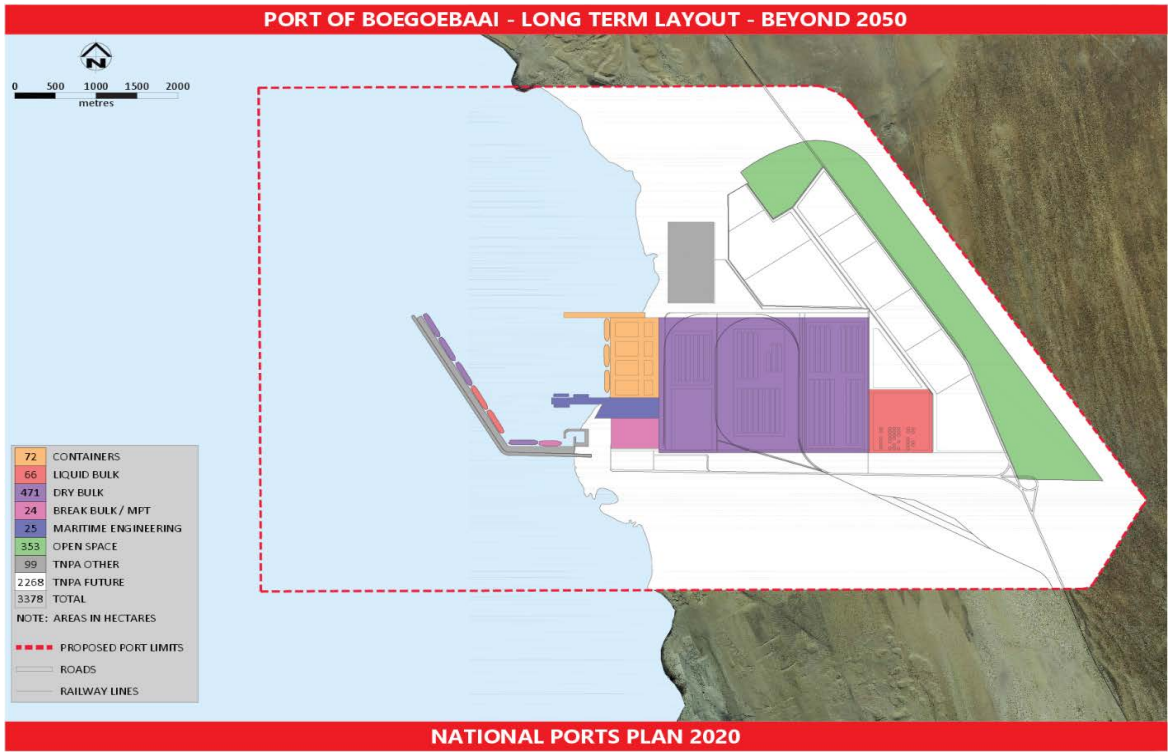
11.3.2.8. Port of Boegoebaai

The Port of Boegoebaai is a proposed greenfield deep-water port to be constructed approximately 60 km north of Port Nolloth and 20 km away from the border between South Africa and Namibia. This port has been envisaged as part of South Africa's green hydrogen strategy, which was proposed at the 2021 Sustainable Infrastructure Development Symposium (SIDSSA). The TNPA aims to have the port operational by 2026.

Current concept designs include a single point mooring terminal, subsea and onshore pipelines, a lightweight trestle for shore crossing, and ammonia storage. The port is also planned to transport large quantities of mining products (iron ore, manganese, cement, lime, zinc, lead, and sulphuric acid), which will be transported to the port via a newly built Boegoebaai rail, which will run between the nearby northern mines and the port.

It is currently planned that the area surrounding the port may be declared as an SEZ.

FIGURE 63: ENVISAGED LONG-TERM CONCEPT LAYOUT OF THE PORT OF BOEGOEBAAI.[210]



As shown in Figure 63, the proposed Port of Boegoebaai will cover a large area and be one of South Africa's largest ports. Currently, as plans are not fully defined, comparing the port against the assessment criteria for OSW is impossible. However, as the port is in the early development stages, developing the site with OSW in mind would be possible.

At this stage, it is clear the port is most suitable for its initial intended purpose, which is to transport mining and industrial products. However, its deepwater nature and low need for dredging could make it ideal for OSW purposes. Current port plans include large storage areas that would suit OSW purposes, and analysis of the local area shows there is additional land around the proposed port area that could be utilised for dry storage needs. The current port plan does not allow for enough wet storage. However, this would be possible based on the proposed geography, but it would be expensive.

11.3.3. Discussion of port analysis

This report presents and reviews seven South African ports with the potential to serve locally as ports for the fixed and floating OSW market. These ports have been reviewed against industry criteria to support the build-out of fixed and floating OSW farms and for their support of OSW project operations and maintenance vessels, CTVs, and SOVs.

A colour coding within Table 32 in green, the ports that, based on the analysed data sources, are ready to serve the OSW sector at a given capacity but will require confirming the available information in situ and collecting those pieces of information not publicly available to assess the capacity to serve the industry are represented.

The analysis focuses on the capacity of a port to serve a specific OSW industry need. The study does not account for upgrade activities currently being undertaken or future contractual obligations of ports that might saturate the ports' activities serving industries other than the OSW industry. None of the ports meet the criteria for crane lift capacity. As such, crane lift capacity has been removed from Table 32 to allow for a clearer comparison between the remaining criteria. Ports with amber colour coding are those that, based on available information, meet one or more criteria at an amber value but would require some upgrades to reach a green value. Ports with red colour coding would require significant upgrades, considerable disbursements, and over 18 months to complete. Where the available information for a port is inadequate to assess its capacity to serve the OSW market, these are marked in grey.

The analysis did not take into account potential environmental and social constraints, which would require further investigation as part of a more detailed feasibility assessment.

TABLE 32: COMPARISON OF ALL PORT SUITABILITY SCORES.

	Floating OSW fabrication port	Fixed OSW fabrication port	Fixed OSW marshalling port	CTV based O&M port	SOV based O&M port
Port of Richards Bay	Quay length Quayside draft	Quay length	Quay length Harbor entrance		
Port of Durban	Quay length Quayside draft	Quay length	Quay length Harbor entrance Quayside draft		
Port of East London	Quay length Quayside draft	Quay length Quayside draft	Harbor entrance		
Port of Ngqura	Wet storage area (Quay length) (Quayside draft)	Quay length	Quay length Harbour entrance		
Port of Mossel Bay	Yard area Quayside draft Harbor entrance Quay strength Quay length	Yard area Quay strength Quay length Quayside draft	Yard area Quayside draft Harbor entrance Quay strength Quay length	Yard area	Yard area Quayside draft

	Floating OSW fabrication port	Fixed OSW fabrication port	Fixed OSW marshalling port	CTV based O&M port	SOV based O&M port
Port of Cape Town	Yard Area Quayside draft Quay length	Yard area	Yard area Harbor entrance		
Port of Saldanha Bay	Yard area				
Port of Boegoebaai (not scored)	–	–	–	–	–

Note that all ports also require crane upgrades, which have been excluded from the above table for clarity.

11.3.3.1. Floating OSW fabrication port capability

Port of Richards Bay

The Port of Richards Bay has a large yard and identified wet storage capacity. This port can be upgraded to become a floating OSW fabrication port. The main upgrade required is increasing the quayside length and draft. These upgrades would require several years to undertake but are achievable.

Port of Durban

With its significant land area expanding over 1,800 ha, the Port of Durban has the potential to provide the yard area required for a floating OSW fabrication port. However, as with Richards Bay, the port requires the quayside length to be increased and the deepening of the quayside draft to meet the criteria. Based on the RAG criteria described in this section, the quayside length would require at least 134 m expansion. Initial estimates suggest that approximately four years (i.e. 48 months) would be necessary to expand the quayside.[211] Aerial imagery of the port indicates that if OSW activities were prioritised over other activities, such as the multipurpose bulk shipping area, existing port facilities and quays could be repurposed to serve the floating OSW industry. Such repurposing would reduce the time required to develop a floating OSW-ready port, potentially decreasing to approximately 26 months.[212]

Port of East London

Given the Port of East London's quayside draft depth and quay length, significant upgrades would be required to convert this port into a floating OSW fabrication port. Upgrades would include dredging activities to increase the quayside draft and ensure the sailing path from the sea into the harbour is deep enough.[30] Given the magnitude of the required work (doubling the quayside length from 250 m to 500 m), it is unlikely that this port will be upgraded into an OSW port.

30 Bathymetry surrounding the port of East London. Global Wind Atlas: https://globalwindatlas.info/en

Port of Saldanha Bay

Saldanha Bay is regarded as South Africa's largest and Africa's deepest natural harbour. Outside of crane lift capacity, yard area and confirmation of wet storage area, Saldanha Bay meets all the floating OSW fabrication port criteria. The port already has a stated 22 ha of offshore fabrication yard area. Given that the port's combined land and sea area is 19,300 ha, it is realistic to assume this could be extended to meet the green RAG criteria of 30 ha within the short term.

Ports of Ngqura, Cape Town and Mossel Bay

The Port of Ngqura can potentially serve as a floating OSW port pending confirmation of wet storage capacity. However, aerial imagery suggests the port area is limited to 18 ha. The limitations are based on quayside draft depth and quay length. Expansion needs could however be overcome as the port is located outside of urban areas. This contrasts with the ports of Cape Town and Mossel Bay that, surrounded by urban areas, would be limited in their capacity to expand operations.

The capacity of the existing ports with the most significant potential to serve as floating OSW ports must be understood within the context of where future sites would be located. Distance from ports to the project site would be a limiting factor for ports to serve future OSW projects and for ports to be used as base ports for CTVs and SOVs. Consequently, the capabilities of the analysed ports to achieve the modelled medium and high-growth floating OSW scenarios are limited by distance.

11.3.3.2. Fixed OSW fabrication port capability

Only the Port of Saldanha Bay meets all the criteria required to operate as a fixed OSW fabrication port as well as being located near some of the proposed fixed OSW sites. With minor upgrades, five ports could operate as fixed OSW fabrication ports: the Ports of Richards Bay, Durban, East London, Ngqura, and Cape Town. Out of these five ports, the Ports of Durban, East London, Ngqura, and Richards Bay will require minor upgrades to quay length, and the Port of East London will require upgrades to quayside draft depth. Port of Cape Town will require upgrades to increase yard area. All six ports will require additional crane lift capacity. However, this is to be expected given the current functions of each port. Port of Richards Bay, for example, operates primarily as a coal export facility and, as such, has a high capacity of aggregate loaders (conveyors) but no heavy lift capacity. Similarly, the Port of Ngqura operates primarily as a container port, so it currently has sufficient ship-to-ship crane capacity but limited lift capacity.

This is a more positive picture than that for floating OSW port requirements and could become a first stepping stone in South Africa's OSW journey, where, for instance, ports like the Port of Saldanha Bay and the Port of Durban could first serve to construct fixed OSW projects, while incorporating the required port upgrades to serve the floating OSW industry into the future.

11.3.3.3. Fixed OSW marshalling port capability

Fixed OSW marshalling ports have significant space requirements, which translates to only four of the seven analysed ports being able to serve as marshalling ports: the Ports of Richards Bay, Durban, Ngqura, and Saldanha Bay. Of those four ports, only the Port of Saldanha Bay has a sufficient harbour entrance width to meet the green RAG criteria (wider than 300 m). The remaining ports would all require upgrades to quay length and harbour entrances, and the Port of Durban would require additional upgrades to quayside draft depth.

Given the significant distance between ports, it is unlikely that ports will share activities for sizeable OSW development. Hence, as OSW activities expand in the country, there will likely be a need to expand the number of ports supporting OSW or expand non-urban ports to cater to OSW turbine construction, marshalling, and vessel operation.

11.3.3.4. O&M port capability

CTV and SOV ports have a significant set of yard requirements, air draft restrictions, and quay length. Table 32 indicates that all the selected ports, except for Port of Mossel Bay, can support O&M activities in the OSW sector, especially CTV port requirements.

11.3.3.5. Decommissioning ports (not assessed)

Requirements for decommissioning have not been addressed for three key reasons. First, the requirements for decommissioning are very similar to those for commissioning, ensuring that the necessary capabilities will be available. Second, decommissioning will not be needed until 25 years after initial power generation, which places it approximately 35 years into the future. Third, as no commercial scale wind farm has been decommissioned yet, a complete understanding of the total requirements is not yet known. Therefore, it is recommended that this be reviewed once the commercial scale decommissioning has commenced in matured markets.

11.3.4. Case study on required upgrades in three ports

The required upgrades in the Port of Saldanha Bay, the Port of Richards Bay and the Port of Durban have been considered in more detail below.

As stated in Section 11.3.3 crane lift capacity would need upgrading to greater lift heights and lifting capacity across all ports and for all port assessment criteria (floating OSW fabrication ports, fixed OSW fabrication ports, and fixed OSW marshalling ports). Ground conditions would also need infrastructural improvements to support the additional weight of these cranes. However, crane capacity is expected to be driven by project demand.

In addition to ring cranes, deepwater cranes, rail cranes, and stacking cranes would need to be installed or upgraded, the number of which would differ across operational scenarios. The costs associated with extensive crane upgrades are site-dependent, and leasing the cranes could be a cost-effective solution as large capital expenditures are required to purchase ring cranes (>$90 million). In contrast, the range for leasing a ring crane is approximately US $70,000 a day.[213]

Outside of increasing crane lift capacity, the two primary port upgrades necessary to unlock port capabilities to serve the floating OSW are **increasing the draft depth and extending the quay length**. Increasing the draft depth requires dredging, which costs approximately US $16 per cubic yard, and maintenance costs US $5.2 per cubic yard; therefore, the total investment will be in the millions of dollars.[214]

The **Port of Saldanha Bay** has significant potential to serve as a floating OSW fabrication port, fixed OSW fabrication port, and fixed OSW marshalling port. The proximity of the port to both fixed and floating OSW energy areas off the west coast of South Africa suggests that it should be considered a high priority for the development of a robust OSW industry in South Africa.

FIGURE 64: SUPPORTING INFRASTRUCTURE AND OSW AREAS SURROUNDING THE SALDANHA BAY AND CAPE TOWN AREA.

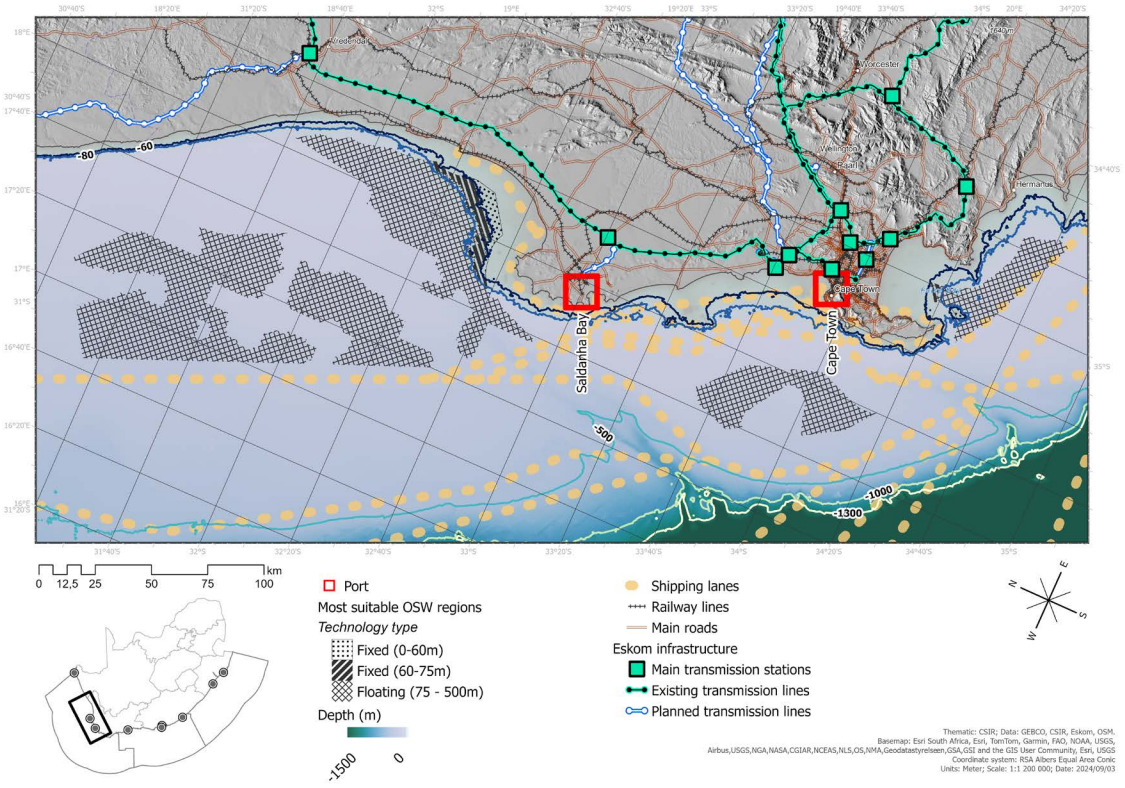
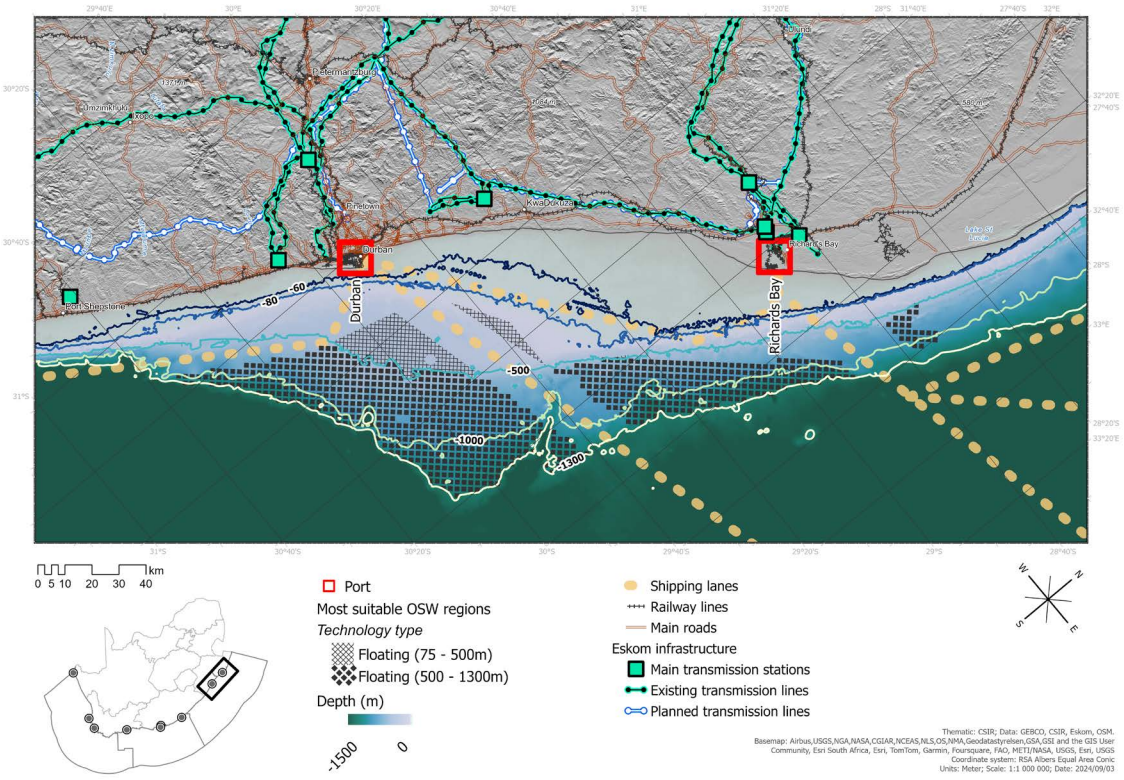


FIGURE 65: SUPPORTING INFRASTRUCTURE AND OSW AREAS SURROUNDING THE DURBAN-RICHARDS BAY AREA.



Confirmation of the available wet storage area is still a priority. Although Saldanha Bay is South Africa's largest natural anchorage, several competing activities exist, such as aquaculture, which currently occupies 301 ha of water space, and oil rig stacking areas identified within the Langebaan side of the inner anchorage area.[215] Depending on project delivery schedules, however, it would be realistic to assume that areas identified as suitable for oil rig stacking could also be utilised for the wet storage of floating OSW platforms in the future.

The Port of Saldanha Bay has an offshore fabrication yard area of 22 ha, 8 ha under, or 73% of the green RAG assessment value of 30 ha. That being said, the total combined land and sea area of the port is stated as 19,300 ha, with the iron-ore bulk loading facility occupying around 30 ha of shoreside land area. However, coexistence of different sectors and activities in the port could be achieved in the future.

After the Port of Saldanha Bay, the Port of Richards Bay and the Port of Durban have the most immediate potential to serve the floating OSW industries. The two ports have the necessary infrastructure (subject to data clarity on the missing characteristics). However, both would benefit from quayside expansion to increase overall capacity and better serve the industry. Given that there is little immediate work to be done, it could be possible to extend the quayside while the port is already operating in OSW activities.

After upgrades to crane lift capacity, the Port of Durban would be viable as both a CTV and SOV-based O&M port and a fixed OSW fabrication port. To meet the criteria of a floating OSW fabrication port, upgrades to quayside draft depth, quay length, and crane capacity would be required. Table 33 illustrates the upgrades that would be necessary to meet the needs of the growth scenarios, the associated costs, and the time required for the upgrades.

Considering the consenting and investigation phase lengths, construction could take at least 4 years. [216] Table 33 illustrates that crane lifting capabilities need to be upgraded, and the port could be ready without major cost upgrades. The quay length is currently 874 m and is a multipurpose quay. Repurposing space instead of extending the quay may be more suitable, which could reduce costs due to reduced dredging requirements.

To estimate the cost and time needed for construction, figures have been adjusted from existing projects with cost figures and scaled to the case study ports. Based on the Port of Dundee Wharf extension project, a 200 m quay extension costs GBP £7,000,000. Following conversion into US Dollars, assuming 1m of quay extension equals ~$45,000, a 40m extension could cost US $1.8 m. For the medium and high growth scenarios, a 134m extension could cost US $6.1m, and a 220m extension could cost US $10m. To obtain cost estimates for dredging, the figures were extrapolated from a dredging project in the Port of Aberdeen that cost US $16m for 400 m; therefore, the dredging 134 m could be ~$5.4m.

TABLE 33: INFRASTRUCTURE UPGRADES NEEDED ACROSS THE THREE GROWTH SCENARIOS.

Port	Low Growth Scenario (mainly fixed foundations and 1 GW of OSW by 2040)	Medium Growth Scenario (Mix of fixed and floating foundations and 5 GW of OSW by 2040)	High Growth Scenario (40 GW by 2050)
Port of Durban	Limited infrastructure upgrades are required as the quayside draft is sufficient. In its current state, the port is a suitable CTV O&M port. Minor crane upgrades could be required depending on the wind activities taking place at the port.	To become a suitable floating OSW fabrication port, the length of the quay would need to be increased by over 134 m and dredged by 10 m. The cost would be roughly US $6 million, and the cost of deepening the quayside could be approximately US $8 million. The upgrades to make the quay suitable for floating OSW activities could take 26 to 48 months Crane upgrades would be required.[217]	Depending on the land use constraints, an extension of around 200 m would be suitable to help reach targets. An extension of ~220 m could cost roughly US $10 million and take two years to construct.[31] Additional dredging would be required for the port to accommodate floating OSW, and deepening the quayside by ~15 m could cost up to US $1 million and take multiple years to complete.[32] Crane upgrades would be required.

31 Note: Figures converted from Great British Pounds (GBP) to US Dollar (USD) This project value £7m for a 200m quay extension and took 2 years to construct. further estimations are based on this figure. Southbay, Prince Charles Wharf Extension Port of Dundee. https://southbaycivils.co.uk/wp-content/uploads/2020/03/Prince-Charles-Wharf-Extension.pdf

32 Note: The Port of Aberdeen dredging project is for a 400m length quay, GBP. The Press and Journal, 2024. Port of Aberdeen's new £25 million upgrade is funding route 'priority' — https://www.pressandjournal.co.uk/fp/business/6420135/port-of-aberdeens-new-25m-upgrade-is-funding-route-priority/

Port	Low Growth Scenario (mainly fixed foundations and 1 GW of OSW by 2040)	Medium Growth Scenario (Mix of fixed and floating foundations and 5 GW of OSW by 2040)	High Growth Scenario (40 GW by 2050)
Port of Richards Bay	Limited infrastructure upgrades are required as the quayside draft is sufficient. In its current state, the port is a suitable CTV O&M port.	Currently, the port has a large yard and wet storage capacity. The port could be upgraded by increasing the quayside draft and length. The upgrades could cost between US $8-12 million and take two years.	The quay would need to be extended to become a floating OSW fabrication port. Extending a quay can take roughly two years to construct. Depending on the additional quay walls or repurposing, a 125 m extension with wall renewals and demolishing existing infrastructure can cost up to US $24 million.[33]
Port of Saldanha Bay	The Port requires minor updates to the existing cranes that would take under 18 months to implement.	Crane upgrades will be required for the Port of Saldanha Bay to become a fixed OSW marshalling and fabrication port and invest in gantry and mobile cranes. Currently, the cranes are wharf cranes at the quayside, and cranes with a 500t lifting capacity would need to be invested in and installed for the port to become a fixed OSW marshalling and fabrication port.	Ringer cranes for foundation integration and additional cranes with a significant lift capacity (3,500t) would be required at the port to assemble substructures and require ground reinforcement. Heavy lifting equipment would cost roughly US $16 m for a 450 MW floating OSW farm. There is no information available on wet storage areas in the Port of Saldanha; however, wet storage areas could be needed for storing floating OSW bases. For a 450 MW project, up to 12 ha of wet storage is required.[218]

11.3.4.1. Assessment of the supporting road and rail infrastructure

Due to their substantial size and weight, the primary components requiring specialised onshore transportation are turbines and blades. These components are needed in significant quantities for each wind farm.

Turbines will be transported by sea directly to port, assembled, and then shipped out again. Consequently, they will not require any onshore transportation.

The transportation needs will be limited to smaller components, which can be efficiently moved via railway or lorry. Therefore, no specialised infrastructure will be required for these components. Personnel will also need transport to the site, which the existing road and rail infrastructure will cover.

All three of the top ports currently have existing road and rail connections. These will be adequate for transporting the required components and personnel. Given the current infrastructure, no upgrades are necessary.

Should local turbine manufacturing be developed in the future, it must be situated in or adjacent to an existing OSW port. This would negate the need for broader road and rail upgrades.

33 Converted from Great British Pounds. Southbay. Riverside Quay Extension Port of Tyne. https://southbaycivils.co.uk/wp-content/uploads/2016/05/RSQE-1.pdf

11.4. SUMMARY OF INFRASTRUCTURE ANALYSIS FOR OSW DEPLOYMENT IN SOUTH AFRICA

In a low-growth scenario, there would be a limited local supply chain, and most components would be imported. The port infrastructure upgrades across the three case study ports would be minimal as the ports in their current states are suitable for CTV and O&M operations. Upgrades to quay infrastructure, such as removing obsolete infrastructure to make it more OSW focussed, or quay extensions (>40 m), could cost between US $2-5 million and take less than two years to finalise. The Port of Richards Bay and the Port of Durban require quay extensions; therefore, it could be prioritised to make the ports suitable for OSW activities.

Significant infrastructure investments are required to make the ports suitable for floating OSW activities in a medium-growth scenario to reach 5 GW of installed capacity by 2040. The upgrades to make the quays suitable could take up to 48 months, and deep-water capabilities would be needed; dredging projects can be costly and deepening the Port of Durban could cost US $5-10 million.

The High Growth scenario is based on consistent OSW growth to reach 40 GW by 2050. This scenario would require significant crane technologies, quay extensions, and dredging investments. In addition, associated installation, training and maintenance costs have not been included in the cost estimations throughout this analysis. They would be required as this is a novel technology, and there may not be existing floating OSW expertise at the ports. The heavy lifting equipment for a 450 MW floating OSW farm is an estimated US $16 m; therefore, to meet the high-growth scenario's ambitious target, the crane's costs would significantly exceed US $16m when incorporating the needs for fixed OSW turbines and fabrication.

Port upgrades considering the growth scenarios

When considering the three scenarios described in this report, the following considerations regarding port infrastructure can be made:

Low Growth Scenario:

- Most components will be imported, eliminating the need for a dedicated fabrication port. However, marshalling port capabilities are limited, especially along the eastern side of the country, where upgrades will be required to the Port of Richards Bay and Port of Durban due to the focus on fixed OSW development on the east coast, and crane upgrades would be required at all ports.
- While some O&M is required, existing capabilities are adequate.
- The low growth scenario, therefore, only requires minor upgrades.

Medium Growth Scenario:

- Port infrastructure for O&M is sufficient, and no significant upgrades are needed.
- Marshalling port infrastructure for fixed OSW is also adequate with minimal upgrades. As with the low scenario, crane upgrades are explicitly required at Saldanha so that there is a marshalling port on the western side of the country.

- The current infrastructure is inadequate for a floating OSW fabrication port on the eastern side of the country; key upgrades include quay length, water depth, and storage facilities, which will take up to 48 months. The Port of Saldanha can be a suitable floating OSW port with minimal upgrades.
- The medium growth will require moderate crane and yard area upgrades, primarily at Saldanha, but at Port of Richards Bay and the Port of Durban also.

High Growth Scenario:

- Similar requirements to the medium scenario, but with a need for greater capacity.
- More ports will need upgrades to increase both capacity and capability.
- If turbines are to be manufactured locally under a high growth scenario, manufacturing facilities should be sited at a port to avoid costly and complex overland transport.
- Significant upgrades and expansion are required for high growth, including strategic siting of manufacturing facilities.

11.5. RECOMMENDATIONS

Analysing South Africa's port infrastructure under various growth scenarios reveals the need for distinct upgrades and expansions to support OSW energy development. By understanding these infrastructure needs and strategically planning upgrades, South Africa can better position itself to develop OSW energy. The department responsible for energy and electricity (DEE) governs the policy and regulations for electricity generation, transmission and distribution. However, the Department of Transport, alongside the Transnet National Ports Authority, governs the policy and regulations for activities within the port area. It is essential, therefore, that the two departments collaborate and coordinate efforts to enable OSW development. Recommendations to guide future infrastructure investments and policy decisions are provided:

- **PORT1.** DEE should work with the TNPA to conduct a feasibility study to understand the detailed requirements, potential E&S impacts, costs and business case for establishing the Port of Saldanha Bay as a fully operational fixed and floating OSW port.
- **PORT2 – MED-HIGH.** To support medium and high growth scenarios, the government and relevant authorities such as the DEE and TNPA should carry out a more detailed analysis of port suitability and upgrade feasibility, using this to inform a long-term strategy for port development and financing and upgrade ports to accommodate floating OSW fabrication starting from 2040.

12. SUPPLY CHAIN ANALYSIS

12.1. PURPOSE

The supply chain for OSW is multifaceted and encompasses several critical stages: planning and development, turbine supply, balance of plant supply, installation and commissioning, operations and maintenance, and decommissioning. In emerging markets like South Africa, establishing a minimum viable OSW supply chain is gradual process that involves leveraging local resources and capabilities while importing critical components and expertise. South Africa can utilise its existing capacity in parallel sectors, such as maritime, construction, and logistics, to bolster the development of a domestic OSW supply chain.

This chapter assesses OSW supply chain capacity and future potential in South Africa. It provides an understanding of the local capacity in parallel sectors, identifying the potential to capitalise on the country's existing resources and capabilities, thus reducing reliance on imports and expediting the growth of the domestic OSW industry.

12.2. METHOD

This section sets out the criteria for assessing the current and future capability of the supply chain in South Africa.

12.2.1. Labour requirements for OSW development

To contextualise the local capacity, we calculated the generic job requirements per MW for OSW deployment using available job data outlined in Chapter 13 Jobs and economic benefits. We then applied these to the medium growth scenarios in 2035, 2040 and 2050 to calculate the job requirements for different periods.

12.2.2. Current capability and track record

Companies relevant to the OSW supply chain were identified for assessment based on their current capability and track record. They were then mapped against the relevant development stages, as shown in Table 34.

TABLE 34: MANUFACTURING AND SERVICES REQUIRED ACROSS OSW DEVELOPMENT STAGES.

Planning and development	• Project developer • Project design • Site investigation and environmental surveys • Research & development
Manufacturing — turbine supply	• Nacelle, rotor and small components • Blades • Towers
Manufacturing — balance of plant supply	• Electrical systems • Foundation / Offshore substation structures • Cables/Subsea cables • Steelwork • Concrete
Installation and commissioning	• Installation equipment, vessels, and support services • Installation ports and logistics • Substation installation
Operations and maintenance	• Maintenance and inspection services • O&M ports • Vessels & Equipment
Decommissioning	• Decommissioning services

The assessment of the track record considers the size of identified companies, their current facilities and presence in South Africa, qualitative evaluation of their existing capability in a given supply chain, and any planned expansion or development.

For the qualitative assessment of existing capability in the given supply chain stages, companies were rated on a scale of 1-4 based on the confidence level assigned: 'None', 'Low', 'Medium' and 'High'. An average score for each supply chain stage indicates the OSW experience in South Africa.

TABLE 35: SCORING KEY FOR EXISTING CAPABILITY IN OSW DEVELOPMENT STAGES.

Score	Description
1	None – No relevant experience
2	Low – Onshore wind experience or other relevant experience
3	Medium – More than five companies with onshore wind experience or other relevant experience; or relevant OSW experience in other markets
4	High – OSW experience in the South African market

12.2.3. Capacity in parallel sectors

Capacity in parallel sectors considers the availability and relevance of skills, labour, and experience that can be transferred to support the growth of the OSW industry. To assess this capacity, we focused on several sectors that we consider adjacent to OSW due to their overlapping skill sets, technical requirements, and similarities in operations with OSW. These sectors include:

- Manufacturing (basic metals, electronic components, machinery and equipment)
- Maintenance and repair services of industrial machinery and equipment
- Electricity, gas, steam, and air conditioning supply
- Construction
- Land transport and transport via pipelines
- Information and communication
- Architectural, engineering and scientific-technical services
- Business facilities management and support services

When reviewing parallel sectors, we have only considered relevant sectors like offshore oil and gas (as opposed to onshore).

We assessed the relevant capacity of these sectors in terms of their labour supply, specifically the number of people employed in these sectors and their relative contribution to the economy. The overall capacity available in the parallel sectors to support the expertise required in each stage of the OSW supply chain was rated on a scale of 1 to 4:

TABLE 36: SCORING KEY FOR CAPACITY (LABOUR SUPPLY) IN EXISTING SECTORS.

Score	Description
1	None – No relevant parallel sectors identified
2	Low – Relevant parallel sectors identified
3	Medium – Relevant parallel sectors with high labour supply
4	High - Relevant parallel sectors with high labour supply and relevant qualifications

12.2.4. Potential benefits of developing local supply

The potential benefits of developing local supply chains include creating high-quality local jobs, significant cost reduction opportunities and the required investment scale. To assess these benefits, we estimated the following:

- Generation of local employment opportunities, which involved assessing the potential for job creation across the OSW lifecycle based on proxies from other OSW projects;
- Potential for cost savings compared to relying on international suppliers in the short and long-term;
- Investment required to develop the pipeline of OSW projects, considering initial capital requirements and ongoing investment needs.

In our analysis, we used the following rating system to evaluate the extent of these benefits:

TABLE 37: SCORING KEY FOR THE BENEFITS OF A LOCAL SUPPLY CHAIN.

Score	Description
1	None – no benefits identified
2	Low – limited long-term benefits identified, high investment
3	Medium – long-term benefits identified, high investment
4	High – short- and long-term benefits identified, low and high investment

By applying these ratings, we aimed to identify immediate opportunities, or "quick wins," that South Africa could leverage in the short-term and longer-term investment opportunities that support a medium to high growth OSW scenario across the entire supply chain.

12.3. RESULTS AND DISCUSSION

12.3.1. OSW job creation

Table 38 outlines the anticipated labour requirements across various supply chain areas to achieve OSW capacities of 1 GW, 5 GW, and 15 GW by 2035, 2040, and 2050, respectively. This is based on IRENA estimates of labour days required over the life cycle of a typical 500 MW OSW farm and does not include indirect or induced jobs.[219]

TABLE 38: TOTAL WORKFORCE (IN FTE YEARS) REQUIRED TO DELIVER OSW CAPACITY IN 2035, 2040 AND 2050 UNDER A MEDIUM GROWTH SCENARIO.

Area of supply chain	1 GW by 2035	5 GW by 2040	15 GW by 2050	Total FTE years 2030-2050
Planning & Development	544	976	1,400	**2,920**
Procurement	186	310	434	**930**
Manufacturing — turbine	10,681	26,702	42,723	**80,106**
Manufacturing — balance of plant	10,459	26,147	41,834	**78,440**
Transport & Logistics	55	182	310	**547**
Installation & Connection	3,003	10,011	17,018	**30,032**
Operation & Maintenance	106	3,174	22,217	**25,496**
Decommissioning*	-	-	-	-
Total	**25,033**	**67,501**	**125,936**	**218,470**

**Decommissioning is only expected 25 years after the first wind farm becomes operational; therefore, no decommissioning jobs will be created between 2030 and 2050 and are expected only to be created by 2060*

Under the medium growth scenario, implementing almost 15 GW of OSW by 2050 in South Africa can create 218,470 direct jobs in FTE years between 2030 and 2050 across the entire project lifecycle, with a significant concentration during the manufacturing stage. It should be noted that the job creation estimates are based on typical OSW project requirements and do not differentiate between fixed and floating OSW needs. Additionally, these figures represent total global job estimates and do not exclusively reflect local job creation. The extent to which South African workers can fill these roles will depend on local skills and policies enacted to support local employment.

12.3.2. South Africa's existing capabilities and track record

This section evaluates South Africa's capability to support the OSW supply chain by examining existing companies and their capacity across various sectors relevant to OSW development. The assessment categorises the companies according to the relevance of their expertise to each stage in the OSW supply chain, evaluates their track record, and highlights gaps that may affect South Africa's ability to meet different growth scenarios for OSW development. This existing capability is outlined in Table 39.

TABLE 39: SUMMARY OF SOUTH AFRICAN COMPANIES ASSESS FOR TRACK RECORD AND OSW SUPPLY CHAIN CAPABILITY.

Note that both manufacturing categories have included the same companies in the 'Steel' and 'Concrete' sub-categories.

Supply chain category	Includes	Number of companies / notable and Relevant Companies	Comments	Median track record and capacity in OSW (1-4)
Planning and development		**28**		**3**
Project developer	Companies are responsible for identifying suitable OSW farm locations, securing permits and finances, and managing the overall project.	12	There is a significant presence of onshore wind and PV developers. There is one joint venture developing floating OSW.	3
Project design	Companies that design the layout of the wind farm.	5	Currently, the most relevant designers are focused on O&G and need upskilling.	3
Site investigation and environmental surveys	Companies that conduct environmental impact assessments, geophysical surveys, and soil investigations to understand seabed conditions.	9	There are many assessment consultancies. However, none have worked explicitly in OSW.	3
Research & Development	Organisations involved in R&D are capable of exploring innovative technologies and methodologies.	2	There are very few R&D institutes, and none specialise in energy.	2

Supply chain category	Includes	Number of companies / notable and Relevant Companies	Comments	Median track record and capacity in OSW (1-4)
Manufacturing — turbine		**37**		**2**
Blades, nacelle, rotor	Manufacturers of large, aerodynamic components and energy conversion equipment assembly.	1	Only one local company specialising in onshore blade production.	2
Small components	These include companies supplying bolts and fasteners.	12	Small component manufacturers are already supplying onshore wind.	3
Turbine assembly	Companies involved in turbine design, engineering, manufacturing, and assembly.	7	Three of the companies only focus on onshore wind. The remaining companies have a global track record in turbine manufacturing and installation.	2
Towers	Companies that are capable of using provided materials to construct an offshore tower.	2	There are capable manufacturers; however, currently, they only service onshore wind.	2
Manufacturing — Balance of plant		**15**		**3**
Electrical systems	Companies specialising in electrical systems design and installation handle cables, substations, and grid connections.	5	Electrical systems suppliers are well established in South Africa; however, they do not have OSW experience.	3
Foundation/ Offshore substation structures (fixed only)	Companies construct and install the foundations supporting the wind turbine and the substation.	NA	There were no identified foundation suppliers.	1
Mooring systems and anchors (floating OSW only)	Mooring service provider	4	The companies don't have direct experience with OSW. Still, their expertise in providing solutions for marine flotation and anchoring, high-performance ropes for offshore projects and rubber marine products can support OSW installation and maintenance.	3

Supply chain category	Includes	Number of companies / notable and Relevant Companies	Comments	Median track record and capacity in OSW (1-4)
Cables/ Subsea cables	Manufacturers of high-voltage cables are often capable of supporting OSW development	7	South Africa has many cable manufacturers, but few can produce high-voltage cables.	3
Secondary steelwork	This category includes providers of structures that protect or support ancillary equipment, such as crew entry points, boat landings, and ventilation systems.	3	Few companies were identified as having potential for upskilling; however, most relevant companies are small.	2
Steel	Companies that supply large amounts of structural steel can often construct the final product.	11	There is a well-developed supply chain for steel, and some have provided steel for OSW.	3
Concrete	Companies that supply the materials (and sometimes construction) for large-scale offshore structures.	4	There seem to be fewer concrete manufacturers than steel; however, some suppliers have already worked on onshore wind energy projects.	2
Installation and commissioning		**21**		**2**
Installation equipment, vessels, and support services	These companies supply vessels, cranes, and other equipment needed for offshore installation.	2	Installation companies in South Africa have worked on onshore wind farms.	2
Installation ports and logistics	Ports are equipped to assemble and load wind turbine components onto installation vessels.	13	South Africa has a few ports which meet many requirements for ports serving OSW. Upgrades and expansion would be required.	3
Cable installation	Companies that are involved in laying and securing undersea power cables.	2	Companies are well established in cable installation for power utilities and onshore renewables but lack a track record in undersea cables for offshore operations.	3
Foundation installation		NA	There were no identified foundation suppliers.	1

Supply chain category	Includes	Number of companies / notable and Relevant Companies	Comments	Median track record and capacity in OSW (1-4)
Substation installation	Companies that install offshore substations.	8	Many companies can build substations because they are part of South Africa's energy landscape. These companies would require upskilling for offshore work.	3
Onshore works	Companies responsible for building onshore infrastructure, including roads and foundations.	6	All companies are based in South Africa and have construction and civil engineering services expertise, focusing on large commercial and industrial projects.	2
Operations and maintenance		**6**		**2**
Maintenance and inspection services	Companies responsible for ongoing maintenance, inspections, and repairs to ensure optimal performance throughout operational life.	1	South Africa has at least one specialised onshore blade maintenance and inspection contractor. Installation contractors and turbine manufacturers often maintain their products for a warranty period.	2
O&M ports	Ports are equipped to service and maintain wind turbines.	5	The same ports used for installation can be used for O&M.	2
Vessels & Equipment	Companies that own and operate specialised vessels for conducting maintenance. Often, these are the same as the companies that supply vessels for installation.	5	South Africa has an offshore O&G sector, and many available vessels and equipment currently serve the O&G industry.	2
Decommissioning				**1**
Decommissioning Services	Companies that handle the safe removal and disposal of decommissioned wind turbines and associated infrastructure.	1	No identified decommissioning contractors	1

Key insights from the table include:

- **Planning and development:** South Africa has substantial experience from onshore wind and solar PV, including in environmental assessment. However, OSW experience is limited, and offshore experience focuses primarily on O&G. The **overall capacity in this sector is rated 3**, indicating moderate readiness.
- **Manufacturing – Turbine:** Small component and turbine manufacturers already serve the onshore wind market, indicating a reasonable foundation for expansion into OSW. The manufacturing of basic metals and towers shows a well-developed supply chain, though currently focused on onshore applications. It is not always attractive to serve both the onshore and offshore markets. For example, blade manufacturers are unlikely to serve both as moulds are difficult to change. The **overall capacity rating of 2.8** reflects a solid foundation with room for growth.
- **Manufacturing – Balance of plant:** Electrical systems suppliers are established but lack OSW experience. There are no identified foundation suppliers specifically for OSW, posing a significant gap. Cable manufacturers exist but need upskilling to produce the high-voltage cables required for OSW. Secondary steelwork providers are few and relatively small. South Africa has experience handling topside modules, sub-sea systems, mooring systems, and sub-sea pipelines. Private fabrication facilities exist nationwide, including a significant facility in Saldanha Bay.[220] The **capacity in this sector is rated 3**, emphasising the presence of strong onshore wind experience but a need for strategic investments in upskilling and infrastructure development.
- **Installation and commissioning:** Installation companies have onshore wind experience, and ports meet many requirements for OSW but would require expansion. Substation installation companies are present and part of the existing energy landscape, needing upskilling for offshore work. The **capacity rating of 2.9** suggests a strong potential for transition to OSW, supported by targeted investments in infrastructure and training.
- **Operations and maintenance:** South Africa's history in O&G ensures the availability of some vessels and equipment which can be repurposed for OSW. The **overall capacity is rated 2**, indicating a need for further specialisation and training in OSW-specific maintenance and inspection.
- **Decommissioning:** No companies are identified as having expertise in decommissioning OSW infrastructure. This is expected as South Africa doesn't have an OSW market, and decommissioning services will only be required at the end of the wind farm's operational lifetime (around 25 years). Installation and commissioning players could support decommissioning.

While many skills from onshore wind operations, such as technical knowledge, safety protocols, project management, regulatory compliance, and engineering, are transferable to OSW, transitioning between the two is not always optimal for companies. Onshore expertise provides a strong foundation, but OSW introduces significant challenges that may be difficult to manage without specialised experience.

The marine environment demands different operational skills because of harsher weather conditions, corrosion risks, and complex logistics for transporting equipment and personnel. Adapting to these new demands can involve high costs, additional training, and logistical complexity, making the shift to OSW a significant and sometimes impractical undertaking without substantial investment.

12.3.3. Capacity in parallel sectors

This section highlights the workforce landscape in parallel industries to OSW and their capacity to support various segments of the OSW supply chain.

12.3.3.1. Employment in parallel sectors

TABLE 40: BREAKDOWN OF WORKERS EMPLOYED IN PARALLEL INDUSTRIES TO OSW.

Industry	Total workers employed	% of total employment	Relevant OSW skills	OSW supply chain
Manufacturing	**1,710,140**	**10.2%**		
General Manufacturing [221]	1,507,000	9.0%	Production of various parts used in turbines and nacelles	Turbine supply; Balance of plant supply
Manufacturing of basic metals [222]	131,151	0.8%	Production of steel and other metal parts required for turbine towers, nacelles and foundations	Turbine supply; Balance of plant supply
Manufacturing of electronic components	48,299	0.3%	Production of electronic parts used in control systems, sensors	Balance of plant supply
Manufacture of machinery for mining, quarrying, construction, and metallurgy	23,690	0.1%	Providing heavy machinery for the installation of turbines and foundations and the maintenance and repair of OSW farms	Installation and commissioning; Operations and maintenance
Generation, transmission and distribution of electricity [223]	40,419	0.2%	Managing distribution and transmission networks required to connect OSW farms to the onshore grid	Operations and maintenance
Electricity, gas, steam, and air conditioning supply	54,047	0.3%	Operations and maintenance of the power system and managing distribution of electricity generated by OSW	Operations and maintenance
Construction	**1,476,883**	**8.8%**		
General construction	1,322,000	7.9%	Construction of foundations and substructures for turbines; building onshore substations and transmission infrastructure	Turbine supply; Balance of plant supply
Specialised construction activities [224]	154,883	0.9%	Expertise in underwater construction for turbine foundations	Installation and commissioning

Industry	Total workers employed	% of total employment	Relevant OSW skills	OSW supply chain
Land transport and transport via pipelines	1,023,000	6.1%	Transport of turbine components, equipment and materials; managing transport logistics for heavy and oversized components	Installation and commissioning; Decommissioning
Information and communication [225]	32,280	0.2%	Remote monitoring, control and data analysis of turbine performance	Operations and maintenance
Engineering and other scientific-technical services [226]	197,565	1.2%	Engineering design of turbines, foundations and electrical systems	Turbine supply; Balance of plant supply
Business support services	2,964,000	17.7%	Administrative, financial and legal services supporting project management and development; day-to-day operations of wind farms	Planning and development
Building and repairing of ships [227]	1,664	0.0%	Construction and maintenance of vessels used for transporting and installing OSW components; using service vessels for OSW maintenance and repair activities	Installation and commissioning; Operations and maintenance
Petroleum sector [228]	110,000	0.7%	Installation of equipment; management of operations ensuring safety and efficiency	Manufacturing; Installation and commissioning; Operations and maintenance

The data highlighted in Table 40 notes that South Africa has a substantial workforce in parallel industries that can support various aspects of the OSW supply chain. The manufacturing and construction sectors provide many workers with relevant skills in turbine supply, balance of plant supply, and installation and commissioning.

FIGURE 66: ESTIMATED CAPACITY IN PARALLEL SECTORS BY OSW SUPPLY CHAIN STAGE.

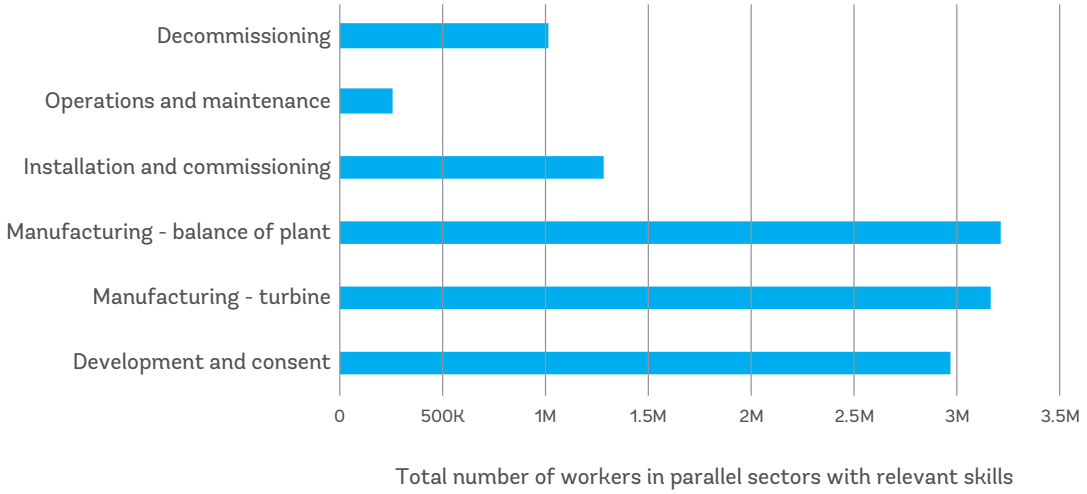


Figure 66 provides insights into the total workforce capacity available in parallel sectors that may be relevant across different segments of the OSW industry, assuming seamless transition to supporting the OSW supply chain. With this assumption, the combined workforce potential is highest in the balance of plant and turbine supply segments, given the relevant skill sets in the manufacturing, construction, and engineering sectors. The transferability of skills is provided in Sections 13.3.1-13.3.4.

Case study: South Africa's offshore O&G sector

Markets with experience in offshore O&G development can transition skills and expertise to OSW development. This is because existing infrastructure and expertise can be repurposed for OSW:

- Specialised vessels, such as jack-up rigs for fixed OSW and support ships, can be used for turbine installation and maintenance.
- Technical knowledge in project management, environmental compliance, and large-scale offshore construction can transfer to OSW, ensuring effective project execution.
- Fabrication facilities developed to support O&G operations in the Western Cape can produce OSW components like turbine foundations and subsea cables.
- Subsea technologies used for O&G pipelines can also be applied to OSW subsea power cables.

South Africa has some offshore O&G experience to support an OSW transition, although this is not as significant as other offshore wind markets such as UK and Norway. South Africa's offshore O&G industry was established in 1969. Since then, over 300 exploration wells have been drilled, and oil and gas production has continued, mainly around the Mossel Bay area.[229]

12.3.3.2. Skills shortage

Despite existing skills being aligned with OSW development needs across several stages, South Africa faces significant labour shortages in key areas critical for OSW development. Developed OSW markets face similar challenges as the OSW sector competes for skills against other sectors:

- **Manufacturing and construction:** Both sectors report an 84% skills shortage, particularly in high-tech manufacturing and construction roles.[230] Manufacturing's contribution to the South African economy has also halved from 26% in 1990 to 13.6% in 2023.[231]
- **IT:** An 81% shortage in this sector will limit the opportunity for skills transfer to the OSW industry.
- **Engineering and management [232]:** Acute shortages in engineering, science, and management personnel are prompting the government to call for urgent reforms to attract skilled workers.
- **Logistics and transport [233]:** As of 2022, a shortage of approximately 3,000 truck drivers has been noted, and the gap has been growing over the past few years.

Skills shortages and the development of an OSW industry also present opportunities for training and skilling the future workforce. OSW's growth will be gradual, which provides the opportunity to retrain and reskill workers in sunset industries.

12.3.3.3. Technical training and skills development initiatives

Technical training programmes help to shape a skilled workforce. The enrolment rates in these courses are a valuable indication of how well-qualified the existing workforce in various sectors is and a gauge of how well workers from these sectors could transition to OSW.

TABLE 41: ENROLMENT NUMBERS ON TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING (TVET) COLLEGES IN SOUTH AFRICA — 2021.[234]

Technical training course	Relevant Industry	Number of students enrolled	% of total enrolment
Civil engineering and building construction	Engineering and other scientific and technical services	10,138	14%
Electrical infrastructure and construction	Construction	16,945	23%
Engineering and related design	Engineering and other scientific and technical services	17,962	25%
Finance, Economics and Accounting	Business support services	7,991	11%
Information Technology and Computer Science	Information and communication	7,935	11%
Management	Business support services	6,205	8%
Mechatronics	Engineering and other scientific and technical services	855	1%
Process plant operations	Manufacturing	708	1%
Transport and logistics	Land transport and transport via pipelines	4,317	6%

Table 41 notes that many students are enrolled in courses closely aligned with the skills required for OSW. However, while these programs lay a solid foundation, the specific demands of the OSW industry require further alignment and specialisation.

Further targeted courses specific to OSW will be beneficial in supporting skills transfer. For example, several South African initiatives focus on building energy-specific skills.[235]:

- The Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) and the South African Renewable Energy Technology Centre (SARETEC) are developing dedicated training and skills development initiatives driven by green procurement policies. These initiatives incentivise local stakeholders to create dedicated green skills initiatives.
- The Green Skills Project aims to build capacity in the national skills system to integrate green skills across all sectors.
- In 2022, Eskom, SARETEC based at the Cape Peninsula University of Technology, and the Global Energy Alliance for People and Planet (GEAPP) began developing the Komati Training Facility. This facility seeks to contribute to a 'just' transition for the local community as the Komati power station is decommissioned. The facility will enable the reskilling and retraining of workers and communities historically reliant on the coal value chain.
- Universities such as the Cape Peninsula University of Technology and Stellenbosch University have developed specific education centres to deliver education and training for the renewable energy sector. This includes SARETEC and CRSES at Stellenbosch University.[236] SARETEC, which is the only Quality Council for Trades & Occupations (QCTO) — accredited renewable energy training facility in the country — could provide the Global Wind Organisation (GWO's) training standards.
- South African Maritime Safety Authority (SAMSA) provides minimum standards for seafarers, which will be important for vessel crew required for OSW installation and operations.[237]
- TVET institutions are expected to focus on developing a green curriculum and increasing industry links to create student skills uptake opportunities.

To facilitate further skills development related to renewable energy development in the country, the South African Department of Higher Education and Training has developed a specific Sectoral Education and Training Authority (SETA) for the energy and water sector, referred to as the EW SETA. EW SETA has been developed to facilitate and manage internships, skills development programmes, and apprenticeships within the energy and water sectors in South Africa.[238] The Manufacturing, Engineering and Related Services Sector Education and Training Authority (MERSETA) also exists. They are responsible for, among other things, developing sector skills plans for their respective sectors; allocating grants to employers for training opportunities, education and training providers and workers; and monitoring education and training in the industry.[239]

While skills development in the renewable energy sector is gaining traction, renewable energy skills shortages are a notable concern. Organisations such as the EW SETA are working with other stakeholders such as the South African Wind Energy Association (SAWEA) and the Presidential Climate Commission (PCC) to develop an accurate skills demand profile for the country but have noted that skills development in the sector is not keeping up with renewable energy rollout in the country.[240]

12.3.3.4. Parallel sectors capacity assessment

Based on the assessment of (i) the presence of relevant parallel sectors for each part of the OSW supply chain, (ii) the relative size of the workforce in those sectors, and (iii) the prevalence of relevant qualifications in those sectors as per the scoring framework outlined in section 12.2, the capacity of parallel sectors to support the OSW supply chain is evaluated as follows:

- **Planning and development** – South Africa's business support services sector is relevant for this phase of development. It has the largest workforce compared to other industries and a significant number of students enrolled in technical training in management, finance, economics, and accounting. **This is rated as 4 (high).**
- **Manufacturing — turbine supply** – Some parallel sectors, such as manufacturing, construction, and engineering, have a large workforce, and most students are enrolled in specialised courses. However, this sector faces labour shortages despite its comparatively large workforce, so **it is rated as 3 (medium).**
- **Manufacturing — balance of plant supply** – Some parallel sectors, such as manufacturing, construction, and engineering, have a large workforce, and most students are enrolled in specialised courses. However, this sector faces labour shortages despite its comparatively large workforce, so **it is rated as 3 (medium).**
- **Installation and commissioning** – Parallel sectors are comparatively few, including specialised construction, transport, building and repairing of ships, and the petroleum sector. These sectors have a small workforce and comparatively fewer technical courses. **This is rated as 2 (low).**
- **Operation, maintenance, and services** – These parallel sectors are significant, but they have a limited workforce size and comparatively fewer technical courses. **This is rated as 2 (low).**
- **Decommissioning** – There are few parallel sectors, a small workforce, and limited technical courses. **This is rated as 2 (low).**

Therefore, while South Africa's existing workforce in parallel sectors to OSW provides a foundational capacity to support the OSW supply chain, unlocking the industry's full potential hinges on addressing significant skills shortages in manufacturing, construction, IT and engineering. This requires targeted training and recruitment strategies tailored to meet the specialised demands of OSW development.

12.3.4. Potential economic benefits of local supply

Finally, the potential economic benefits of local supply (e.g. jobs, export opportunity, LCOE reduction) have been evaluated relative to the investment required to realise these benefits.

- **Planning and development** – Although the job creation potential under this stage is relatively small (50 jobs / GW) compared to other project lifecycle stages, planning the employment of local labour to achieve cost reductions in higher growth scenarios is critical. Local labour can also provide specialised expertise well-suited to South Africa's unique geography and environmental conditions. Addressing these skills gaps requires relatively low investment but necessitates dedicated training and recruitment programmes. Specialist experience relevant to planning and development includes offshore and marine expertise, technical survey design and delivery (wind and metocean, benthic/pelagic, geophysical/geotechnical, bird and marine mammals), software development and legal services.[241] This phase has been **rated 4 (high)** to recognise its strategic importance in leveraging local capabilities.

- **Manufacturing — turbine supply** – This phase offers significant long-term benefits with a potential for a substantial number of jobs, estimated at around 5,000 per GW deployed. Establishing local manufacturing capacity would require significant capital investment, estimated at US $200-400 million per OSW turbine component manufacturing facility, depending on the component.[242] Existing facilities for onshore wind components may not be suitable for OSW. This stage has been **rated 3 (medium)** to reflect the considerable time and investment needed. However, given the large number of jobs and the significant economic impact of the local supply chain, both in economic contribution and reducing LCOE, it can justify the large investment required. Of the turbine components, South Africa has the potential to manufacture towers and blades locally.

- **Manufacturing – balance of plant supply** – This stage offers both short- and long-term benefits, potentially creating a significant number of jobs (around 4,400 per GW). South Africa has the potential to manufacture floating OSW substructures if the supporting infrastructure is developed, which will require high capital expenditure. Initial investment costs for manufacturing facilities range from US **$100m** for a floating platform manufacturing facility, **$40m** for a mooring rope manufacturing facility, **$500m** for a mooring chain manufacturing facility, and **$350m** for the cable manufacturing facility.[243] This has been given a **rating of 3 (medium)** to account for the high capital investment requirements that present a barrier.

- **Installation and commissioning** – This stage offers short- and long-term benefits with a medium level of potential job creation, estimated at around 500 jobs per GW deployed. Local supply chain involvement is crucial to reducing costs in higher growth scenarios. The level of capital investment required is moderate and depends on the type of projects installed (fixed or floating). For example, a new-build foundation installation vessel for fixed OSW projects would require an investment of approximately US $400 million.[244] Dedicated training and recruitment programmes would be essential to address labour and skill shortages. This has been **rated 3 (medium)** to reflect the training and recruitment efforts necessary to address skills shortages.

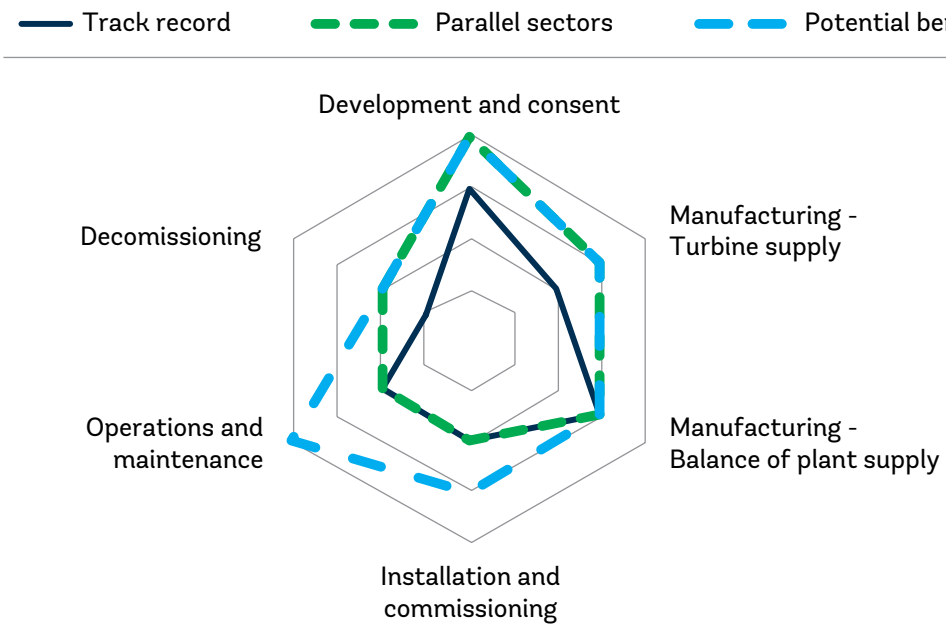
- **Operation, maintenance and services** – This stage offers short- and long-term benefits with a moderate job creation potential of around 250 jobs per GW deployed. Local supply is critical to achieving cost reductions in higher growth scenarios. Local operations and maintenance capability is essential for deployment as the capability must be present for the entire 25-30 year lifecycle. This results in a potential benefits **rating of 4 (high).** Medium capital investment is expected to support dedicated training and recruitment programmes to address labour and skill shortages and gaps. For example, the annual O&M training costs for a 450 MW floating OSW farm are estimated at US $1.2 million, [245] while the costs of service operation vessels (SOV) range from EUR 35-80 million, and crew transfer vessel costs range from EUR 2-3 million (second-hand) to EUR 5-6 million (new build).[246]

- **Decommissioning** – The decommissioning phase presents opportunities for long-term benefits, with an estimated job creation potential of around 250 jobs per GW deployed and a moderate level of investment required. Local supply chains will be necessary to achieve cost efficiencies during decommissioning. However, the requirement for decommissioning skills will not materialise until around 25-30 years after the first installation. In the intervening time, skills in parallel sectors will likely increase, as OSW installation will be relevant for decommissioning. This stage has been given **a rating of 2 (low)** to reflect the long-term nature of the opportunity and required investment balanced against the potential job creation.

12.3.5. Summary of South Africa's OSW supply chain capacity and future potential

South Africa's OSW sector shows promising potential across several stages. The track record of existing companies, the relevance and skills available in parallel sectors, and the potential benefits to the supply chain are all well-rated in these areas. This is summarised in Figure 67.

FIGURE 67: SUMMARY OF SOUTH AFRICA'S OSW SUPPLY CHAIN CAPACITY AND POTENTIAL.



No-regret investment in the local supply chain

- **Planning and development**: Local presence is crucial for effectively executing the planning and development tasks.
- **Operations and maintenance**: Local presence is essential for effective operations and maintenance as this is required for the entire duration of the wind farm's lifecycle. Not only do operations and maintenance provide long-term jobs, but effective operations can also increase Annual Energy Production (AEP) through fast and effective repair, and efficient proactive maintenance reducing outages. Although investment is required for upskilling in these areas, this is balanced by job creation and cost reduction.

Opportunities to support the medium-growth scenario

- **Manufacturing – turbine:** There is potential for turbine towers to be produced locally. In the medium growth scenario, at least half of the towers are expected to be manufactured locally by 2040, and all towers will be manufactured locally by 2050. Local manufacturing capabilities will offer considerable job opportunities across various skill levels and can have significant economic impacts.
- **Manufacturing – balance of plant supply:** This component presents a strong opportunity, offering many jobs alongside substantial capital investment requirements. Despite this challenge, investing in local manufacturing capabilities can lead to long-term economic benefits and a reduced dependency on imported components.

Opportunities to support longer-term investment under medium and high-growth scenarios and broader economic development

- **Manufacturing – turbine:** While there is potential for local blade manufacturing, it is likely to occur at a later stage in South Africa's OSW development. Although it would require significant investment, it has the potential to generate substantial job creation and economic impact.
- **Installation and commissioning:** High capital investment balanced with medium job creation and strong cost reduction capability makes this more relevant for medium to high growth scenarios and longer-term investment. This is likely to be substantially imported in the early stages of the market. Still, investment benefits will outweigh the high capital investment required once the market gets large enough.
- **Decommissioning:** Although relevant for all growth scenarios, as all deployments will need to be decommissioned, investment and catalysation will only be needed in the longer term as decommissioning is only required at the end of the project's life.

Mechanisms to support local supply chain development

Support and catalysation mechanisms are crucial in capitalising on the identified supply chain areas of most significant local impact and cost reduction potential. Many of these mechanisms, especially those that require public funding, are essential to catalyse local development.

Policy and planning

Implementing policies that help catalyse supply chain development can effectively encourage investment in the local market. Local content policies are increasingly being adopted globally as part of site lease and subsidy evaluation criteria. However, overly stringent local content requirements can push up LCOE significantly. Taiwan is an example of a government that has included strict local content requirements in its evaluation criteria but has also had to implement generous subsidies.[247]

Local content requirements have been embedded in overall government procurement regulations in South Africa since 2011 through the regulations adopted in the Preferential Procurement Policy Framework of Act 5 of 2000.[248] These local content requirements have fed into South Africa's REIPPPP programme, where economic development criteria must be satisfied for a bid to be awarded to a prospective renewable energy developer. In the REIPPPP Bid Window 6, prospective developers were required to commit to local content spend of at least 40% of project value during the construction phase and at least 45% of local content spend during the operation phase of a project. In addition, there are criteria for other local economic development areas including equity ownership for black and female shareholders, and local community participation.[249] These criteria form part of the overall REIPPP programme and will likely be applied to OSW should it be included within the programme. The role of these requirements in restorative justice and resolution of local procurement from onshore wind is explored further in Chapter 14: Just transition.

Care must be taken to ensure that supply chain incentives do not unduly increase cost or risk or create more barriers to deployment but instead provide value for money and incentivise economic and efficient delivery of OSW while supporting local growth. Ultimately, the trade-off between the cost of incentivising local supply chain development and the economic benefits of achieving this is a policy decision. For example, the UK has adopted a less interventionalist approach, requiring minimal local content to date. The UK still imports many components from elsewhere but it has experienced rapid growth. Taiwan, by contrast, has invested significantly in local content requirements, but this has contributed to increasing the LCOE of developments in the market. South African policymakers must determine the best policy mechanisms to support OSW and reap the most benefits.

Hubs and clusters

Industry hubs and clusters can support industry growth by acting as a central location for manufacturing, assembly, and maintaining OSW components. These can then drive local economic development, skills development, and job creation while bolstering the supply chain, contributing to cost reduction. Industry hubs are discussed in greater detail in the Chapter 18: Public and concessional finance.

South Africa has already developed industry hubs and clusters, such as SEZs. An SEZ is a geographically designated area set aside for specific economic activities. It is supported through special arrangements (such as laws) and systems that may differ from arrangements in the rest of the country.[250] One SEZ of particular interest in this context is the Atlantis SEZ, located north of Cape Town. The SEZ has been developed to focus on developing green technology in the country. The Atlantis SEZ aims to become Africa's leading, globally competitive, export-oriented green tech manufacturing zone.[251] The Atlantis SEZ has been developed to manufacture components for the renewable energy sector, including battery storage, thermal insulation materials, solar PV panels and wind towers.[252] Given these aims, OSW industry could easily be incorporated into its overall manufacturing output.

Supply chain development considering the growth scenarios.

When considering the three scenarios described in this report, the following considerations regarding supply chain can be made:

- Low growth scenario
    - **Planning and development:** This requires a significant local presence; therefore, this area would have a significant local element.
    - **Operations and maintenance:** Development will require a significant and ongoing local presence regardless of the growth scenario.
    - **Decommissioning:** These skills will be similar to those required for operations and installation, so some decommissioning will be provided locally.
- Medium growth scenario – as low but with the addition of:
    - **Manufacturing–turbine:** The manufacturing of turbine components such as towers is expected to increase locally in the medium growth scenario. By 2050, all towers will be manufactured locally, offering significant job opportunities and economic impacts. Potential also exists for blade manufacturing.
    - **Manufacturing–balance of plant:** The high capital investment required would require at least medium growth to incentivise local investment. However, utilising local labour would come with considerable benefits, such as job creation, economic growth, and cost reduction.
    - **Installation and commissioning:** Under a medium growth scenario, we would expect to see an increase in the local deliverability of this area, but much may still be imported, such as specialist vessels and crew.
- High growth scenario — As medium but with the addition of:
    - **Installation and commissioning:** Under a high-growth scenario, we expect to see an increase in local capability and investment in installation and commissioning services with minimal imports.

In all scenarios, the production of technologically advanced turbine subcomponents such as the nacelle, rotor, gearbox, generator, and electronics would likely involve imports due to the specialised skills often unavailable locally and the significant capital investment required for turbine manufacturing, compounded by lower manufacturing costs in markets like China.

12.4. RECOMMENDATIONS

The South African government should support the high-opportunity sectors of planning and development, operations and maintenance, and manufacturing balance of plant to grow locally and maximise local benefit and cost reduction. The following recommendations aim to support the development of a robust local OSW supply chain:

- **SC1 / JT1.** The DEE should work with the Department of Higher Education, institutions of higher learning and training (including TVET colleges and SETAs), and industry bodies to undertake a comprehensive skills assessment for the OSW industry, identifying existing and transferable skills that can be leveraged, and the key gaps to be filled.
- **SC2-4.** Industry bodies, project developers, the Department of Higher Education, and institutions of higher learning and training, including TVET colleges and SETAs, should:
  - **SC2.** Strategically plan for skills needs and education and training for the OSW industry; this could, for example, be done through SSPs developed by EWSETA and MERSETA. Include OSW in university and TVET college-level programmes.
  - **SC3 / H&S2.** Expand the existing GWO courses available in South Africa by introducing and offering additional training programs that align with international standards, including the GWO Basic Training designed for personnel involved in OSW operations. Require personnel involved in OSW operations to hold specific certificates that can be obtained from, for example, the Global Wind Organisation or equivalent.
  - **SC4.** Invest in training and education programmes and leverage existing skills development initiatives to equip the local workforce with the necessary skills to participate in the OSW industry. The focus should be on planning and development, operations and maintenance, and manufacturing.
- **SC5 – MED-HIGH.** Key government departments such as the DTIC and National Treasury should implement policies that catalyse supply chain development to encourage local market investment, such as tax incentives, grants, and subsidies for companies that invest in local manufacturing and supply chain capabilities, engaging with global OEMs early and often to encourage participation in the local market.
- **SC6 – MED-HIGH.** DTIC should leverage SEZs, such as the Atlantis SEZ, or establish industry hubs and clusters to support industry growth by centralising OSW manufacturing, assembly, and maintenance.

13. JOBS AND ECONOMIC BENEFITS

13.1. PURPOSE

South Africa must tackle the triple challenges of poverty, inequality, and unemployment as it transitions to a low-carbon and sustainable economy and society for all its people. This ambition is encapsulated in South Africa's NDP and NDC commitment to ensure a just transition while moving to a low-carbon economy and society. Due to its capital- and labour-intensive nature, OSW holds significant potential for value creation and socio-economic benefits. By fostering new industries and employment opportunities during its development, OSW can play a crucial role in addressing these challenges through job creation, local content, and economic growth.

This chapter examines the potential economic impact of OSW development in South Africa. It details the overall potential for employment creation across the OSW value chain and skills level requirements under the three growth scenarios.

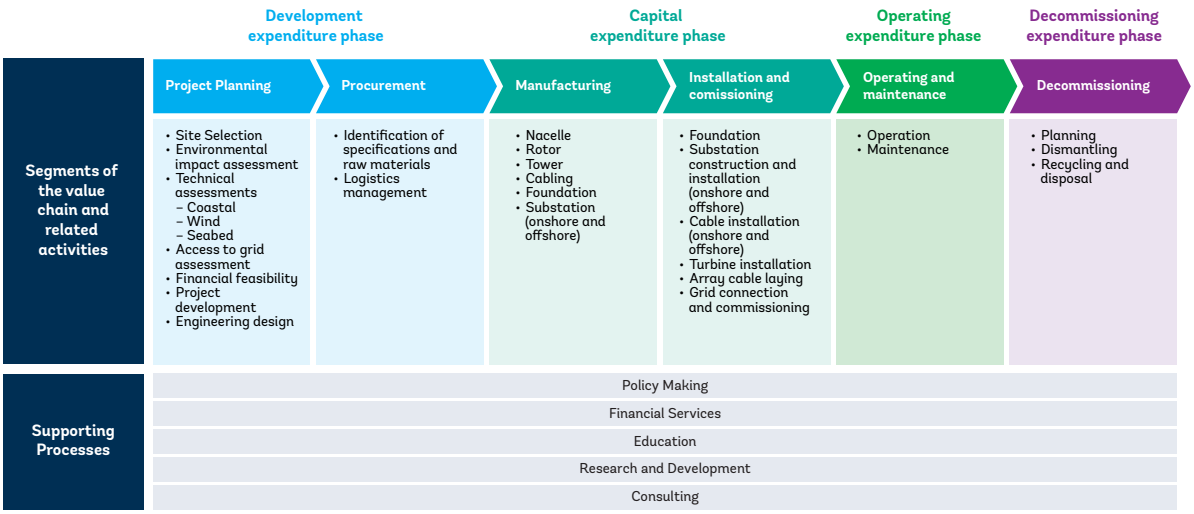
13.2. METHOD

This chapter's analysis considers employment creation and employment wage contribution across the supply chain at each project lifecycle stage, from development and consenting through manufacturing, installation, O&M, and decommissioning. It also indicates the type of jobs created and their potential geographic distribution.

While specific data for OSW is unavailable for South Africa, international examples and literature have been used to determine the economic impact of OSW in South Africa. The 2018 IRENA report informed this approach.[253] Given the lack of active floating OSW projects to draw from, this study relies primarily on data from fixed OSW technologies. However, Ørsted expects floating OSW projects to create similar direct and indirect jobs in development, construction, operation, and decommissioning.[254] In this study, therefore, we have assumed that the data from fixed OSW provides a reasonable proxy for floating OSW projects.

Figure 68 illustrates the phases of an OSW energy project, detailing the activities involved in different segments of the value chain, along with cross-cutting or supporting services such as policymaking and consulting. These phases were used to categorise the employment creation and its impacts from OSW development.

FIGURE 68: OSW ENERGY SUPPLY CHAIN SEGMENTS AND ASSOCIATED ACTIVITIES AND SUPPORTING PROCESSES.



Source: Adapted from IRENA.

Table 42 shows the direct person-days needed for a 500 MW OSW development across the project lifecycle (Figure 68), as outlined in IRENA's 2018 report on leveraging local capacity for OSW. The analysis relies on this breakdown of the person-days required to deliver OSW across the supply chain segments.

TABLE 42: PERSON DAYS NEEDED FOR A 500 MW OSW DEVELOPMENT ACROSS THE PROJECT LIFECYCLE.

Area of supply chain	% of employees required	The estimated workforce needed to deliver 0.5 GW (person-days)
Planning & Development	1.0%	23,828
Procurement	0.3%	7,299
Manufacturing	58.7%	1,252,514
Transport & Logistics	0.1%	2,159
Installation & Connection	11.0%	237,250
Operation & Maintenance	24.0%	626,825
Decommissioning	4.9%	97,453

The analysis used the cumulative installed capacity projections (scenarios) for 2035, 2040, and 2050 to determine the workforce demand for each lifecycle stage. This was achieved by converting person-days as provided in Table 42 into FTE years for each project phase and the annual equivalent, allowing the FTE years to be mapped on a timeline to provide a temporal element to employment creation. The conversion considered the total person-days throughout each project phase, the length of the project phase, and the average annual number of working days in South Africa as follows:

1. FTE years = Person days / annual working days in South Africa [255]
2. The FTE years were divided by each project phase length to be plotted temporally.

The employment wage contribution was calculated and broken down annually by project phase for each growth scenario. Employment wage contribution was determined as the aggregate of labour costs across various project phases, with typical salary levels estimated for each job category.

The jobs were categorised based on the type and level of skill required, indicating the nature of these roles. The jobs were grouped into five categories:

- **Lower certification:** This category encompasses roles that require on-the-job training and certifications with minimal formal qualifications.
- **Administrative personnel:** This category includes roles focused on providing administrative support.
- **Technical occupations:** These roles demand specialised knowledge and skills, typically acquired through vocational training, apprenticeships, or associate degrees.
- **Non-STEM professionals:** This category includes qualified professionals such as lawyers, logistics experts, regulatory and standardisation specialists, and marketing and sales personnel.
- **STEM professionals:** This group includes individuals with degrees in science, technology, engineering, and mathematics (STEM).

A high-level analysis of the estimated geographical distribution of jobs was also conducted, considering the predominant types of jobs and their locations relative to the most suitable development areas.

TABLE 43: SUMMARY OF CUMULATIVE INSTALLED CAPACITY ASSUMED UNDER THE LOW, MEDIUM AND HIGH GROWTH SCENARIOS AND USED IN THE ECONOMIC IMPACT ASSESSMENT.

	Low Growth (LG)	Medium (MD) Growth	High Growth (HG)
Cumulative installed capacity	2035: 500 MW 2040: 1 GW 2050: 5 GW	2035: 1 GW 2040: 5 GW 2050: 15 GW	2035: 1 GW 2040: 8 GW 2050: 40 GW
Sites	Coega East, Coega West, Cape Point South, Saldanha Bay	Coega East, Coega West, Cape Point South, Saldanha Bay	Richards Bay, Coega East, Coega West, Cape Point South, Cape Point West, Saldanha Bay, Boegoebaai

The IRENA report only estimates direct jobs and does not consider indirect jobs (those needed to produce the goods and services workers need) or induced jobs (resulting from additional personal spending on or around the project). This analysis, therefore, only considers employment wage contribution and employment creation in the low, medium and high growth scenarios derived from direct jobs.

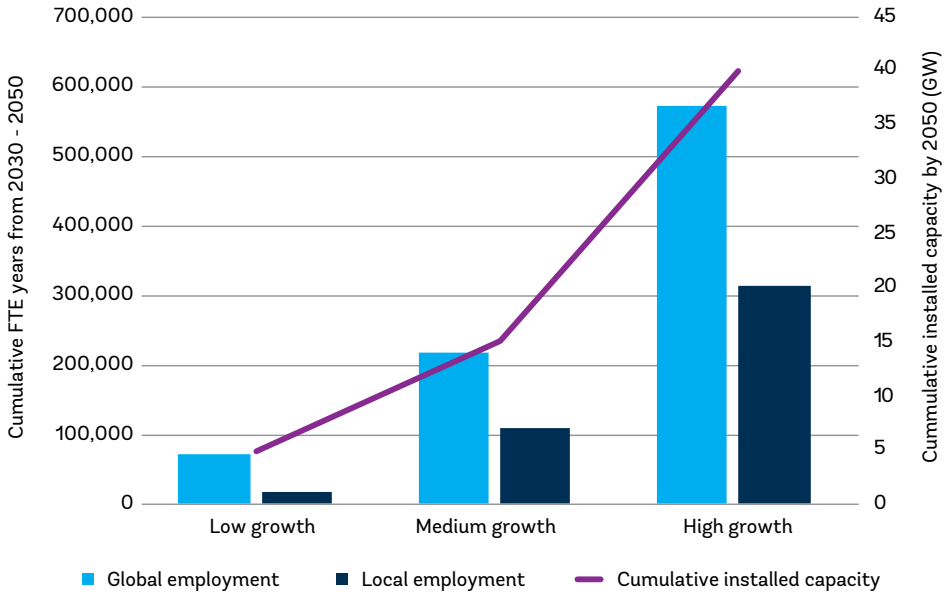
13.3. RESULTS AND DISCUSSION

13.3.1. FTE years and employment wage contribution under each growth scenario

The FTE years for each growth scenario are detailed in Figure 65, reflecting the gigawatt (GW) capacity that will become operational annually. The total number of global FTE years was calculated for each scenario, representing the total employment generated worldwide, not confined to local employment creation. Further analysis of local jobs was conducted based on the specific growth scenario (low, medium, and high) and supply chain components.

Figure 69 summarises the cumulative number of FTE years created from 2030-2050 under each growth scenario, split between global and local FTE years.

FIGURE 69: CUMULATIVE NUMBER OF FTE YEARS CREATED BETWEEN 2030 AND 2050 UNDER EACH GROWTH SCENARIO, SPLIT BETWEEN GLOBAL AND LOCAL FTE YEARS.



Low growth scenario

In the low growth scenario, 71,218 total global FTE years are expected to be created between 2030 and 2050, based on a cumulative installed capacity of 5 GW (Figure 70). The corresponding figures show that the number of FTE years closely aligns with the GWs installed yearly. Due to the irregular commissioning schedule in this scenario, employment creation fluctuates significantly from year to year.

When evaluating South Africa's local supply chain capabilities, it is projected that 17,671 local FTE years will be created cumulatively over the same period (Figure 71). Given the limited development of local manufacturing capabilities — due to the relatively small amount of GW installed and irregular commissioning thereof — local employment creation in the low growth scenario remains considerably lower than the global figures. Most of these local employment opportunities will be concentrated in installation and connection, operations and maintenance activities, and limited manufacturing.

FIGURE 70: GLOBAL FTE YEARS CREATED UNDER THE LOW GROWTH SCENARIO, SPLIT BY PROJECT PHASE.

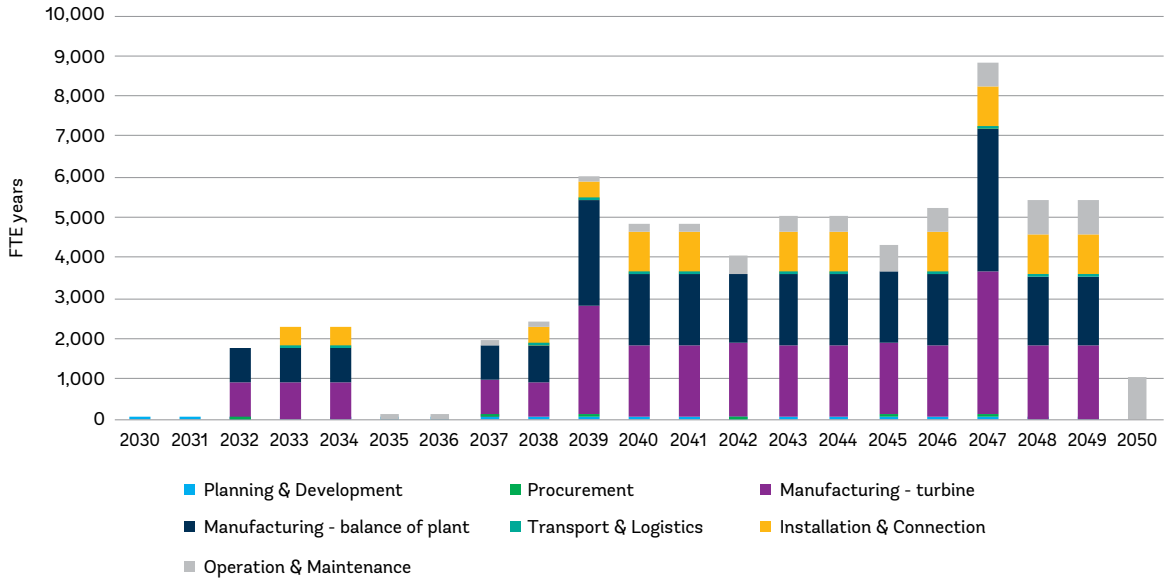


FIGURE 71: LOCAL FTE YEARS CREATED UNDER THE LOW GROWTH SCENARIO, SPLIT BY PROJECT PHASE.

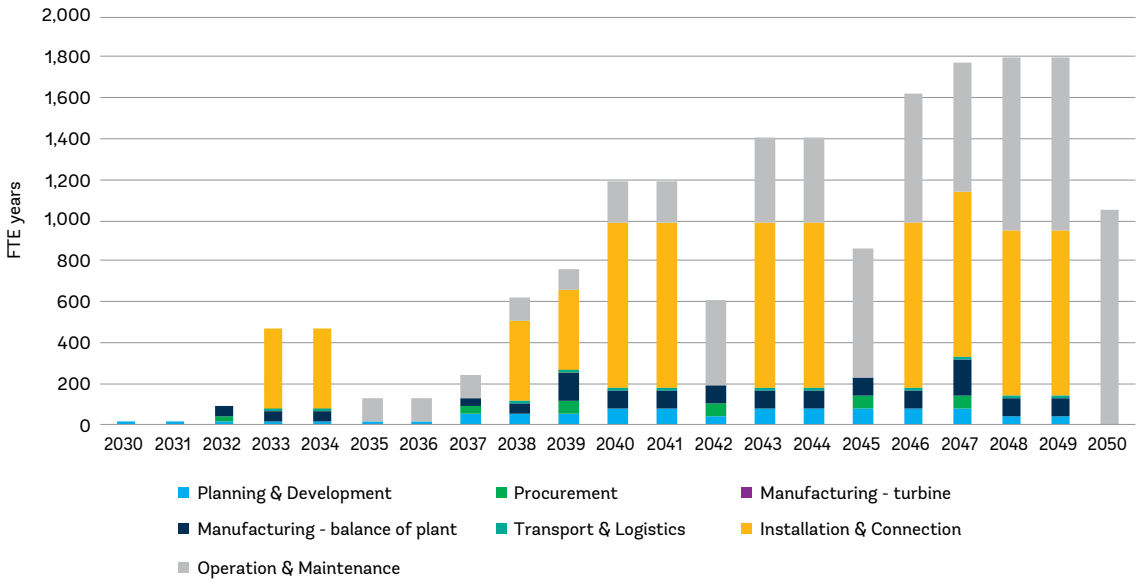
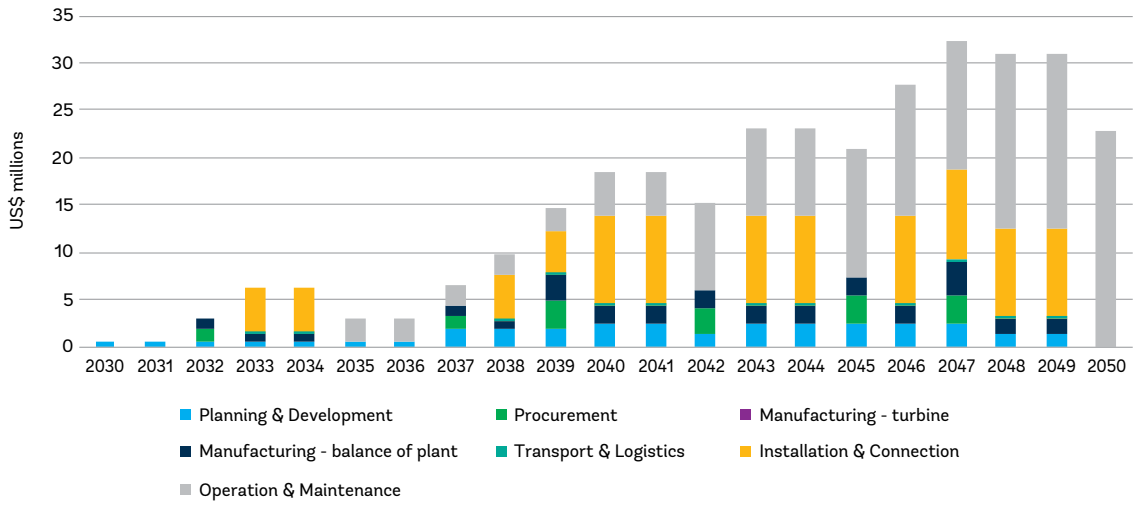


Figure 72 illustrates the projected employment wage contribution from the various project phases per year between 2030 and 2050. For the low growth scenario, US $317 million is generated.

FIGURE 72: LOCAL EMPLOYMENT WAGE CONTRIBUTION UNDER THE LOW GROWTH SCENARIO, SPLIT BY PROJECT PHASE.



Medium growth scenario

In the medium growth scenario, 214,470 global FTE years (Figure 73) are expected to be created, with 108,920 of these FTE years being created locally (Figure 74). This is more than six times the local employment expected in the low growth scenario, from three times the deployed capacity. This scenario assumes a consistent annual installation of 1 GW from 2030 onwards, leading to a steady increase in employment creation each year. The consistent installation rate contributes to stable and predictable employment growth, which remains strong throughout the period.

A fundamental assumption in this scenario is the development of enhanced local manufacturing capabilities. As a result, a substantial portion of local employment will be created mainly through manufacturing 'balance of plant' components. This focus on local manufacturing supports employment creation and strengthens the supply chain, making it more resilient and reducing import dependency. By maintaining a steady installation rate, the industry can also achieve better access to financing, as financial institutions are more likely to support projects with predictable development patterns. Moreover, this approach benefits local economies by providing sustained employment opportunities and fostering industrial growth.

FIGURE 73: GLOBAL FTE YEARS UNDER THE MEDIUM GROWTH SCENARIO, SPLIT BY PROJECT PHASE.

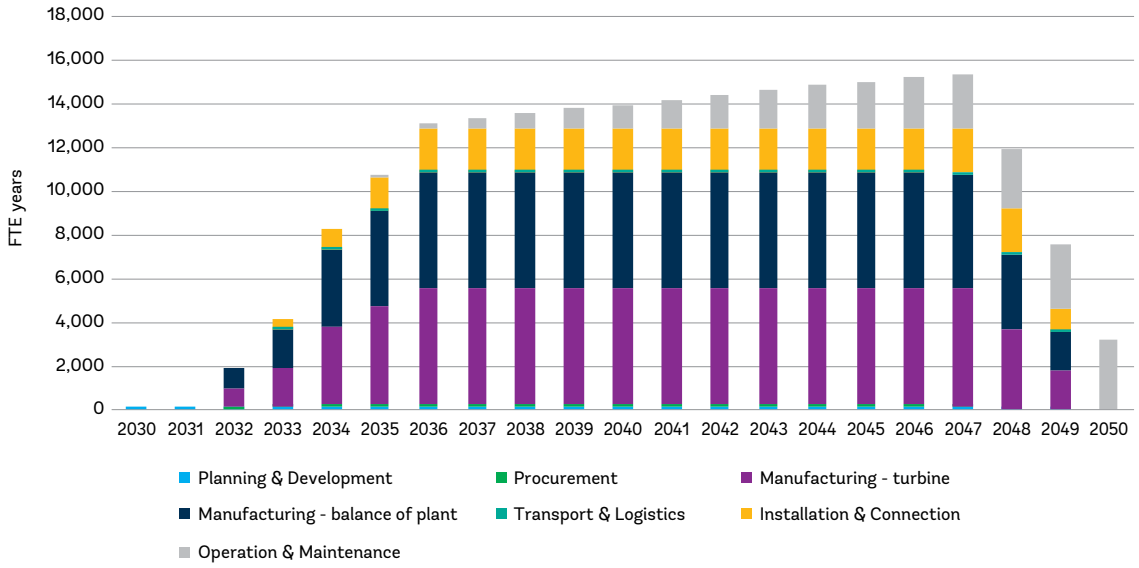


FIGURE 74: LOCAL FTE YEARS UNDER THE MEDIUM GROWTH SCENARIO, SPLIT BY PROJECT PHASE.

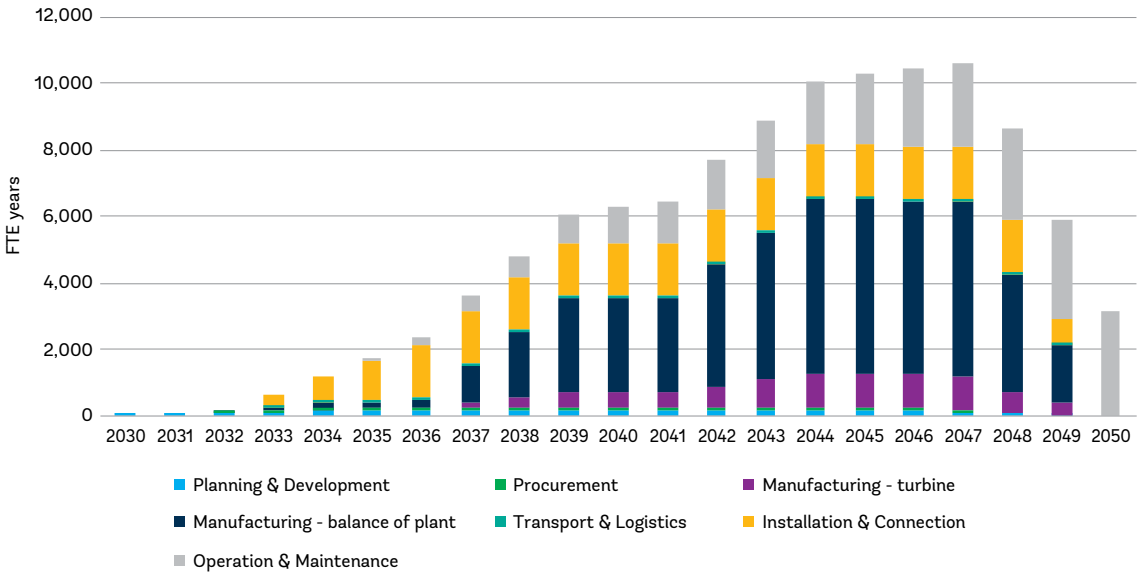
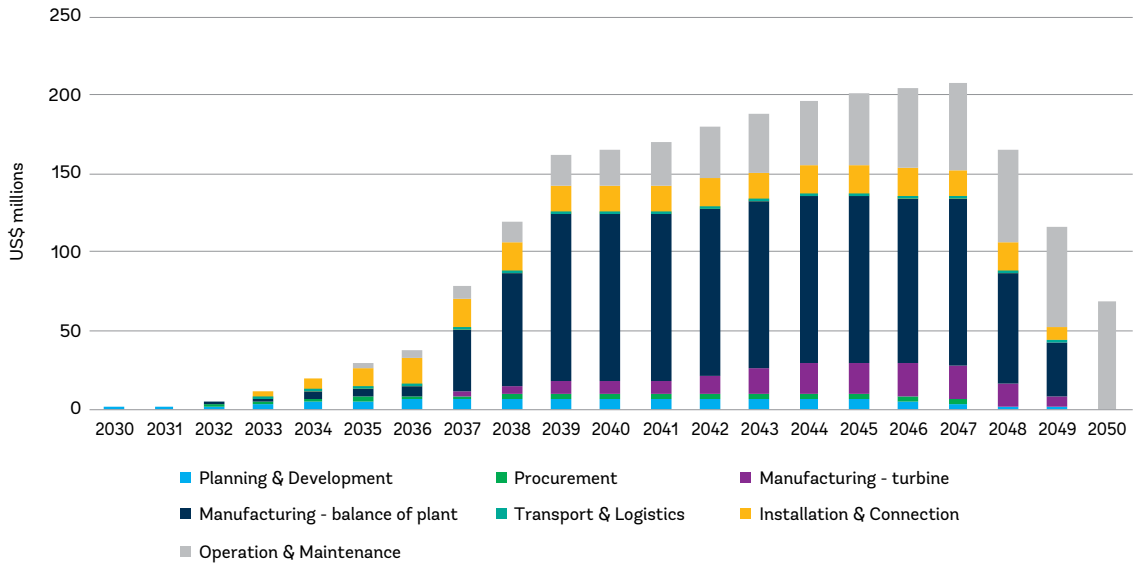


Figure 75 illustrates the project employment wage contribution from the various project phases per year. Between 2030 and 2050, US $2.4 billion is generated, over seven times more than the low scenario and more than double the wage generation per MW.

FIGURE 75: LOCAL EMPLOYMENT WAGE CONTRIBUTION UNDER THE MEDIUM GROWTH SCENARIO, SPLIT BY PROJECT PHASE.



High growth scenario

The high growth scenario projects a substantial increase in employment creation, with 572,786 global FTE years (Figure 76) and 314,780 local FTE years expected between 2030 and 2050 (Figure 77). This scenario anticipates a rapid expansion of OSW capacity, leading to a substantial rise in employment creation. Initially, the number of local FTE years is projected to be lower, reflecting a reliance on importing from established global supply chains.

However, by around 2037, when local manufacturing capabilities are assumed to expand significantly, there is a marked increase in local employment creation, particularly in the manufacturing sector. As more GWs of capacity are installed annually, the demand for skilled labour in manufacturing, installation, and operations grows, driving substantial job growth in the region.

This high growth scenario underscores the enormous potential for large-scale job creation driven by strategic investments in local manufacturing and the scaling up of OSW capacity. The significant ramp-up in local jobs by 2037 highlights the importance of long-term planning and coordination for investment in local industries, ensuring that the region can fully capitalise on the opportunities presented by the global OSW market.

FIGURE 76: GLOBAL FTE YEARS CREATED UNDER THE HIGH GROWTH SCENARIO, SPLIT BY PROJECT PHASE.

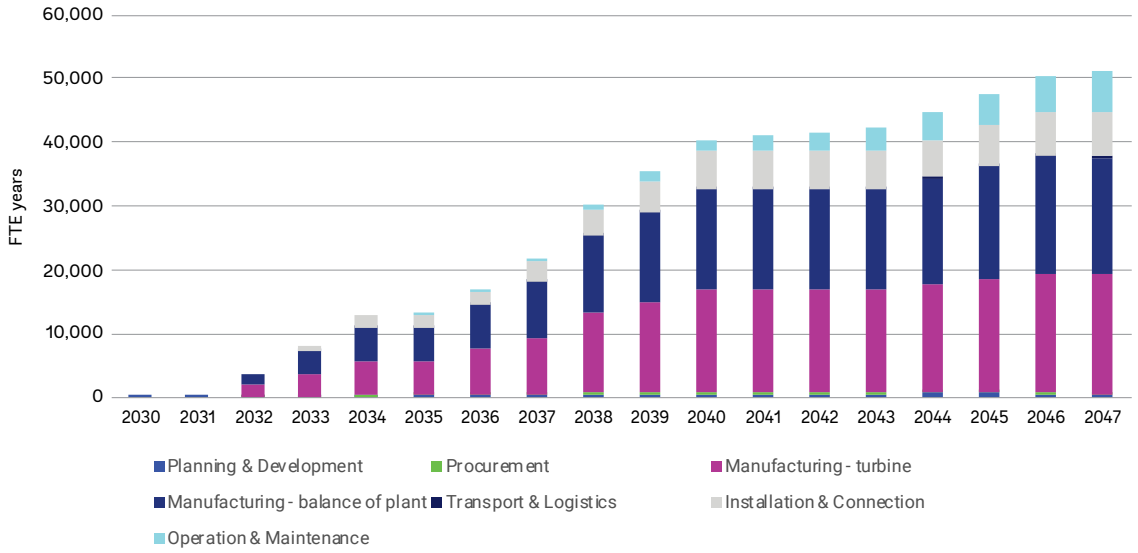


FIGURE 77: LOCAL FTE YEARS CREATED UNDER THE HIGH GROWTH SCENARIO, SPLIT BY PROJECT PHASE.

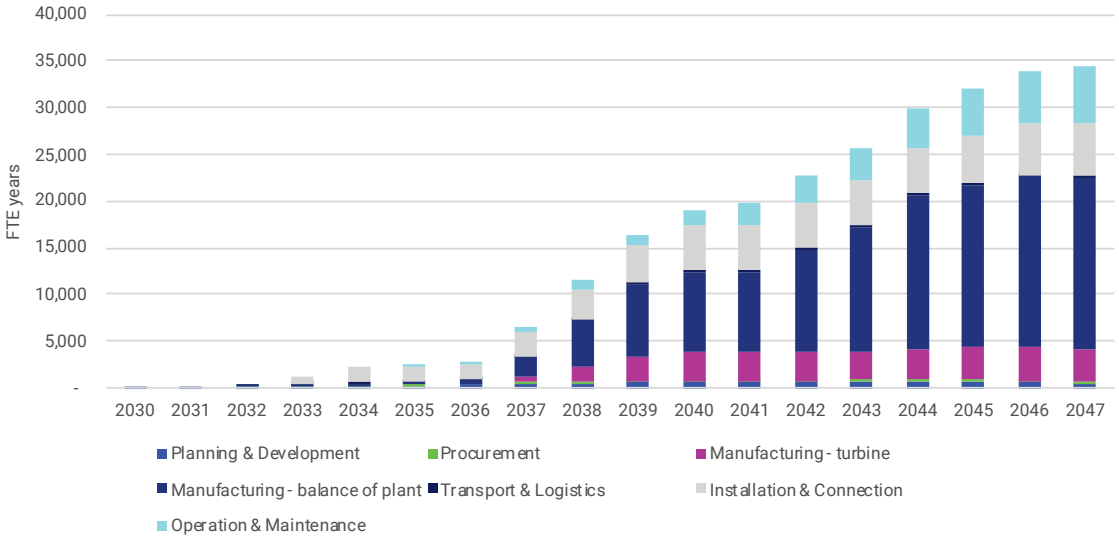
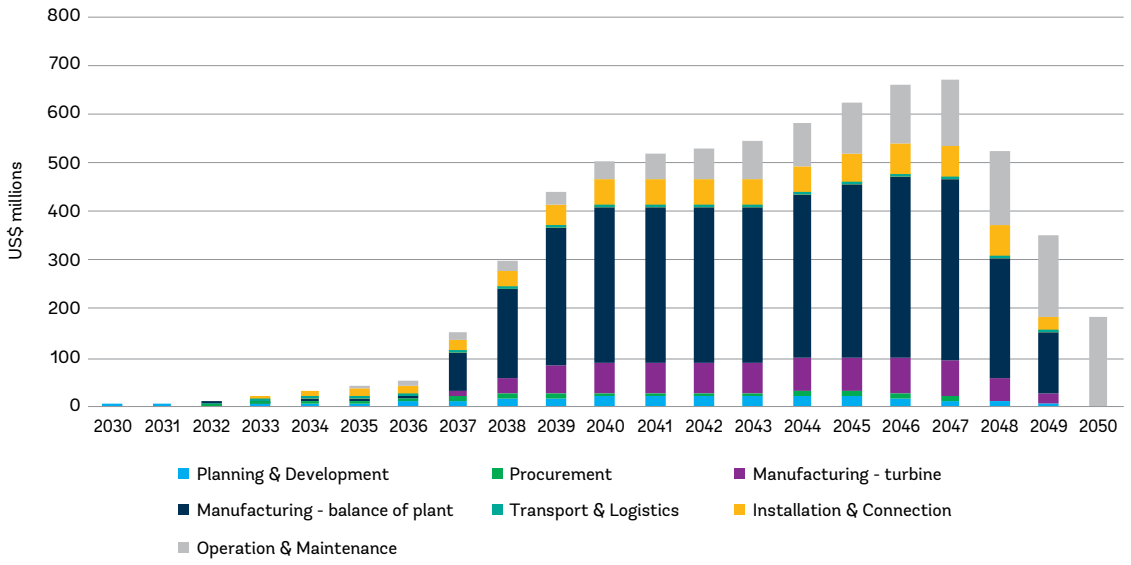


Figure 78 illustrates the project employment wage contribution from the various project phases per year. Between 2030 and 2050, US $6.7 billion was generated, an increase of more than 20 times compared to the low scenario.

FIGURE 78: LOCAL EMPLOYMENT WAGE CONTRIBUTION UNDER THE HIGH GROWTH SCENARIO, SPLIT BY PROJECT PHASE.

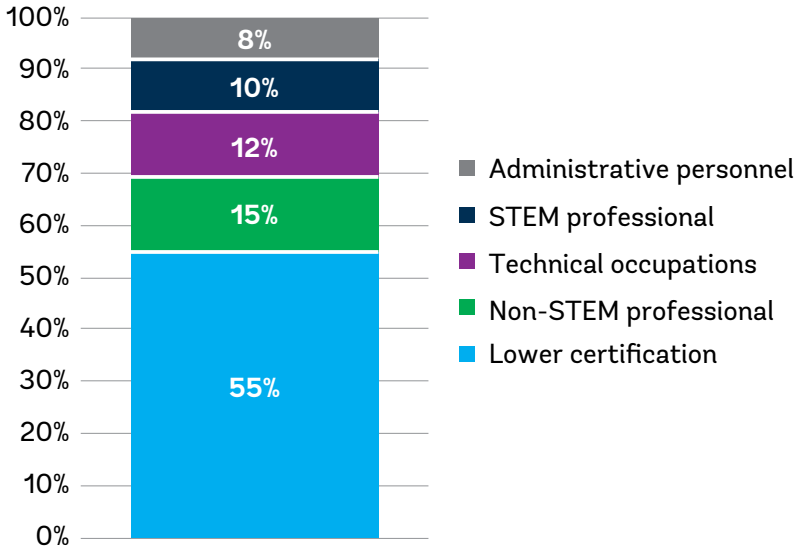


13.3.2. Job roles and skill requirements

Due to the costs and complexity involved, OSW projects demand diverse and specialised skills and expertise across various industries and skill levels. These requirements span the entire project lifecycle. The composition of job roles and skills requirements across the project lifecycle is provided in Figure 76:

- **Administrative services:** Administrative positions constitute 8% of the workforce, mainly during the manufacturing phase.
- **STEM professionals:** A range of STEM professionals, including industrial, mechanical, electrical, telecommunications, and computer engineers, as well as environmental experts, is essential across various project phases. STEM professionals comprise 10% of the workforce, concentrated in operations, maintenance, and industrial engineering roles within the manufacturing phase.
- **Technical occupations:** 13% of the workforce falls under technical occupations. A significant portion of these jobs are for technicians in the operations and maintenance of wind farms and the Safety, Health, Environment, and Quality (SHEQ) personnel involved in manufacturing.
- **Non-STEM professionals:** These roles account for 15% of the workforce. Most of these positions are in marketing and sales during the manufacturing phase and legal and logistics experts during the transport, logistics, operations, and manufacturing phases. Finance experts and project managers play vital roles during project design and planning.
- **Lower certification jobs:** These positions represent 55% of the workforce, with the majority being factory workers and ship crews, accounting for approximately 80% of lower certification jobs. This underscores the critical role of local manufacturing in creating jobs. Additional roles in this category include civil workers, crane operators, and drilling system operators.

FIGURE 79: COMPOSITION OF JOB ROLES AND SKILLS REQUIREMENTS ACROSS THE OSW PROJECT LIFECYCLE.



13.3.3. Spatial distribution of jobs

Most jobs are expected to be created during the projects' manufacturing, operation, and maintenance phases. Manufacturing activities should be close to ports to reduce transportation and logistics costs over long distances. Existing SEZs near ports are expected to serve as manufacturing hubs. As a result, if these SEZs are utilised, most manufacturing jobs will most likely be located in coastal provinces. However, this would not be exclusive, as some components could be manufactured nationwide.

Typically, SOV planned operation and maintenance jobs are shift-based, with employees living offshore on vessels for the duration of their shift (which could be a few weeks at a time). As a result, operations and maintenance personnel do not need to live near the ports or OSW projects. However, CTV-type maintenance for near-shore projects, as well as unplanned maintenance will require the workforce to be located near ports.

In addition, other jobs, such as planning and development and logistics, would be distributed across the country.

13.3.4. Discussion

This analysis underscores the critical role that component manufacturing plays in employment creation within the OSW sector. As South Africa grapples with an unemployment rate of 32.9%, OSW presents an opportunity to support local jobs, and therefore provide a role in helping to address unemployment, poverty, and inequality. To maximise this opportunity, fostering a favourable environment that enhances local manufacturing capabilities is essential.

The global FTE years generated are directly tied to the annual GWs of capacity commissioned. Ensuring a steady and yearly consistent development of GWs is crucial for sustained growth and securing financing. Predictable development also allows financial institutions to allocate resources confidently and supports manufacturing capacities' stability and expansion.

The local FTE years per MW in the medium and high growth scenarios are double that of the low growth scenario. This is because they stimulate the localisation of South African manufacturing.

This study likely underestimates the total workforce potential, as it does not account for indirect and induced job creation in secondary markets, which can increase job numbers by 100% to over 300%. Further study is needed to gain a more comprehensive understanding of OSW's economic impact, considering the potential of indirect and induced jobs.

European investment interest in South Africa's energy market further underscores the sector's potential.[256] The resulting tax revenues from OSW could significantly contribute to public funds for essential services, making OSW development a strategic priority for South Africa's future.

Skills and capacity challenges, as discussed in the Chapter 12: Supply chain analysis , must be overcome to realise the employment potential of OSW and other clean technologies.

Investing in South Africa's local supply chain for OSW offers strategic advantages. OSW could provide secure, reliable, near-baseload capacity to the grid, supporting the transition to cleaner electricity generation while ensuring supply stability. Moreover, developing OSW facilities near existing ports like Saldanha and Richards Bay and leveraging the planned development of Boegoebaai could drive the growth of green hydrogen production — identified as a critical future economic sector in South Africa's Just Energy Transition Implementation Plan.

Additionally, OSW can support the transition of South Africa's automobile manufacturing sector to producing NEVs, which is essential for maintaining competitiveness in the rapidly evolving European market. The broader impacts of investment in OSW include infrastructure development, technological advancement, and innovation, all of which can boost South Africa's overall economic output.

13.4. RECOMMENDATIONS

OSW development in South Africa creates many opportunities for economic growth and diversification required for GDP growth, helping to eliminate the triple challenges of unemployment, inequality and poverty. It provides additional opportunities and avenues for employment and skill deployment/ redeployment. OSW can facilitate skills transfer from existing sectors, like oil and gas, into this new, cleaner generation industry. To maximise the economic potential of OSW development, the following key recommendations are made:

- In establishing the vision for South Africa's OSW development (see REG1), the DEE should consult with the Department of Economic Development and Department of Trade Industry and Competition to assess whether projected economic benefits of the medium and high growth scenario justify the investment required to realise them.
- Industry bodies, project developers, the Department of Higher Education, and institutions of higher learning and training, including TVET colleges and SETAs, should focus investments and skills initiatives on establishing manufacturing capabilities for the OSW industry and its supply chain.

14. JUST TRANSITION

14.1. PURPOSE

The Just Transition (JT) aims to ensure that the shift to a low-carbon economy is fair and inclusive, benefiting communities while promoting economic diversification, skills development, and environmental sustainability. The transition can be leveraged to support economic growth and help address South Africa's unemployment, inequality, and poverty levels.

This chapter outlines how the development of an OSW market can aid socio-economic development and be aligned with Just Transition Principles.

14.2. METHOD

This chapter provides a high-level assessment of the socio-economic impacts and value that can be derived by deploying OSW in South Africa. It also includes policy recommendations that can be considered to maximise OSW benefits while ensuring that the industry's development promotes a JT in the country. To this end, we discuss how the:

- inclusion of OSW in the country's long-term energy strategy,
- development of renewable energy adoption policies,
- use of local content requirements,
- establishment of skills development and training programs, and
- implementation of initiatives to enhance the competencies of local firms,
- can all assist in developing an OSW sector and positively contribute to the JT by promoting procedural, distributive and restorative justice.

A desktop-based research approach was followed using multiple secondary data sources. The review sought to understand:

- The general OSW industry value chain, the development opportunities from OSW deployment, and dynamics in countries with developing OSW sectors, particularly in Western Europe.
- South Africa's renewable energy landscape, with a focus on onshore wind, to highlight: how renewable energy development has been approached in South Africa; the value that has been created through the deployment of other RE technologies; and capabilities and capacities associated with RE deployment that have been developed in the country.

- South Africa's Just Transition Framework [257] and Just Energy Transition Implementation Plan [258] to ascertain the essential elements needed to ensure that introducing OSW in the country's energy mix contributes towards Just outcomes.

The following sections review the potential value and socio-economic benefits of deploying OSW projects internationally (Section 14.3.3) and an assessment of the South African context in terms of the current electricity generation regime, the country's energy transition and the deployment of renewable energy technologies and the opportunities for value creation from OSW deployment considering the country's existing capabilities and capacities in related industries such as the onshore wind industry (Section 14.3.4). We conclude with policy recommendations that embody the three JET justice pillars that must be included in the development of OSW.

14.3. RESULTS AND DISCUSSION

14.3.1. The role of OSW in South Africa's just transition

South Africa's economic growth has remained stagnant for the last decade, with GDP growth averaging only 0.8% since 2012.[259] This is insufficient to address high levels of unemployment, inequality and poverty. The Just Transition for South Africa is defined as "a shift towards a low-carbon, climate-resilient economy and society and ecologically sustainable economies and societies which contribute toward the creation of decent work for all, social inclusion and the eradication of poverty."[260]

The PCC has been established to ensure a just transition and measure its success. The PCC has published the cabinet-approved Framework for a Just Transition.[261] This document outlines the guiding principles for a just transition in South Africa: procedural, restorative, and redistributive justice. South Africa's new OSW market must support the country's just transition agenda to achieve buy-in across government and broader social license.

As mentioned, OSW development in South Africa creates many opportunities for economic growth and diversification. It provides additional opportunities and avenues for employment and skill deployment/redeployment. OSW can facilitate skills transfer from existing sectors, like oil and gas, into this new electricity generation industry.

These opportunities from OSW align with the JET-IP, the key investment plan for South Africa's Just Energy transition. The JET-IP supports the development of large-scale and distributed renewable energy generation. This plan anticipates that the private sector will primarily meet the generation demand, with the state and the private sector procuring power. Beyond energy generation, the JET-IP identifies the opportunities and required support for NEVs and GH_2. The scale of OSW under the medium and high growth scenarios provides the opportunity to support the development and growth of these sectors through the supply of reliable, clean energy:

- The JET-IP sets out supply-side incentives for the automotive industry to unlock NEV production and supply chain investments, and to protect and grow manufacturing employment. It calls for co-funding investments in NEV auto assembly and supplier parts, component manufacturing and supply chains, and early-stage investments in project and business development for decarbonising transport and logistics supply chains and associated charging infrastructure.

- For GH_2, the JET-IP aims to mobilise grant and first-loss funding from dedicated GH_2 global funds to de-risk the early stages of project development.

It is recommended that there is further alignment between the opportunities of ambitious OSW development such as in the medium and high growth scenarios and the recommendations in the JET-IP. These recommendations include:

- **Shared infrastructure:** Coordinate, accelerate, and provide visibility on the development of all infrastructure projects (port, grid, pipeline, rail) and plan for shared infrastructure development costs between developers.
- **Technology incubation and workforce skills:** fast-track research and development funding for public and private innovation and building South Africa's competitive advantage.
- **The establishment of SDZs** (local learning networks) focused on three core value chains: in Mpumalanga (renewable energy and transmission), in the Eastern Cape (NEVs) and in the Northern Cape (GH_2), anchored in local education institutions in partnership with business to support community and regional economic development initiatives. OSW development can expand these opportunities to regions like the Western Cape and KwaZulu-Natal.

14.3.2. Socio-economic benefits along the OSW value chain

OSW projects are highly capital and labour-intensive and require a diverse range of specialised skills. As such, there is significant potential for value creation and socio-economic benefits through new industries and employment during their development and, by extension, the development of an OSW industry. Table 44 shows the domestic value creation potential across the different value chain segments and the supporting activities depending on the stage of the industry's development. This suggests that domestic value creation potential is low during the initial stages of OSW industry development due to a lack of experience and knowledge, for example, in project planning, manufacturing, and installing equipment required in OSW projects. Consequently, in the early years and with limited development, as in the low growth scenario, most of the activities are conducted by imported labour using imported equipment from OEMs; this is also the case in installation. However, local value can still be created during the initial development of the OSW industry through grid connection, operation and maintenance, and support services such as financial services, education, and training. The potential for domestic value creation increases with scale as more projects are commissioned and the local industry develops.

TABLE 44: POTENTIAL FOR DOMESTIC VALUE CREATION THROUGHOUT THE LIFECYCLE PHASES OF OSW PROJECTS AND IN THE SUPPORTING SERVICES, DEPENDING ON THE STAGE OF DEVELOPMENT.

Potential for Domestic Value Creation	Stage of Development		
	Beginning of OSW Energy Development	First Projects Realised, Local Industries Suitable for Participating	Many Projects Realised, National OSW Industry Developing
Lifecycle phase			
Project planning	Medium	High	High
Manufacturing	Low	Medium	Medium/High

Potential for Domestic Value Creation	Stage of Development		
	Beginning of OSW Energy Development	First Projects Realised, Local Industries Suitable for Participating	Many Projects Realised, National OSW Industry Developing
Installation	Low	Medium	High
Grid connection	Medium	High	High
Operation & maintenance	Medium	High	High
Decommissioning	Low	Low	Medium
Supporting processes			
Policymaking	High	High	High
Financial services	Low/Medium	Medium	High
Education and training	Low/Medium	Medium	Medium/High
Research & development	Low	Low/Medium	Medium
Consulting	Low	Low	Medium

Source: IRENA and CEM.

Note: Originally developed for solar and onshore wind energy but adapted for OSW energy.

14.3.3. International review of OSW socio-economic benefits and value creation

Box 1 [262] Describes some of the critical issues commonly raised during the initial scoping of economic impacts of projects. These include local employment content (direct, indirect, and induced), local procurement, gross value added (GVA) and extended effects on local businesses. These variables are essential as they are benefits that can be quantified. Chapter 13: Jobs and economic benefits provides a high-level economic impact assessment of OSW development under different scenarios.

Box 1

Some critical issues raised during the initial scoping of a project's economic impacts.

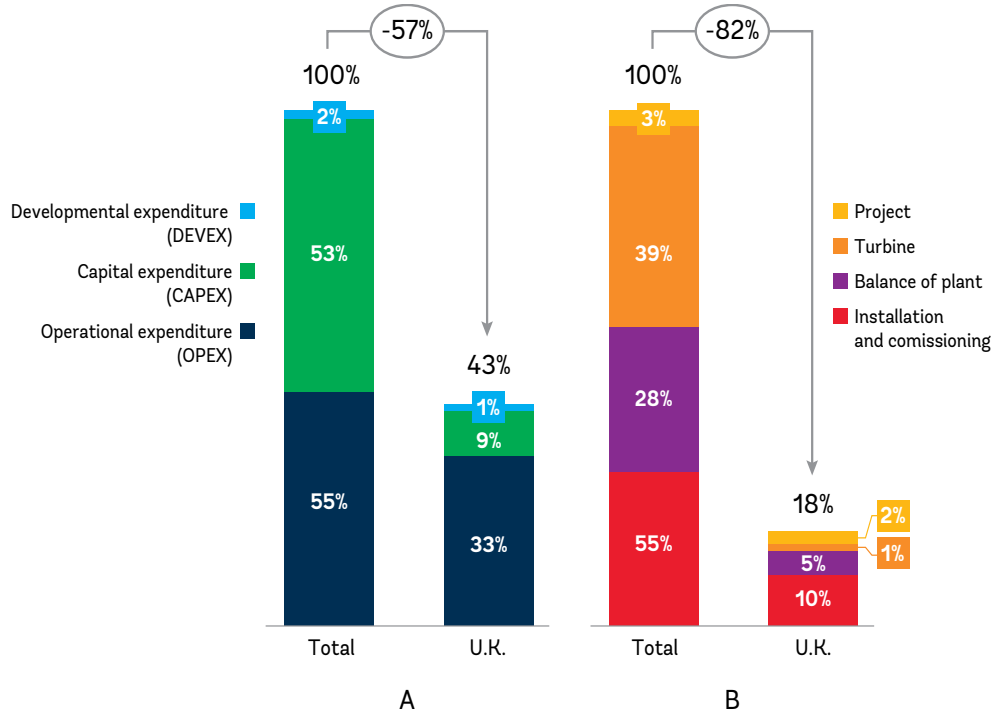
- **Local employment content (direct)** – the proportion of jobs filled by local workers during the DEVEX, CAPEX and OPEX stages. The local labour recruitment ratio is of crucial importance for the assessment of local content.
- **Local procurement** – the proportion of local procurement resulting from the project.
- **Local employment content (secondary — indirect and induced)** – likely magnitude of secondary employment (local) resulting from the project.
- **GVA** – what is the GVA economic impact of the project at various scales (from local to national);
- **Local business effects** – will local businesses benefit from the development's supply chain and retail opportunities, or will they suffer from competition for labour and local wage inflation?

Source: adapted from Glasson et al. (2019).

The phases of OSW projects present many opportunities for economic benefits for the areas where they are developed, including its auxiliary systems, such as the onshore substations. Despite these opportunities, there are usually concerns regarding the leakage of project expenditures and jobs outside local areas and the country.[263]

Figure 80 presents a comparison between the total project expenditure for UK OSW farms commissioned after 2009 and spending on UK content, divided into development, capital, and operational costs.[264] Overall, the spending on UK content is mainly during the developmental and operational phases of OSW projects, with 1% (out of 1.5%) and 33% (out of 45.5%), respectively (see Figure 80(a). Given that the UK has one of the highest installed OSW capacities globally and was one of the first movers in the market, [265] it is worth noting that UK local content only represented 9% of the 53% capital expenditure on OSW projects.

FIGURE 80: BREAKDOWN OF EXPENDITURE FOR UK OSW FARMS: (A) SHOWING THE COMPOSITION OF TOTAL PROJECT EXPENDITURE AND (B) SHOWING THE COMPOSITION OF CAPITAL EXPENDITURE.

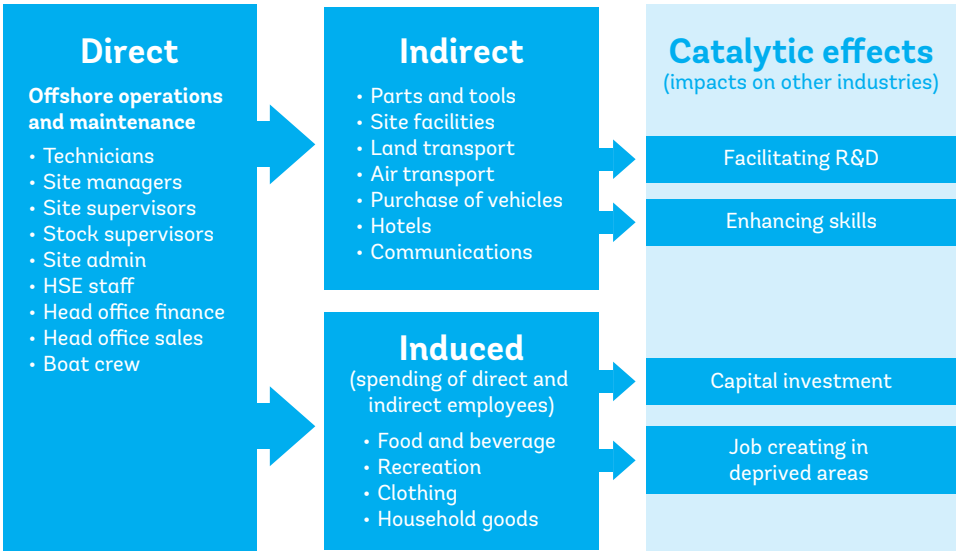


Source: CSIR analysis with data from BVG Associates (2015).

Figure 80 further indicates that during the capital expenditure phase, UK local content is for installation and commissioning and providing the balance of plant equipment; this is because these are easy to localise, for example, installation and commissioning benefits by using local labour from industries such as offshore oil and gas. It is important to note, however, that one of the main reasons for the low levels of capital expenditure on UK local content is that during the initial stages of its OSW industry, the UK prioritised reducing the LCOE of OSW farms instead of focusing on increasing expenditure on local content.

The substantial expenditure on local content during the operational phase of these UK OSW projects is shown in Figure 81. This is likely the case for other countries that do not have an established OSW wind industry but have skills that can be transferred into occupations and activities required during the operational phase. These skills might already exist in other sectors, such as construction, civil, marine engineering, and onshore wind. They could thus be transferred to the OSW industry with requisite reskilling and upskilling to ensure that the workforce can meet its unique requirements. Figure 81 shows the types of direct employment opportunities within OSW operations and maintenance and sectors/industries likely to accrue indirect and induced benefits from OSW's existence.

FIGURE 81: OSW OPERATION AND MAINTENANCE (O&M) OPPORTUNITIES FOR LOCAL/ REGIONAL/NATIONAL ECONOMIES.



Source: adapted from Glasson et al. (2020).

14.3.4. The South African context

Coal is an abundant resource in South Africa and has historically been the backbone of the country's energy system, providing approximately 70% of installed power generation capacity.[266] Although coal's share has decreased since the late 2000s, it is still the dominant energy source. Mpumalanga is the centre of the South African coal industry, accounting for approximately 80% of total coal production and housing twelve of Eskom's fourteen coal-fired power stations.[267]

Due to the country's dependence on coal, it ranked as the 13th biggest emitter in CO_2 from fuel combustion in 2022 according to the IEA.[268] South Africa's NDC targets emissions of 350-420 Mt CO_2-e by 2030, aiming to reach Net Zero by 2050 in the Long-term Emissions Development Strategy (LEDS).[269]

The electricity sector is the largest contributor to emissions but presents the most significant reduction opportunity through a shift to clean energy. Access to electricity in the country has increased considerably over the past two decades; the proportion of households connected to mains electricity increased from 76.7% in 2002 to 89.6% in 2022. As a result of these high levels of electrification, 94.7% of households nationally report that they use electricity as their primary energy source for lighting, and 64.9% use it for cooking.[270] However, despite the high levels of electrification, frequent power outages (load shedding) are undermining South Africans' access to electricity and energy security. Consequently, while electrification is high, reliability and security of supply are poor.[271] This challenge undermines the country's ability to realise its commitment to the Sustainable Development Goals (particularly SDG 7: "Ensuring access to clean, affordable, reliable and modern energy for all").

In recognition of the carbon intensity of its energy sector and the negative health impacts of coal activities, as well as the issues of electricity security and affordability, the country's NDP envisages that South Africa should move towards a just, low-carbon and resilient economy and society with a reduced dependency on carbon-intensive energy sources.[272] The 2019 IRP sets out a plan for diversifying the electricity mix by 2030 to reduce the sector's carbon intensity while meeting growing energy demand, and includes decommissioning several coal-fired power stations as they end their technical and economically viable life.[273] The coal value chain employs over 100,000 people [274] and sustains many livelihoods beyond direct employment, particularly in Mpumalanga. As such, the national Just Transition Framework, the Just Energy Transition Investment Plan, and its Implementation Plan outline that this process should be undertaken in a manner that not only does not exacerbate the triple challenges of poverty, inequality, and unemployment but maximises the socio-economic development opportunities for all.[275] [276]

Due to its significance in the energy landscape, current Just Energy Transition interventions primarily focus on Mpumalanga. However, it is crucial to recognise that poverty and vulnerable communities are prevalent throughout the country. Many workers in the coal value chain are migrant workers from other provinces, like the Eastern Cape. The increase in renewable energy sources generates alternative and more diverse employment in the energy sector. This can partially replace the decline in coal-related jobs in Mpumalanga and other provinces, aligning with OSW distributed nature.

South Africa must transition to cleaner forms of energy to meet its commitment to decarbonisation and longer-term climate ambitions. Decentralising electricity generation through increased deployment of distributed energy resources such as OSW energy could increase the resilience and reliability of South Africa's electricity grid, increase energy security, and contribute to achieving the country's developmental targets. Coupling the deployment of the energy resources with other interventions, such as investment in transmission grid expansion, could significantly enhance these benefits.

14.3.5. Maximising socio-economic benefits and value creation of an OSW market in South Africa

To maximise the value from the opportunities presented by the development of an OSW energy industry, the country would have to build onto the capabilities and capacities that currently exist within the manufacturing, installation and commissioning, and operations and maintenance segments of the value chain and potentially develop those that do not exist.

The most critical enabler for developing an OSW market is its inclusion in the long-term energy strategy.[277] This should be in the context of how the South African government plans to increase energy security and affordability while decarbonising its economy. It is essential to consider how OSW development will contribute towards creating a Just Energy Transition and what role OSW will play. Answers to these questions would then be articulated in an overarching energy strategy such as the IEP and IRP.

In designing deployment policies for the OSW market (discussed further in Chapter 15: Regulatory, legal and permitting framework), policymakers should take an inventory of the country's OSW resource potential and the availability of local capabilities and related sectors to identify where the most value can be generated. Such deployment policies should be paired with local content requirements to maximise value creation.

Some degree of local content requirement (LCR) will be essential to continuing to build on the successes already experienced in programmes such as the REIPPPP for developing an OSW market in South Africa. However, despite the local economic benefits created through LCRs, a balance must be struck between these and anticipated impact on LCOE. LCRs reduce competition, increase cost and risk, and slow market development. As such, the government should be clear about its goals for developing an OSW market because the cost of energy and economic value creation are essential issues for South Africa and thus need careful consideration.

There will be more opportunities for local content manufacturing, economic growth and employment as the market matures and the scale of OSW increases, such as in the high-growth scenario. For example, as previously highlighted, in the early years of its OSW development, the UK focused on reducing the LCOE of OSW and allowing the market time to mature. Now that it has matured, in its 2019 *Offshore Wind Sector Deal*, the UK government set a sector target of 60% lifetime content to be sourced locally for all projects commissioned from 2030 onwards, up from an estimated 32% in 2017.[278] [279] A similar approach has been followed in South Africa for the solar PV and onshore wind REIPPP, during which LCR was increased incrementally over the various bid windows (only being reduced to expedite bid window 5); as such, this approach could also be considered for OSW projects, as discussed in Chapter 13. It should be reiterated that LCRs may have cost implications if they are implemented in an overly strict manner and prohibit supply chain competition, and therefore should be considered cautiously for OSW.

The government can also introduce incentive schemes such as rebates to encourage developers to source content locally. This approach has been used in the South African automotive sector, a case study of which is provided in Box 2.

Box 2

How local content has been incentivised in South Africa's automotive sector

In response to declining local content levels in South African manufactured vehicles, the government published the South African Automotive Masterplan (SAAM), which sets a target of 60% local content by 2035 as part of its objectives.[280] The government then amended the Automotive Production and Development Programme (APDP), which is the central supporting policy of the SAAM, replacing the original APDP's Vehicle Assembly Allowance (VAA) with the Volume Assembly Localisation Allowance (VALA) and the Production Rebate Credit Certificate (PRCC) with the Production Rebate Certificate (PRC).[281] The VALA, for instance, provides rebates for manufacturers with a minimum plant capacity of 10,000 vehicles per annum, which is used to offset import duties on OEM components; the rebate is based on their local value addition. On the other hand, production incentive factors are designated as 50% for specific motor vehicles and 62.5% for automotive parts and tooling for PRC claims. The timeline for the SAAM and APDP Phase 2 is from 2021 to 2035; as such, it is yet to be determined whether this strategy and policy will lead to increased local content and reach the 60% target by 2035. Nevertheless, it does provide an example of how the South African government can incentivise local content sourcing.

A vital consideration in the decommissioning of coal-fired power stations and deployment of renewable energy technologies, including OSW, is the loss of employment and livelihoods that are likely to occur in transition hotspots. To ensure a just transition, there should be planning of how such negative socio-economic impacts will be avoided or mitigated. For example, economic diversification can be realised through developing renewable energy economic development zones/industrial parks (solar PV, onshore wind, and bioenergy) and expanding agriculture and tourism activities.

Plans and programmes for education and training, and the reskilling and upskilling of workers in the coal value chain and other affected and vulnerable communities must ensure that all are included in participation, opportunities, and benefits. Box 3 provides an example of the proposed Komati Training Facility under development at Eskom's decommissioned Komati power station. This facility will reskill and upskill former power station workers and community members. When successfully and inclusively implemented, this initiative can ensure that workers and vulnerable communities are empowered to participate in a low-carbon and climate-resilient economy.

Box 3

Komati Training Facility — a just skills transition pilot for coal power station workers and their communities

The Komati Training Facility (KTF) is a training centre dedicated to renewable energy technologies that will be developed at Eskom's decommissioned Komati power station in Mpumalanga. It forms part of the Komati Repowering and Repurposing project, which also involves the "repowering" of a power station with 150 MW of solar PV, 70 MW of onshore wind, 150 MW of battery energy storage and a synchronous condenser and "repurposing" with a containerised microgrid assembly facility and an agri-voltaics installation. The KTF aims to reskill Eskom employees and upskill qualifying local community members with skills for renewable energy deployment at the site, other Eskom power plants that will be decommissioned and other projects not done by Eskom.

Eskom has partnered with the Cape Peninsula University of Technology (CPUT's) SARETEC to develop the KTF with funding from the Global Energy Alliance for People and Planet.[282] After completion, the centre will be handed over to the Eskom Academy of Learning (EAL), which will receive support from SARETEC to get accreditation from the Quality Council for Trades & Occupations (QCTO). Once accredited, the EAL will use the KTF as a blueprint to establish training facilities at other Eskom power stations due for decommissioning.

Skills development has been identified as one of the critical pillars of South Africa's just energy transition. To this end, the Just Energy Transition Investment Plan (JET-IP) highlights proposals for the establishment of 'skills development zones (SDZ)' in four provinces: one focusing on the coal transition in Mpumalanga, another focusing on the automotive sector (particularly, new energy vehicles) in the Eastern Cape, and the other two concentrate on green hydrogen in Gauteng and the Northern Cape. The green hydrogen opportunity in the Northern Cape — which has excellent OSW resource potential [283] — presents synergies for developing an OSW industry on the province's coast that could result in a lower levelized cost of hydrogen. As such, training and education for the OSW industry might also be considered in the SDZ planned in the Northern Cape.

It is important to note that OSW-related education and training efforts will only yield the envisaged socio-economic benefits if an enabling policy environment includes deployment policies for demand creation and market development. This would ensure the availability of opportunities where the knowledge and skills developed could be applied.

The strengthening of firm-level capabilities refers to a range of cross-cutting policy initiatives geared towards technology transfer, lowering barriers to entry, improving the competitiveness of local firms and broader socio-economic targets such as employment creation and increases in GDP. These are discussed further in Chapter 12: Supply Chain Analysis.

14.3.6. Applying procedural, distributive and restorative justice to the South African OSW market

The policy interventions outlined above should be tailored to address the principles outlined in the National JT Framework. The following paragraphs highlight how the abovementioned policy levers fit into South Africa's JT context.

14.3.6.1. Procedural justice

Transparency in decision-making and the inclusion and engagement of affected stakeholders during planning such developments is important in OSW development globally. Policies should be developed in consultation with affected stakeholders. Some of the stakeholders that would need to be consulted in South Africa include coastal communities, fishers, and shipbuilders.

A judgement made by the Eastern Cape High Court in Makhanda upheld a ban on Shell's planned exploration of oil reserves in the Indian Ocean near the Wild Coast using seismic waves. The community and environmental groups litigated against Shell and the government, indicating that they were not consulted about the proposed exploration and were concerned about the effects of this technology on marine wildlife illustrates the need for consultation of communities and other stakeholders regarding offshore activities near them.[284] [285] This is further emphasised by Wiersma & Devine-Wright who suggest that similar to their onshore counterparts, there should be extensive, deliberate and inclusive stakeholder engagements during the earlier phases of OSW projects to ensure procedural justice for all parties affected by such developments.[286] Glasson et al. propose an eight-step approach for developers to conduct community/stakeholder engagements, this is summarised in Box 4. This approach can also be adopted/adapted by OSW developers for projects in South Africa and could minimise negative social impacts while increasing buy-in from communities.

Box 4

Community engagement plan for OSW developers.[287]

- Appoint a Local Community Liaison Officer (LCLO) or equivalent;
- Participate early in community workshops/focus groups to scope potential vital issues;
- Engage regularly with the community throughout project stages;
- Utilise engagement opportunities provided by community groups (e.g. community councils);
- Fund support for engagement activities in the development and construction stages and a Community Benefits Agreement (CBA) for the O&M stage;
- Survey community views of development impacts at crucial stages in the project lifecycle, including a focus on key impacted groups (e.g. specific settlements close to onshore works, the broader community of interest, and specific potentially impacted industries, such as fishing and tourism);
- Monitor media coverage of views on project impacts and
- Produce regular publicly available monitoring reports on the project and its local and regional impacts.

14.3.6.2. Distributive justice

Developing an OSW industry will have a myriad of socio-economic impacts, both positive and negative; what is essential, however, is that these are distributed in a manner that does not leave others as winners and others as losers. There are two scenarios wherein this may not be the case, the first being where increases in jobs related to the OSW supply chain resulting in improvements in the community's economic conditions might mask job losses in other industries such as fishing, which might have substantial impacts on the well-being of the affected individuals. The second relates to how, due to the global nature of the OSW industry, positive social well-being impacts might be exported outside the communities where OSW developments are made.[288] Such scenarios must be considered when planning for an OSW industry in South Africa. An essential consideration for achieving this for new technology is the design of LCRs, which are usually geared towards supporting local firms and industries and enhancing other national socio-economic objectives. Other policy levers include investments in education and training, which assist in building the local stock of skills and knowledge, and initiatives to strengthen the capabilities of local firms, which are necessary for meaningful participation in the new industry. There is also a need for upskilling and reskilling programmes for workers displaced from sunset industries because of the transition from fossil fuel-based energy generation to renewable energy generation.

14.3.6.3. Restorative justice

South Africa already has policies aimed at restoring past injustices, including the country's preferential procurement policy that seeks to increase the level of participation of B-BBEE suppliers in public projects. Similar policies could be extended to OSW projects to ensure that economic injustices are not exacerbated. The design of the REIPPPP and its progress to date show that projects under the programme have attempted to foster community investment by giving host communities a share of ownership in the projects via Trusts. However, a report by Intellidex (now Krutham) demonstrates that these arrangements and ownership structures are usually complex, and data on their social impact is difficult to obtain or measure. These models are therefore unlikely to be applicable in any early-stage OSW projects in South Africa.[289] However, other community benefits may be realised through enterprise development initiatives and socio-economic development projects, for which R200 and R700 million had been spent by onshore wind IPPs as of December 2021. Some of these developmental models could be adopted for OSW development in the country.

Furthermore, the development of OSW will also contribute towards reducing South Africa's dependence on coal for power generation and consequently lead to a reduction in the air and water pollution that results from coal mining and power generation. This would, in turn, improve the health of communities living near coal mines and power stations. Therefore, in addition to supporting SDG7, OSW development could also contribute towards the attainment of SDGs such as:

- **SDG 6 target 6.3** – improving water quality by reducing pollution, minimising dumping, and minimising the release of hazardous chemicals and materials; and
- **SDG 3 target 3.9** – reduced deaths and illnesses caused by hazardous chemicals, air, water and soil pollution, and contamination.

Aligned with SDG7, ensuring access to affordable, reliable, sustainable and modern energy for all, South Africa's vast coastline and OSW resource potential across multiple provinces, OSW development can contribute towards increasing the decentralisation of electricity generation in the country. This has numerous benefits, including increasing the country's generation capacity and energy security and the electricity grid's stability, security, resilience, and reliability. These are all salient points advocated for by the national JT Framework and recognised as contributing towards restorative justice in the country.

14.4. RECOMMENDATIONS

To maximise OSW benefits while ensuring the industry's development promotes a Just Energy Transition in the country, the following recommendations are made:

- **JT1 / SC1.** The DEE should work with the Department of Higher Education, institutions of higher learning and training (including TVET colleges and SETAs), and industry bodies to undertake a comprehensive skills assessment for the OSW industry, identifying existing and transferable skills that can be leveraged and key gaps.
- **JT2.** Following (JT1 / SC1), DTIC should explore how upskilling the domestic workforce and building the local supply chain could support distributive justice in the South African OSW industry. This work should be informed by the government's long-term vision for OSW development and consider how to balance international and domestic supply to manage the cost of energy generation and its impact on consumers.
- **JT3.** Invest in education and training to build local capabilities and ensure a just transition. This is important for both grassroots skills development and labour transitioning from other industries, especially sunset industries such as coal mining and coal-fired power generation. This could include initiatives to:
    - Provide financial support for OSW training, research and development using the National Skills Fund (NSF) and National Research Foundation (NRF) grants.
    - Develop and support OSW-related upskilling and reskilling programmes for workers impacted by the energy transition.
    - Include OSW skills that do not already exist in the national workforce in the Critical Skills List and import skilled labour using a Critical Skills Work Visa for the early development years. A straightforward skills transfer programme should accompany this phase to ensure the industry's long-term sustainability and the creation of local jobs and opportunities.
- **JT4 / REG8 – LOW.** DEE, DFFE and other relevant government departments and agencies should work together to establish guidelines for developer-led stakeholder engagement aligned with consenting frameworks and JET principles, to reduce consenting bottlenecks, avoid ineffective engagement and secure a social license for development.

15. REGULATORY LEGAL AND PERMITTING FRAMEWORK

15.1. PURPOSE

South Africa has an established regulatory framework for renewable energy, but as a nascent industry, OSW development is not yet specifically accommodated. A supportive regulatory framework is a powerful enabler to give industry stakeholders confidence to enter the market. This confidence and certainty are key as OSW development requires high capital expenditures, long lead times, and long project lifecycles. Thus, establishing an effective, stable, and specific policy environment in South Africa to support OSW development is vital.

This chapter presents the overall regulatory context that could support the development of an OSW market in South Africa and assesses the applicability and readiness of existing regulatory frameworks in South Africa for OSW development.

It focuses on specific categories of policies and regulations relevant to OSW development, including targets and other renewable energy policies, marine spatial planning, site exclusivity, site investigation, grid connection and market access, and provisions relating to environmental impact assessment, consents, and permitting.

15.2. METHOD

The main aspects of regulation needed to support OSW development were identified through a literature review.[290] [291] [292] These regulatory categories are set out in Table 45: Overview of regulatory aspects:

TABLE 45: OVERVIEW OF REGULATORY ASPECTS.

Market development stage	Regulatory aspect	Description
Establishing market scale and visibility	Targets	Targets serve a dual purpose: first, they signal the government's long-term commitment to the industry, and second, they establish clear expectations regarding the amount of installed capacity over a given timeframe. They are instrumental in generating industry interest and investment while fostering market growth through transparent communication of long-term objectives and associated benchmarks.
	Policies	Policies and incentive mechanisms aim to address the sector's unique challenges and opportunities for growth and are essential for balancing economic, social, and environmental considerations.

Market development stage	Regulatory aspect	Description
Facilitating site development	Marine spatial planning	Marine spatial planning involves establishing OSW development zones and guiding developers to areas the government prioritises for development. These zones account for environmental and social constraints and other ocean users' needs.
	Site investigation	Site investigation relates to guidelines or policies regarding preliminary investigations of sites identified in marine spatial planning before developers gain exclusivity over the site through tendering. These investigations can be commissioned by the government or by project developers. Care should be taken to ensure that already planned projects are considered as part of this.
	Site exclusivity	Site exclusivity is typically granted through a lease or license from governmental bodies and authorities and provides developers exclusive rights to explore, assess, and potentially develop specific offshore areas.
	Consenting and permitting process, including Environmental Impact Assessments.	Environmental Impact Assessment regulations are intended to establish a structured process for developers to evaluate a project's environmental impact, propose mitigation measures, and provide essential information for decision-making and regulatory approval. Consenting and permitting frameworks ensure that OSW projects are planned, constructed, and operated in compliance with established standards and guidelines throughout their lifecycle, covering critical timeframes from pre-development to operation. These processes are designed to ensure compliance across legal, environmental, and regulatory requirements at every project stage.
Ensuring grid integration	Grid connection and energy system integration	This involves establishing a regulatory framework that enables developers to connect wind farms to the grid and sell electricity generated to the market. The regulations are also intended to ensure efficient power transmission to areas of demand while minimising the risk of uncompensated curtailment for developers.
Facilitating market access[34]	Offtake support mechanisms and incentives	This involves implementing mechanisms to facilitate market access through negotiating power purchase agreements (PPAs) with utilities or other buyers.

Desktop research was undertaken to identify South African regulations relevant to the above elements. Information from government websites, primary legislation, and grey literature, including articles from law firms in South Africa [293] [294] [295] were assessed to identify any regulations relevant to the OSW sector.

For each regulatory aspect, we identified relevant regulations or documentation in South Africa, described their relevance to OSW development, and assessed their 'readiness' compared to similar regulations in existing OSW markets. We also noted the history and status of each piece of regulation (e.g. whether it is in draft format or has been promulgated into law).

There was little to no provincial or municipal legislation relating to offshore development. Furthermore, several regulations identified in this review are in draft format and have not been enacted as part of the country's overall legal framework as of the time this chapter was written.

34 This aspect is discussed in Chapter 16: Procurement and commissioning options.

15.3. RESULTS AND DISCUSSION

To establish and support an OSW market in South Africa, market scale and visibility, a clear site development process, and a method for grid integration will be needed.

Although South Africa lacks specific policies or regulations tailored for OSW, its existing regulatory framework for renewable energy provides a foundation that could be adapted to accommodate OSW development. For example, South Africa's framework for environmental authorisations, which would inform OSW consenting and permitting regimes, is well developed, and existing environmental impact assessment regulations are robust.

Several national government departments consider a range of policies applicable to OSW development, which have or may have direct or indirect roles and responsibilities in the authorisation or governance of OSW. Some national government departments may not have direct or indirect responsibility or authority but may be an interested and affected party. These Department's include:

- Department of Electricity and Energy (formerly the Department of Mineral Resources and Energy),
- Ministry for Electricity in the Presidency (now defunct and absorbed into the new Department of Electricity and Energy),
- Department of Forestry, Fisheries and the Environment (DFFE),
- Department of Trade, Industry and Competition (DTIC),
- Department of Science and Innovation (DSI)
- Department of Transport (DoT) (The National Ports Authority)
- Department of Defence (DoD) (Interested and Affected Party)

This section outlines the current regulation in South Africa and discusses the need for additions and alterations.

FIGURE 82. REPRESENTING GENERALISED REGULATORY FRAMEWORKS REQUIRED TO FACILITATE THE INITIAL STAGES OF OSW PROJECT DEVELOPMENT (SITE IDENTIFICATION TO CONSTRUCTION).

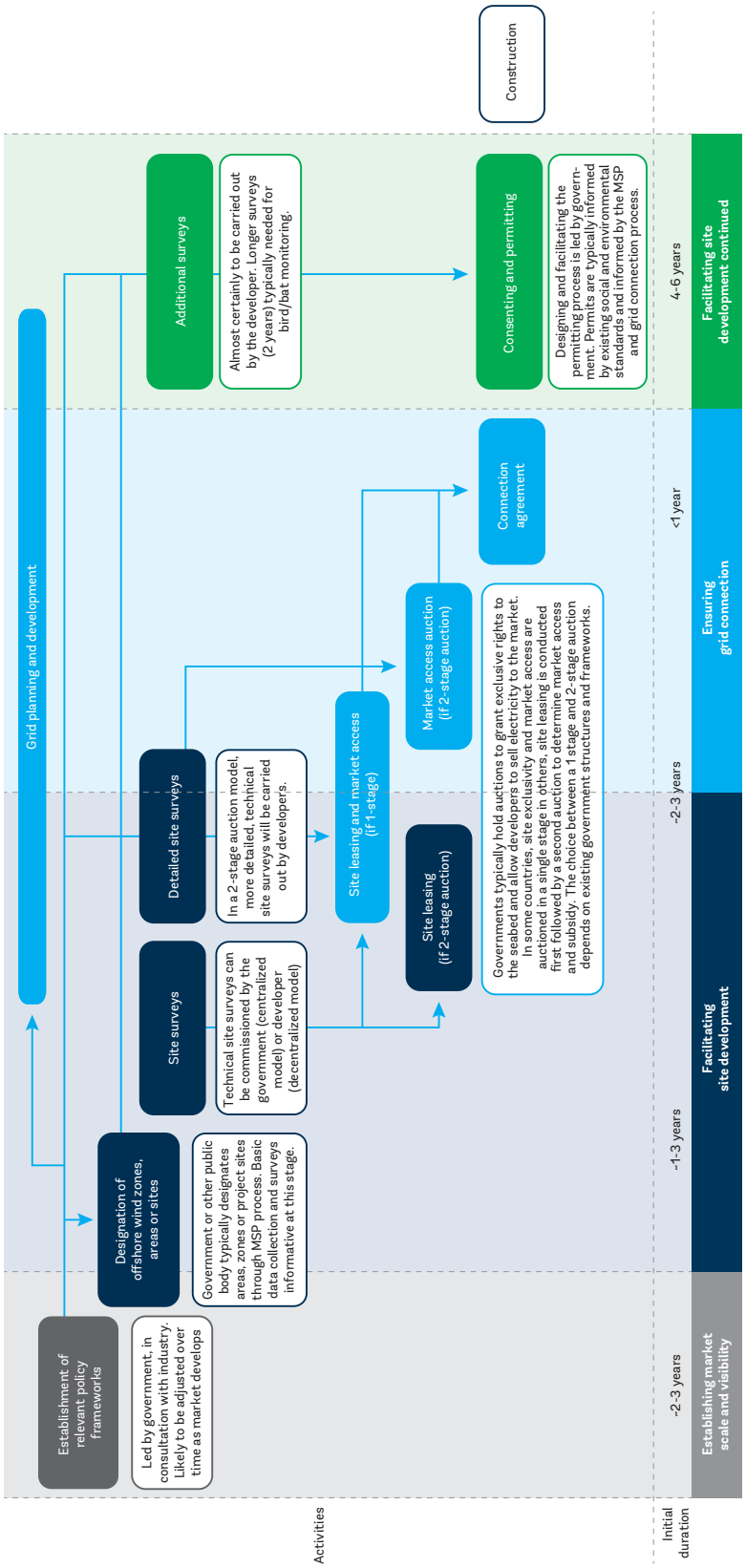


Table 46 provides an overview of the status of various regulatory aspects in South Africa, indicating whether an aspect is not present or lacking (red), is present but needs to be updated to be more tailored to OSW (amber), or is largely appropriate and may only require minor changes (green).

TABLE 46: OVERVIEW OF REGULATORY ASPECTS NEEDED FOR OSW, THE STATUS IN SOUTH AFRICA.

Market development stage	Regulatory aspect	RAG Rating
Establishing market scale and visibility	Targets	Red
	Policies	Red
Facilitating site development	Marine spatial planning	Amber
	Site investigation	Amber
	Site exclusivity	Red
	Environmental Impact Assessment process and requirements, consenting and permitting.	Green
Ensuring grid integration	Grid connection and market access	Amber

RAG rating key:

R: Regulatory aspect not present/lacking.

A: The regulatory aspect is present, but it needs to be updated to be more tailored to OSW.

G: Regulatory aspect appropriate for OSW; minor changes required

15.3.1. Establishing market scale and visibility

15.3.1.1. Targets and other renewable energy policies

South Africa's policy framework relating to OSW is limited. There is little to no specific mention in South Africa regarding targets or policies that directly address OSW. However, current policies and targets apply to wind generation in general, which can be extended and interpreted to include OSW.

South Africa has enacted a raft of policies and targets related to renewable energy generation. These include the IRP, the IEP, as required by the Electricity Regulation Act (as amended), the South African Renewable Energy Master Plan (SAREM), and the Just Energy Transition — Implementation Plan (2023–2027).[296]

The draft IRP 2023 makes no specific reference to OSW. However, it recognises that a further 3,000 MW of wind is required annually as part of a mix of generation options to end load shedding in the short-term and ensure energy security in the long-term. This 3,000 MW/annum excludes wind projects already under construction. Previously, the IRP 2019 recognised the need for additional wind generation capacity of approximately 1,600 MW per year between 2022 and 2030.

The SAREM is the foundational policy document for RE sector development in South Africa. The plan includes various implementation components to stimulate sector development, which cover market identification, barriers, SMME development, and market integration. SAREM does not explicitly identify OSW; however, the plan aims to support the overall development of renewable energy in South Africa.

The JET-IP also does not explicitly include provisions or targets for OSW. Instead, it has calculated that, for the country to meet its NDC and long-term decarbonisation targets, South Africa will need to add around 6 GW of new renewable energy capacity to its general electricity mix annually between 2023 and 2027. The period covered by this plan is too soon to incorporate OSW, given the development period of these projects. However, the quantum of new RE generation included in this plan indicates the pace and scale of RE deployment required to ensure electricity security. This trend leans favourably towards generation at a significant scale. Given the size of OSW farms, this technology could play a critical role in achieving the country's decarbonisation targets while ensuring the security of supply.

For OSW to be developed in South Africa, clear policy signals for developers are required. This should be achieved by recognising OSW as a distinct form of renewable energy generation and providing guidance on how OSW development will be supported in the country.

Setting a specific OSW deployment target will catalyse OSW development in South Africa. Explicit inclusion of targets for OSW in the IRP update for the post-2030 (Horizon 2) scenario will support OSW development at the scale required for long-term energy reliability and security.

Further, should further analysis indicate that OSW coupled with solar PV is cost competitive, OSW could potentially provide an attractive opportunity for developing green (renewable) hydrogen. Accordingly, it would be beneficial if the DTIC included provisions for OSW in the green hydrogen strategy and sector development plans.

International experience [297] from countries such as the United Kingdom and Poland demonstrates that regulated targets can give tangible impetus to market development by attracting the attention of international developers, increasing investor confidence in government buy-in for OSW, and encouraging local industry to develop OSW strategies. Consistently, those markets that have clear and ambitious targets are those with higher deployment rates.[298]

A deployment target should seek to balance ambition with realism. International experience demonstrates that more ambitious targets can have a more significant catalytic effect on OSW deployment. However, unrealistic targets, in their total deployment capacity or timeline, may draw criticism from the industry. For South Africa, incorporating an ambitious but realistic target to attract international attention will likely be the most beneficial.

For an OSW deployment target to be a catalyst in market development, it must be accompanied by a clear and straightforward development process or plan for its implementation. This clarity is of the utmost importance to developers and investors. While a deployment target can attract international interest, combining a clear target and a well-defined plan for other necessary aspects of OSW development will have the most impact. Therefore, target-setting without a clear development plan should be avoided to prevent stagnation.

15.3.1.2. Development models

There is currently no specified OSW development model for South Africa, and it is unclear how much direct involvement the government would like to have in this process. A centralised development model typically has more activities directed and undertaken by a government department or agency. A decentralised model sees most activities as sitting with the project developer. Further work will need to be conducted to understand the details of the development models that are appropriate and preferred for South Africa. Both models have benefits and risks that are best addressed by adopting or designing an approach that best supports the market. Whichever model is selected, the actors must move decisively. Otherwise, more harm may be caused by unintentional stalling than through no action at all. It is worth noting that the development model can change over time, and with sufficient industry notice and engagement, updating this should not be an issue and could be seen as a positive move. The developmental model chosen also depends on the development scenario selected. For example, a zonal approach with long-term deliverables and high capacities allocated to developer entities would benefit the medium or high-growth scenario. In contrast, a project-by-project approach would likely be better in the low-growth scenario.

15.3.2. Facilitating site development

15.3.2.1. Marine Spatial Planning (MSP)

MSP is governed by several pieces of legislation in South Africa, including the Marine Spatial Planning Act (16 of 2018) [299] and the relevant Specific Environmental Management Acts (SEMAs), including the National Environmental Management: Protected Areas Act (57 of 2003) (NEM: PAA) and the National Environmental Management: Integrated Coastal Management Act (24 of 2008) (NEM: ICMA). [300] MSP is undertaken primarily by DFFE as the lead authority.[301] The Department also chairs the National Working Group on MSP, which includes representatives from other Government Departments, such as Defence, Mineral Resources and Energy, Planning, Monitoring and Evaluation, Science, Technology and Innovation, Tourism, Public Enterprises etc. As the lead authority for MSP, the DFFE is responsible for planning, publishing, and adopting marine spatial plans.[302]

Section 6 of the MSP Act (16 of 2018) recognises the need to develop marine area plans, which, when completed, will help realise the development of a National Marine Spatial Plan. Four Marine Area Plans are being developed: the Eastern Marine Area Plan, the Southern Marine Area Plan, the Western Marine Area Plan, and the Prince Edward Island Marine Area Plan. These Marine Area Plans collectively cover the entire Exclusive Economic Zone of South Africa. The MSP Act also recognises the need to develop Marine Sector Plans to identify developmental objectives of the ocean economy's individual socio-economic, environmental, and cultural sectors. These sector plans inform each Marine Area Plan, which in turn inform the development of a national, multisectoral, Marine Spatial Plan.

The 2018 Act does not explicitly mention how planning should be carried out to designate OSW development areas. Before the promulgation of the MSP Act, the Marine Spatial Planning Framework (2017) (MSPF) was developed by the then Department of Environmental Affairs, [303] which has informed the development of subsequent legislation, such as the MSP Act. The MSPF recognises that EEZ may be used for OSW generation in the future and has identified that additional information-gathering relating to offshore renewable energy generation, among other sectors, must occur.

Although South Africa has a solid legislative foundation underpinning marine spatial planning, only Marine Sector Plans have been developed (10 exist as of 2024). Marine Sector Plans give support to the development of Marine Area Plans, which in turn support the Marine Spatial Planning process. [304] The development of the four Marine Area Plans, as well as the development of the National Marine Spatial Plan, is currently ongoing. The National Coastal and Marine Spatial Biodiversity Plan (NCMSBP), launched in 2020, is one example of a Marine Sector Plan. The NCMSBP sets out priority biodiversity areas that require focused management measures over the coming two decades. The spatial analysis considered biodiversity features and a cost layer, which considered 19 existing marine sectors and activities (e.g. marine tourism, heritage, fishing, aquaculture). However, OSW was not considered in this exercise. As the national, multi-sector MSP is still under development, the South African government could consider carrying out a marine spatial planning exercise focused solely on identifying potential OSW development areas, similar to the work that was carried out to develop the NCMSBP, using the approach set out in this study as a basis.

For this to occur, the South African government should identify which department(s) are responsible for identifying OSW development areas and how any marine spatial planning outputs will be formalised and communicated to the industry and other marine stakeholders. Once OSW development areas have been identified, these results should be integrated into existing plans, like the NCMSBP, and other ongoing planning processes. OSW development areas should also be incorporated into the broader development model (e.g. whether sites within larger zones will be leased and when).

15.3.2.2. Site exclusivity and site leasing

Site exclusivity regulations for OSW have not been enacted, and this aspect of OSW development may be more reliant on initial guidance on prescripts relating to other offshore developments, such as permitting achieved through the Minerals and Petroleum Resources Development Act (Act 28 of 2002) (MPRDA) [305] for offshore gas facilities, or through permitting achieved through the National Environmental Management Act (107 of 1998) (NEMA) [306] and the various SEMAs. Although precedents and equivalent frameworks are in place, there is a lack of legislation and regulation allowing OSW site leasing and exclusivity. Updated regulations will need to recognise OSW specifically, as the rights and requirements for development are unique and must include the right to collect data, undertake site surveys, construct the wind farm, and export power.

Currently, site exclusivity is technically achievable through the MPRDA, NEMA and its SEMAs; however, these provisions are not entirely suitable for OSW development. In many markets, site exclusivity is determined through an auction of broader development zones or specific project sites, informed by marine spatial planning outputs. Many governments choose to make particular areas of seabed available through multiple leasing rounds over several years, or by leasing larger zones from which multiple projects can be developed, to create a healthy pipeline of projects. The design of the site leasing process will be heavily informed by the development framework defined and, therefore, should be developed once this is in place. The government should outline the process by which site exclusivity is determined and communicate clear guidance to developers on this matter. The proposed regulatory frameworks, crucial for the significant and strategic deployment of OSW over time, will ensure a thorough and fair process.

15.3.2.3. Site investigation

Similarly, there are no specific regulations for site investigation for OSW development. However, there may again be other existing laws that could be adapted for OSW development, demonstrating the plan's feasibility. For example, the MPRDA contains provisions relating to offshore reconnaissance for offshore gas and oil drilling. Alternatively, site investigation may be enabled by authorisations provided through NEMA and applicable SEMAs.

Depending on the development model adopted, the government, a delegated agency or developers may conduct or commission some or all site investigations. Multiple rounds of site surveys are required for OSW developments. These include:

- Archaeological studies
- Surveys for unexploded ordnance (UXO)
- Geological, geotechnical, and geophysical studies
- Seabed morphology studies
- Metocean campaigns and wind resource assessment
- Environmental surveys

The early stages of OSW development in South Africa are paramount, and the chosen development model can significantly advance this process. For example, the relevant government department or agency will undertake more studies in a more centralised model. In a decentralised model, the developer would only perform these detailed studies after being awarded exclusivity to the site. In the case of South Africa, it is recommended that some initial surveys are commissioned centrally (i.e. targeted LiDAR campaigns) in the first instance to derisk early-stage development in South Africa. The department or agency responsible for the early site surveys should spend time and effort upfront in designing these well and appropriately for the market, engaging with developers and technical advisors to define the minimum requirements. As these surveys are often costly, they should not be over-specified, but should include all the required information.

Prospective developers will ultimately require various additional *in situ* site surveys (e.g. metocean, geophysical, geotechnical, etc.) to understand the broad attractiveness of a potential site and to complete an EIA. The responsibility for commissioning these could sit with the relevant government department or agency, which could also be responsible for holding and sharing the collected data, where appropriate, or it could sit with developers, depending on the development model the South African government adopts. These upfront surveys are costly and risky (as there is no guarantee that a wind farm will be built on that site). Therefore, careful consideration needs to be made about how to fund them and what is done with the data that has already been collected. The funding could come from various sources, for example, retrospectively from the site lease fee, centrally financed or paid for and managed by developers themselves.

15.3.2.4. Environmental Impact Assessment (EIA) process and requirements

Environmental Impact Assessment regulations are promulgated in terms of NEMA and have a specific bearing on various aspects of OSW developments. South Africa's EIA regulations contain listed activities that may require a full or basic environmental impact assessment, depending on the activity's magnitude and potential ecological impact. Several activities which may be undertaken in the development of OSW infrastructure are likely to trigger the need for a full EIA, as included in the NEMA Impact Assessment Listing Notices [307] and include (but are not limited to) the following:

- The development of facilities or infrastructure for the generation of electricity from a renewable resource
- The development of facilities or infrastructure for the transmission and distribution of electricity
- The expansion of facilities or structures for the generation of electricity from a renewable resource

Additionally, OSW development typically requires assessments of the following:

- Physical processes and water quality
- Benthic ecology
- Fish and shellfish ecology
- Marine mammal ecology
- Ornithology
- Socio-economic impacts, such as effects on commercial fisheries, shipping, navigation, recreation, tourism, and military sectors
- Archaeology and cultural heritage
- Visual impacts

As part of the EIA process, specialist studies will need to be undertaken. South Africa's legislation currently requires specialist studies to be conducted under the following themes [308]:

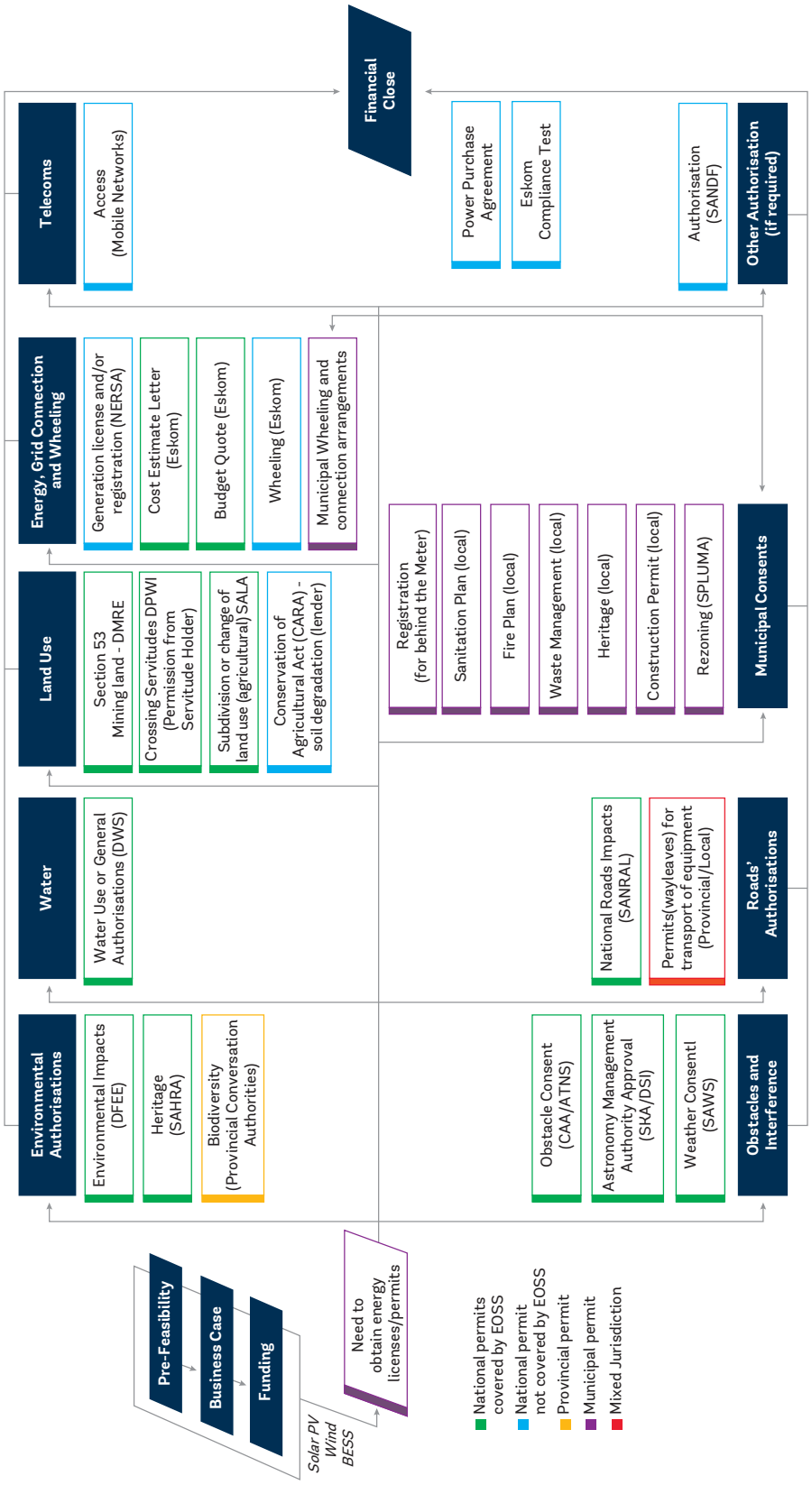
- Agriculture
- Avifauna
- Biodiversity
- Noise
- Defence
- Civil Aviation

Biodiversity Assessments include those relating to aquatic biodiversity. South Africa's existing regulations cover studying impacts typically considered in OSW impact assessments globally.

15.3.2.5. Consent and permitting

A range of permits are required for OSW development, overlapping with other regulatory categories included in the review. For instance, site investigation may require a reconnaissance permit under the MPRDA, OSW installations with a capacity of over 100 MW will need a licence under the ERA, and the development and operation of OSW installations will require an environmental authorisation under the NEMA EIA regulations. Figure 83 sourced from the invest SA Energy One Stop Shop [309] outlines the process for obtaining licences and permits required for Independent Power Producers. While this relates to land-based IPP projects, and thus several land-based permits might not be required for offshore (such as certain land-use permits), the overall process of licencing and permitting will apply to OSW. It is recommended that a similar licensing and permits strategy be developed for OSW.

FIGURE 83: OVERVIEW OF PERMITS AND LICENCES REQUIRED FOR INDEPENDENT POWER PRODUCERS.



It is crucial to review and ensure that permitting and consenting processes are streamlined. Currently, the duration of consenting and permitting processes poses a significant bottleneck for OSW development globally.[310] Moreover, specific infrastructure requirements, such as the height of turbines and the installation of floating substations, may necessitate updates to existing frameworks. For instance, OSW turbines could interfere with bird migration corridors, while installing floating substations may impact benthic species due to moorings and anchors. Therefore, ensuring that consenting and permitting requirements are updated by the relevant national department and tailored to the unique characteristics of OSW is essential for sustainable development. In some cases, this may require the development of or amendments to policies, legislation, and regulations, and it would be subject to consultation, public participation, and parliamentary oversight. Regulatory changes have been known to take up to 2 years. Accordingly, the relevant national department should undertake a more detailed review of the applicable policy, legislation and regulations identified here as soon as possible to allow for timely amendments where necessary, thereby avoiding delays and ensuring the smooth progress of OSW projects.

15.3.3. Grid integration and market access

Grid Connection is primarily governed by the Grid Connection Code for Renewable Power Plants (RPPs) Connected to the Electricity Transmission System (TS) or the Distribution System (DS) in South Africa.[311] Market access is partially covered by the Energy Regulation Act (4 of 2006) and its various amendments. The process of connecting an IPP to the grid is made up of several phases, including:

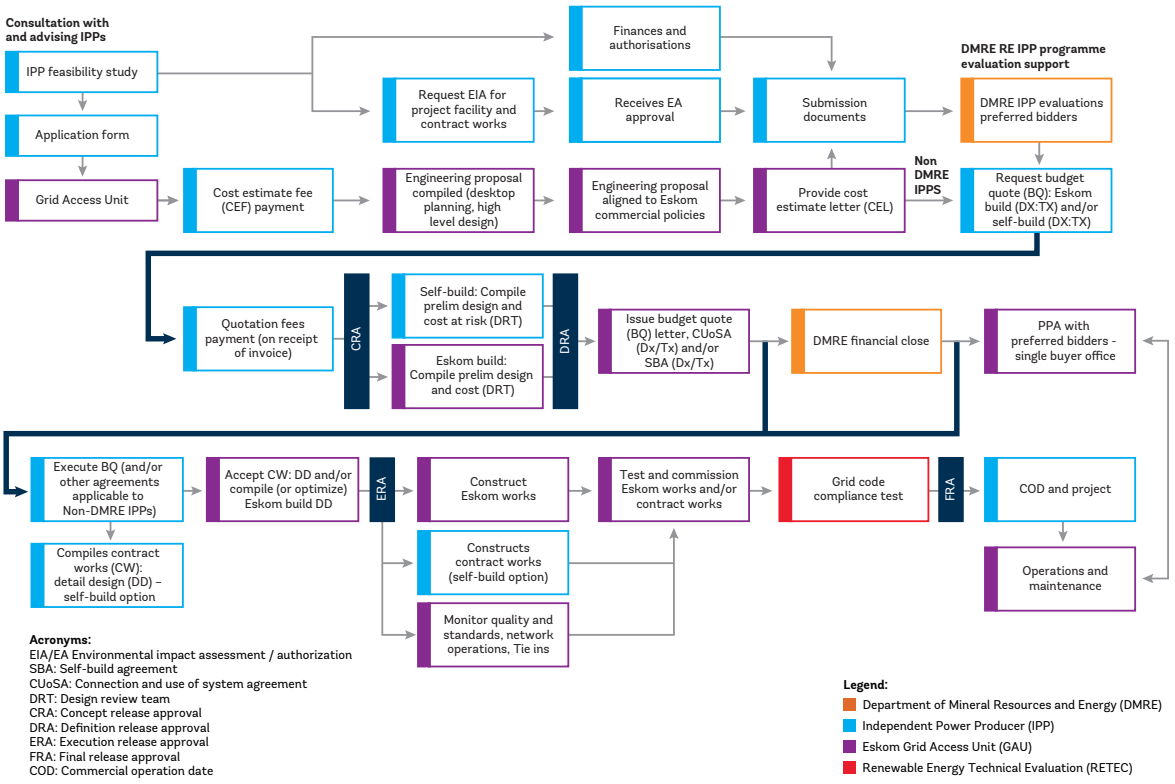
- **Application and consultation phase:** This process begins with completing an application form submitted to the Eskom Grid Access Unit in a respective region. This application must include reasonable assurance and evidence of the right to develop a facility on a proposed site, which requires a completed Environmental Impact Assessment and consent from the landowner in the case of land-based RE facilities. The region's respective IPP executive then captures the application, and the developer is provided with an application reference number. The application is then reviewed, and the IPP developer is contacted for additional information. Upon successful review, a cost estimate letter fee invoice will be provided to the developer for their acceptance.
- **Quotation and contracting phase:** The invoice for the cost estimate letter is then paid to Eskom by the IPP developer. Once this is done, the cost estimate letter is provided to the developer. The developer then evaluates the cost estimates and either accepts or declines the cost estimate letter. If accepted, the developer will complete a budget quotation request letter, which will then be provided to Eskom. This phase then continues developing a design concept, where a scope clarification meeting occurs and all applicable agreements are completed. Eskom then generates a budget quote fee invoice, which the IPP developer pays. The budget quotation and applicable agreements are then issued to the developer for payment. Once paid, the IPP is issued with a payment connection fee invoice. Upon payment and confirmation that all budget quotation conditions are met, the IPP developer signs and issues a Schedule 11 letter confirming that all budget quotation conditions have been per the PPA. The Schedule 11 letter is then ratified. Following this, a meeting will be arranged between the IPP developer, Eskom, and associated stakeholders to develop project milestone schedules.

- **Connection Phase**: Within the connection phase, primary plant connection works, including site establishment, electrical, civil, and steel works, and other aspects, such as metering, telecoms and control, and protection, are developed. The connection phase also includes testing and commissioning the plant and ensuring compliance with relevant codes, standards, and technical specifications. Within the connection phase, the Grid Access Unit office tracks milestone schedules and coordinates grid integration activities between the IPP and Eskom.

Upon completion of construction activities, the project is ready to be connected to the grid. A grid connection date has been established and testing and synchronisation have commenced. Once testing and synchronisation are successfully completed, the project will enter commercial operation.

Clarification of how the grid connection process will apply to OSW, as well as any required grid upgrades should be developed. Given the extended lead times associated with OSW grid connections, consideration should be given to enabling the application process to commence earlier in the development phase, ahead of the completion of the EIA. For example, once site exclusivity has been secured and the EIA scoping process has been completed. Building a grid to support the deployment of OSW is discussed in more detail in Chapter 9: Grid and transmission system.

FIGURE 84: ESKOM HIGH-LEVEL RE GRID INTEGRATION PROCESS.



15.4. RECOMMENDATIONS

The need for a comprehensive specification of renewable energy is identified in each category below.

- **REG1.** The department responsible for energy and electricity planning (DEE) must set the long-term vision and objectives for OSW development to 2050 by establishing OSW targets in the IEP and IRP and identifying the deployment trajectory needed to achieve these. This process should be done in a just manner by being transparent and inclusive of key stakeholders to signal the government's commitment to the sector.
- **REG2.** Key government departments, like DEE and DFFE, should determine and designate clear roles and responsibilities for facilitating site development (designating OSW development areas through MSP, site exclusivity, and leasing).
- **REG3.** Once the responsibility (REG2) has been designated, the relevant government department(s) should establish or update the regulations and frameworks for site investigation, granting site exclusivity, leasing the seabed, etc., aligning these processes with existing consents, permits, and licences while tailoring them to meet international standards and the overall development model. These should be aligned to international best practice and incorporated into the Energy One Stop Shop (EOSS) mandate to expedite and streamline the OSW regulatory process.
- **REG4**. In parallel to progressing the actions set out in REG3, the responsible government departments (defined in REG2) should lead the process of determining and implementing the most suitable development model for South Africa's OSW market. Given the evolving nature of market dynamics and the various factors that influence the choice of model, this decision must be made with flexibility in mind, allowing for adjustments over time.
- **REG5**. DEE, DFFE and other relevant government departments and agencies should revise existing marine spatial planning frameworks to allow for the designation of OSW development areas, and the relevant department (REG2) should formally designate suitable areas based on the best available evidence and potential impacts, aligning with the wider development model (REG4) and regulatory framework (REG3).
- **REG6.** DFFE should conduct a detailed gap analysis of current EIA processes in South Africa compared to international standard procedures for OSW development and establish a process to address gaps. Further research should also identify any additional South African-specific EIA needs not covered by global best practices.
- **REG7 – LOW.** The government should fine-tune REG2-5 such that they support a total of 5 GW over time, revisiting any frameworks regularly, and at least by 2035, after initial projects have been developed.
- **REG8 / JT4 – LOW.** DEE, DFFE and other relevant government departments and agencies should work together to establish guidelines for developer-led stakeholder engagement aligned with consenting frameworks and JET principles, to reduce consenting bottlenecks, avoid ineffective engagement and improve social license for development.

- **REG9 – MED-HIGH.** The government should revisit and refresh targets, development approaches and related OSW policies regularly to ensure they are fit-for-purpose with respect to national progress and global developments.
- **REG10 – MED-HIGH.** The government should refresh the aforementioned regulatory frameworks to support 15 GW (medium growth) or 40 GW (high growth) by 2050, communicating changes and developments to the industry with significant advance notice.
- **REG11 – MED-HIGH.** Proactive community engagement and consideration of other community benefits arising from OSW development should be extended to ensure that economic injustices are not exacerbated. For example, consideration of community enterprise development and socio-economic development projects.

16. PROCUREMENT AND COMMISSIONING OPTIONS

16.1. PURPOSE

South Africa has government-led renewable energy procurement mechanisms through purchase power agreements (PPAs and REIPPPP) and feed-in tariffs (FiT). The applicability of South Africa's existing mechanisms to OSW must consider the high upfront CapEx and financing costs associated with OSW development. A clear revenue mechanism and understanding of the expected revenue before project development starts is critical to unlocking the industry interest and investment required at that early development stage.

This chapter will provide a high-level overview of the necessary procurement strategies/routes to market, considering renewable energy procurement options in South Africa. The aim is to recommend the most suitable procurement strategy for OSW tailored to the South African context.

16.2. METHOD

This chapter identifies and describes global procurement options used to procure OSW electricity, alongside an overview of mechanisms employed in South Africa. Each option undergoes evaluation against the South African context, outlining current mechanisms in place in South Africa and discussing the most suitable procurement strategy tailored for the South African context.

16.3. RESULTS AND DISCUSSION

16.3.1. Global Procurement Options

Various offtake mechanisms have been implemented in OSW markets. Concise overviews of the primary mechanisms are provided below:

16.3.1.1. Contracts for Difference (CfD)

CfD is a popular mechanism in countries with mature electricity markets. CfD requires that the government guarantees a fixed "strike price"[35] for electricity generated. If the market price is lower than the strike price, the government pays the difference to the generator. This mechanism helps stabilise wind developers' revenue and encourages investment in renewable energy.

35 A strike price, in the context of Contracts for Difference (CfD) for offshore wind projects, refers to the pre-agreed price per unit of electricity that the generator will receive for the energy it produces. This price is set by the government or regulatory body as part of the CfD auction or negotiation process. If the market price of electricity falls below the strike price during the contract period, the government pays the generator the difference to ensure revenue stability and encourage investment in renewable energy.

16.3.1.2. Power Purchase Agreements (PPAs)

PPAs are direct contracts between electricity producers (such as OSW developers) and buyers (often utilities or large corporations). These agreements stipulate a fixed price for electricity over a long-term period, typically 10-20 years. PPAs provide revenue certainty for developers and allow buyers to secure renewable energy at predictable prices.

16.3.1.3. Merchant projects

Merchant projects operate without long-term price guarantees. These projects sell electricity directly into the wholesale electricity market, exposing developers to market price fluctuations. Developers must manage price risks but can potentially benefit from higher market prices during periods of high demand.

16.3.1.4. Feed-in Tariffs (FiT)

FiTs involve government-mandated payments to renewable energy producers for each unit of electricity generated. The tariff rates are typically set above market rates to incentivise investment in renewable energy. FiTs provide stable and predictable minimum revenue for developers, although this will fluctuate with energy prices.

16.3.2. Renewable energy procurement options used in South Africa

In South Africa, PPAs and FiTs have been employed as procurement options. How these mechanisms have been used and examples of how projects have been financed are provided below.

16.3.2.1. Power purchase agreements

Government auctions through the Renewable Energy Independent Power Producer Procurement (REIPPP) Programme

The REIPPP programme was previously the primary procurement mechanism for large-scale renewable energy projects in South Africa. It operates through competitive bidding rounds where developers submit proposals to supply electricity to the national grid. Projects are selected based on factors such as price competitiveness and technical and economic feasibility. Successful projects enter into long-term PPAs with the National System Operator. Since REIPPP was introduced in 2011, 11,904 MW of renewable energy has been procured, and 6,106 MW has come online into South Africa's grid.[312] The average tariff and capacity of renewable energy procured across REIPPPP bid windows 1-5 per generation technology is provided in Table 47: Average tariff and capacity of renewable energy procured across REIPPPP bid windows 1-5 per generation technology.

TABLE 47: AVERAGE TARIFF AND CAPACITY OF RENEWABLE ENERGY PROCURED ACROSS REIPPPP BID WINDOWS 1-5 PER GENERATION TECHNOLOGY.[313]

Generation technology	Average tariff and capacity procured (MW)	Bid Window 1 (2011)	Bid Window 2 (2012)	Bid Window 3 (2013/14)	Bid Window 4 (2014/15)	Bid Window 5 (2021)
Wind	Average tariff (R/kWh)	1.51	1.19	0.87	0.75	0.49
	Average tariff (USD c/kWh) [314]	0.14 (R 8/$)	0.11 (R 7.94/$)	0.8 (R 9.86/$)	0.6 (R 12.5/$)	n/a
	Capacity procured	649	559	787	1,363	1,608
Solar PV	Average tariff	3.65	2.18	1.17	0.91	0.43
	Average tariff (USD c/kWh)	0.35 (R 8/$)	0.21 (R 7.94/$)	0.10 (R 9.86/$)	0.7 (R 12.5/$)	n/a
	Capacity procured	627	417	435	813	975
Concentrated Solar Power	Average tariff	3.55	3.32	1.93	n/a	n/a
	Average tariff (USD c/kWh)	0.34 (R 8/$)	0.32 (R 7.94/$)	0.16 (R 9.86/$)	n/a	n/a
	Capacity procured	150	50	200	n/a	n/a
Landfill gas	Average tariff	n/a	n/a	1.11	n/a	n/a
	Average tariff (USD c/kWh)	n/a	n/a	0.10 (R 9.86/$)	n/a	n/a
	Capacity procured	n/a	n/a	13	n/a	n/a
Small hydro	Average tariff	n/a	1.36	n/a	1.24	n/a
	Average tariff (USD c/kWh)	n/a	0.13 (R 7.94/$)	n/a	0.9 (R 12.5/$)	n/a
	Capacity procured	n/a	14	n/a	5	n/a
Biomass	Average tariff	n/a	n/a	1.65	1.61	n/a
	Average tariff (USD c/kWh)	n/a	n/a	0.14 (R 9.86/$)	0.12 (R 12.5/$)	n/a
	Capacity procured	n/a	n/a	17	25	n/a

Financing projects under REIPPPP

Developers and sponsors typically establish non-recourse SPVs to hold debt and equity investments for each project. Projects usually receive 75% debt and 25% equity funding. Commercial banks such as Nedbank, Standard Bank, ABSA, Investec, and others offer a variety of debt facilities structured around senior debt, subordinated debt, and financing tailored to specific project requirements. Multilateral and DFIs such as the African Development Bank (AfDB), Development Bank of Southern Africa (DBSA), International Finance Corporation (IFC), and others have also played essential roles in providing senior debt financing, often at concessional terms to reduce risks and attract private sector participation.[315]

International companies such as Scatec Solar, SolarReserve, Enel Green Power, Phelan Energy Group, and Abengoa Solar are major investors in South African solar projects. Furthermore, local asset managers such as Old Mutual and Stanlib manage funds with equity stakes in SPVs. Government agencies such as the Public Investment Corporation (PIC) have also taken part, using state-owned funds to support renewable energy projects.[316]

The following is an example of how a REIPPPP-awarded project was financed:

Koruson 1 cluster (Wind Energy)

The Koruson 1 cluster, awarded in Bid Window 5 of REIPPPP, is located outside Middelburg on the border of the Eastern and Northern Cape provinces and consists of three wind farms with a combined capacity of 420 MW. The project secured a 20-year PPA to supply electricity to the national grid and is expected to be commissioned in late 2024.

The total capital investment for the project amounts to around ZAR 11 billion. It is funded through a bank club comprising three commercial lenders and a debt fund: Standard Bank, Absa Bank, Investec, and Momentum Metropolitan. The lenders provided two senior debt facilities: CPI-linked debt and JIBAR-linked debt, a subordinated quasi-equity facility, a Debt Service Reserve Facility (DSRF), and a VAT facility.[317]

16.3.2.2. Bilateral Power Purchase Agreements (PPAs)

The private sector in South Africa increasingly uses bilateral PPAs as a procurement option. These agreements involve direct contracts between renewable energy developers and corporate entities (such as large businesses or industrial consumers). Corporates commit to purchasing electricity directly from renewable energy projects at agreed prices over a long-term period, typically 10-20 years (for solar PV and onshore wind, the prices in PPAs are competitive or lower than the cost of electricity from the grid). Corporate PPAs provide developers with revenue certainty and help corporates meet their sustainability goals by sourcing renewable energy directly. Renewable energy projects can either be co-located to the off-taker, or the electricity produced can be wheeled across the national or municipal grid (where the municipality allows wheeling).

PPAs can also be signed with energy traders, entities that manage portfolios of renewable energy generators and serve as intermediaries between electricity producers and consumers. Energy traders aggregate generators and optimise electricity supply and demand dynamics by selling to multiple users.

Below is an example of how a project was financed using a bilateral PPA:

SOLA Group and African Rainbow Energy 200 MW solar PV project for Tronox Mineral Sands

After the legislative landmark in August 2021, which raised the licensing limit for energy projects in South Africa from 1 MW to 100 MW, SOLA Group and African Rainbow Energy achieved financial close on two 100 MW solar PV projects. These projects, totalling 200 MW, are set to supply renewable electricity under a Power Purchase Agreement (PPA) to Tronox Mineral Sands, marking one of Africa's largest corporate renewable energy PPAs. Financial close was achieved within six months of signing the PPAs in mid-March 2022.

The projects required capital investment totalling R4 billion for construction and development. R3.1 billion was secured from senior lenders, including major South African banks and the Development Bank of Southern Africa (DBSA).[318]

16.3.2.3. Feed-In Tariffs (FiTs)

FiTs were introduced in South Africa to incentivise early renewable energy development, but they were not considered a viable option due to the high cost of deployment. The focus has shifted to competitive auctions under the REIPPP programme. FiTs are recently more commonly considered for Small-Scale Embedded Generation, such as rooftop solar PV.

16.3.3. Applicability of procurement mechanisms to OSW development in South Africa

Increasing energy access, security, and affordability is integral to ensuring a just energy transition. Thus, OSW development must be executed using optimal procurement options to protect end-users. To this end, each of the procurement mechanisms and their applicability to OSW in the South African context is discussed and summarised in Table 48.

TABLE 48: OVERVIEW OF APPLICABILITY OF VARIOUS PROCUREMENT MECHANISMS TO SOUTH AFRICA AND OSW DEVELOPMENT.

Procurement mechanism	Applicability within the South African context and OSW development	
Contracts for Difference	Effective in competitive markets, contracts for Difference (CfDs) are not currently appropriate in South Africa due to the country's lack of a structured wholesale electricity market. However, Eskom's unbundling and ongoing efforts to develop a market code and move towards a competitive market may pave the way for its future viability.	It is not feasible with the current power market structure; however, if the market changes to have a liquid market price, CfDs should be considered.

Procurement mechanism	Applicability within the South African context and OSW development	
Power Purchase Agreements	Currently, it is the most widely used mechanism for procuring renewable energy in South Africa and would also be well-suited for OSW projects, especially given the revenue certainty that PPAs provide.	Viable to be used for OSW in South Africa.
Merchant projects	Merchant projects work in competitive markets but would not be appropriate in South Africa due to the lack of a structured wholesale electricity market. Even if the market is reformed to include a liquid market price, merchant projects are not recommended for OSW infrastructure projects in South Africa due to the high risk associated with this procurement type.	It is not viable in the current power market structure and carries a high risk in a competitive wholesale market.
Feed-in Tariffs	Historically, it was tried to be introduced in South Africa, but now it is only used for small-scale embedded generation.	Not recommended for large-scale utility procurement in South Africa

PPAs are currently the most viable mechanism for procuring OSW energy in South Africa due to their established use in renewable energy procurement and the fact that they do not require government subsidies.

CfDs are well-suited for competitive markets but are presently unsuitable for South Africa because the country lacks a structured wholesale electricity market. However, if the transition towards a competitive market happens, it should make CfDs viable in the future.

Merchant projects are not viable because the market structure lacks a liquid market price, and they are not recommended for the future due to the high risk associated with revenue certainty. FiTs were not successfully implemented in South Africa and are therefore not recommended to be reintroduced.

16.3.3.1. Procuring OSW through Power Purchase Agreements

Given that PPAs are the most common form of renewable energy procurement in South Africa, it is recommended to initially focus on private bilateral PPAs with large creditworthy industrial off-takers. Bilateral PPAs can be used to contract with major renewable electricity consumers, such as green hydrogen developers, and special industrial zones like the Atlantis Special Economic Zone, which includes a green manufacturing zone that requires a large and stable amount of clean energy. Such counterparties will also need to be sufficiently creditworthy and stable to provide the long-term stability of the contract necessary for commercial OSW generation. PPAs contracted through the national REIPPP programme can also enable support of large-scale projects. Therefore, it is recommended that the REIPPPP be expanded to include an OSW category based on targets defined in the IRP.

Following this procurement route, OSW would have to compete and be priced competitively with other renewables, such as onshore wind and solar PV. OSW has a higher LCOE (see Chapter 8: Levelised cost of energy) than solar PV and onshore wind. As a result, early-stage OSW projects will benefit greatly from measures that focus on closing the gap between the cost and the expected revenue from the wind farm. This could include philanthropic or development aid support, such as grants and concessional financing. Grants could be critical in lowering capital costs, especially given the maturity and associated risks of OSW development in its early stages. It may also be necessary to secure financing from DFIs willing to take on more risk (see Chapter 19: Bankability considerations).

Strategic deployment of grant and concessional funding to reduce capital costs and LCOE, combined with bilateral PPAs with industrial users, particularly near strategic ports such as Saldanha, Richards Bay, and Boegoebaai, can demonstrate commercial viability while fostering synergy with green hydrogen projects and promoting green industrial development.

16.3.3.2. Procuring OSW through using Contracts for Difference

CfDs are currently not viable because there is no liquid market price; however, if the market structure changes and a competitive wholesale electricity market is established, it would be a potential procurement option. CfDs require funding to cover the price difference between the strike price and the market price, and thus, extensive consultation is required before approving CfDs. However, this is balanced by the fact that the LCOE should be lowered by the introduction of CfDs as the higher revenue certainty afforded will remove risk and, therefore, cost from projects. OSW projects could still be procured through programmes such as REIPPPP, but CfD could be the mechanism to ensure revenue stability instead of entering into a PPA.

16.4. RECOMMENDATIONS

In the early stages of the OSW market in South Africa, procurement would be primarily via bilateral PPAs and potentially REIPPPP. As the market matures and frameworks develop, the REIPPPP framework should be updated to incorporate OSW, and CfDs or a similar revenue support mechanism should be explored to support growth.

The following recommendations are made to effectively procure OSW energy in both the early stages and as the market matures to ensure its development leads to just outcomes:

- **PRO1.** Industry bodies representing developers, off-takers, and the financial sector should collaborate to develop a framework that makes bilateral PPAs as attractive to developers as possible. This would include creating frameworks that ensure the counterparty is creditworthy and allow OSW to be competitive in price with onshore wind and solar. Concessional finance could support this aim.
- **PRO2.** The DEE should incorporate OSW bid rounds, aligned with the OSW targets that would have been included in the IRP (REG1), into the REIPPPP framework.
- **PRO3 - MED-HIGH.** To support the industry's continued growth, the government of South Africa should work with the industry to develop revenue support mechanisms that procure energy at the lowest possible price but also provide revenue certainty to developers, thereby lowering risk and cost. These could be CfD-type mechanisms or similar. A thorough review should determine, if required, the source of funding covering the price difference between strike prices and market prices required for CfDs.

17. HEALTH AND SAFETY

17.1. PURPOSE

With a maritime industry and operations legacy, South Africa has experience developing and maintaining health and safety protocols in an inherently hazardous marine environment. Globally, significant progress has been made in ensuring lessons learnt in established markets transfer into guidelines addressing the numerous health and safety aspects in the construction, operation and decommissioning of both bottom fixed and floating OSW farms. Health and safety protocols should be aligned to meet international best practice standards as the OSW market develops in South Africa.

This chapter provides a high-level overview of existing international guidelines and regulations applicable to health and safety while also considering the South African health and safety-related regulatory framework. This assessment culminates in recommendations for enhancing South African-specific health and safety regulations so that they are tailored to the OSW sector. This analysis does not consider technical design standards.

17.2. METHOD

Both international and local regulations have been assessed to judge the level of alignment that South Africa has with international best practice. Existing local and international guidance was identified through online desktop research. International sources consulted include the Global Offshore Wind Health and Safety Organisation (G+) [319], the Global Wind Organisation [320], Det Norske Veritas [321], the International Electrotechnical Commission [322], and the World Bank [323]. A gap analysis of the local guidance is presented, with recommendations on how gaps could be filled.

17.3. RESULTS AND DISCUSSION

17.3.1. International Health and safety best practice

The global OSW industry has an established and comprehensive range of health and safety-related guidance from organisations such as the:

- Global Wind Organisation,
- Global Offshore Health and Safety Organisation (G+) and
- World Bank.

Organisations such as the Global Offshore Wind Health and Safety Organisation (G+), the Global Wind Organisation and Det Norske Veritas have provided a range of health and safety guidelines that address numerous aspects of health and safety in the construction, operation and decommissioning of both bottom fixed and floating OSW farms. The GWO training standards consist of a range of courses that are developed to address safety, technical and operational aspects specific to wind turbine operations. These guidelines and trainings are based on lessons learnt from more developed OSW markets such as the UK and Europe, where 34 GW of OSW has been installed up until the end of 2023.[324]

The global floating OSW sector is still in its early stages of development, resulting in a limited number of floating-specific best practice and guidance documents. Examples of these include DNVGL-ST-0119, which pertains to Floating Wind Turbine Structures, the G+ Floating Offshore Wind Hazard Identification methodology, and the Floating Offshore Wind Safe By Design Workshop. Because the floating OSW sector is nascent, much of the guidance currently in use has been adapted from more established industries, such as fixed OSW, oil and gas, and the maritime sector, to meet the needs of floating OSW projects. A high-level overview of this international best practice guidance is outlined in Table 49. It should be noted that most of the international guidance has specifically been developed for the international OSW market.

TABLE 49: OVERVIEW OF OSW-RELATED HEALTH AND SAFETY INTERNATIONAL BEST PRACTICE.

Guidance document	Related activities and operations	Primary Related Hazards
Offshore Substations for Wind farms (DNVGL-ST-0145) [325]	Design, Construction	Electrical, Environmental, Operational
Support Structures for Wind Turbines (DNVGL-ST-0126) [326]	Design, Construction	Structural failure, Fire, Falling objects
Loads and Site Conditions for Wind Turbines (DNVGL-ST-0437) [327]	Design, Construction	Environmental
Floating Wind Turbine Structures (DNVGL-ST-0119) [328]	Design, Construction	Extreme weather, Mooring failure, Material fatigue, Corrosion, Fire
Standards for Offshore Helicopter Landing Areas (CAP 437) [329]	Construction, Operations, Maintenance	Turbulence, Wind, Smoke
Wind Turbines - Protective Measures - Requirements for Design, Operation and Maintenance (EN 50308) [330]	Design, Construction, Operation	Working at height, Electrical, Fire, Working at Sea
Construction Design and Management (CDM) Regulations [331]	Design, Construction	Working at height, Electrical, Fire, Lifting, Noise and vibration, Hazardous substances
RenewableUK H&S Publications [332]	Operation	Working at height, Electrical, Fire, Lifting, Noise and, Environmental, Ergonomic
Safety of Life at Sea Regulations (SOLAS) [333]	Design, Construction, Operation	Working over water, Working in remote locations, Community health and safety
World Bank General and industry-specific Environmental, Health, and Safety Guidelines [334]	Design, Construction, Operation	General Environmental Health and Safety

Guidance document	Related activities and operations	Primary Related Hazards
G+ Good Practice Guidelines and Safe by Design Workshop Reports [335]	Construction, Operation	Working at height, Crew Transfer, Electrical, Lifting
G+ Safe Helicopter operations in support of the global offshore wind industry (Section A and Section B) [336]	Construction, Operation	Working at height, Working over water
G+ Integrated Offshore Emergency Response (G+ IOER) [337]	Operation	Community Health and Safety
G+ Floating offshore wind hazard identification (HAZID) [338]	Full life cycle	General Environmental Health and Safety
G+ Offshore wind farm transfer good practice guidelines [339]	Design, construction, operation	Working over water, Working in remote locations, Community health and safety
G+/DROPS Reliable securing booklet for offshore wind [340]	Design, construction, operation	Working in remote locations
G+ Working at height in the offshore wind industry [341]	Design, construction, operation	Working at height
G+ Improving compliance workshop: basic lifting operations [342]	Design, construction, operation	Lifting operations

17.3.2. South African health and safety regulations

The Occupational Health and Safety Act (Act No. 85 of 1993) (OHSA) serves as the foundation for health and safety regulations in South Africa. Over 20 specific regulations have been established under the Act to address a wide range of workplace hazards and ensure worker safety.

In addition to the regulations promulgated under the OHSA, the Merchant Shipping Act (57 of 1951), particularly the Maritime Health and Safety Regulations Amendment of 2021, will also play a role in regulating health and safety for OSW development and operation. These regulations establish requirements specifically for the health and safety of personnel on board shipping vessels used in these activities.

Additionally, the Code of Practice for Lifts Inside Wind Turbine provides guidance to standardise the installation, operation, and maintenance of lifts installed inside the wind turbine towers, as well as guidance to the minimum safety functions and requirements that must be adhered to with respect to lift installations, its operation and maintenance thereof. This Code of Practice was developed for onshore wind and could be applicable to OSW.

The most relevant acts and regulations to OSW are highlighted in Table 50. These regulations provide a comprehensive framework for most, if not all, potential hazards in workplaces.

TABLE 50: OVERVIEW OF HEALTH AND SAFETY REGULATIONS WITH APPLICABILITY TO OSW IN SOUTH AFRICA.

Regulation	Overview
Occupational Health and Safety Act, 1993: Construction Regulations, Guidelines, 2014	The Construction Regulations provides an overview of health and safety requirements for all persons involved in construction, ranging from designers, contractors and construction workers.
Occupational Health and Safety Act, 1993: Electricity Installation Regulations, 2009	The Electricity Installation Regulations provide requirements for OHSA-related considerations in the undertaking of electrical installation work.
Occupational Health and Safety Act, 1993: Regulations for Hazardous Chemical Agents, 2021	The Regulations for Hazardous Chemical Agents provide an overview of requirements for the handling of hazardous chemical substances and applicable OHSA requirements.
Occupational Health and Safety Act, 1993: Electrical Machinery Regulations, 2011	The Regulations for Electrical Machinery provide an overview of requirements for health and safety for the operation of electrical machinery.
Occupational Health and Safety Act, 1993: Guidelines for Lift, Escalator and Passenger Conveyor Regulations, 2015	The Guidelines for lift, escalator and passenger conveyor regulations provide guidance for the safe use of lifts, escalators and passenger conveyors.
Occupational Health and Safety Act, 1993: Major Hazard Installation Regulations, 2022	The Major Hazard Installation Regulations provide requirements for health and safety relating to equipment, structures, pipework, machinery, tools, railway sidings and quays, warehouses and similar structures.
Occupational Health and Safety Act, 1993: General Health and Safety Regulations, 2005	The General Health and Safety Regulations provide an overview of requirements for general workplace safety.
Code of Practice for Lifts Inside Wind Turbine	This code of practice gives clarity with regards to the general aspects of safety, construction, erection, operation, maintenance, inspection, and testing of lifts inside a wind turbine tower
South African Maritime Safety Authority Act (5 of 1998)	The South African Maritime Safety Authority Act provides an overview of the requirements for the establishment of the Maritime Safety Authority.
Merchant Shipping Act (57 of 1951) Maritime Occupational Health and Safety Regulations Amendment, 2021	The Maritime Occupational Health and Safety Regulations provide an overview of safety requirements for Maritime safety, and in particular safety on shipping vessels.
Mine Health and Safety Act No. 29 of 1996 and regulations, 1996	This act includes a chapter on Offshore Installations and outlines capability requirements of offshore installations and other safety considerations.

17.3.3. South African Health and Safety regulations concerning OSW development

South Africa's OHSA covers a variety of workplace risks and hazards and as such will be generally applicable to OSW development and operation, along with any other large infrastructure project.

South Africa does not yet have any OSW development; hence the country's health and safety regulations lack specificity for OSW development and operation. Health and safety regulations in terms of the OHSA have been structured in a more generalised way, in turn applying to a range of occupations and risk or hazard contexts, and invariably many OSW-related activities will be covered by South Africa's existing regulations, however, a clear, thorough and central guidance document for the OSW industry in South Africa would remove ambiguity.

Similarly, the development and operation of onshore wind farms must adhere to overarching health and safety laws and regulations, including the Occupational Health and Safety Act and its associated regulations. This entails obtaining the necessary construction permits and ensuring that appropriate health and safety documentation is in place during the operational phase. Such documentation includes safety plans and policies, fall protection plans, and lockout procedures, among others. Additionally, wind farms must comply with the Code of Practice for Lifts Inside Turbines, which provides specific guidelines for lift safety within wind turbines.

International best practice guidance provides a more comprehensive response to health and safety for OSW than South Africa's regulations currently do. For instance, the UK's CDM Regulations 2015 (Construction Design and Management) require a pre-construction health and safety information (HSI) package. This package identifies hazards specific to each project phase: design, construction and operation.

South Africa could introduce a similar requirement for OSW projects to ensure the development of OSW projects leads to just outcomes for both human health and the environment. This would involve creating a comprehensive HSI package detailing project-specific hazards for each lifecycle stage. The OHSA: Construction Regulations, Guidelines, 2014 have similarities to the CDM whereby they are both designed to be applicable for a range of different construction projects and not specifically OSW, however, the OHSA is not specific to construction. A more detailed and specific construction regulation like the CDM could improve South Africa's health and safety approach.

Many European countries adopt DNV and G+ health and safety standards and guidance, as well as requiring personnel involved in OSW operations to hold specific certificates, such as Global Wind Organisation Basic Training or equivalent national accreditation. This includes topics like safe working at heights, survival at sea, and first aid.

In South Africa, SARETEC already offers the Global Wind Organisation's Basic Safety Training (BST) as well as the Basic Technical Training (BTT) courses. The BST covers First Aid, Manual Handling, Fire Awareness and Working at Heights. The BTT covers areas of mechanical, hydraulic, and electrical operations and is designed to provide common industry best practice standards for maintenance to reduce risks for personnel in the wind industry working on site. South Africa could follow suit in adopting DNV and G+ health and safety standards and guidance and require mandatory training programs aligned with international standards like GWO Basic Training, building on what is already offered. Specialised training or standards specific to South African conditions could also be developed.

Several European countries (e.g. Denmark and Germany) have specific regulations governing helicopter operations associated with OSW farms. These regulations often reference international

standards like CAP 437 (Civil Aviation Publication 437) which sets guidelines for safe helicopter operations on offshore helidecks.

South Africa could adopt regulations referencing established international standards like CAP 437. Additionally, collaboration with relevant authorities (e.g. South African Maritime Safety Authority) would be crucial to ensure effective search and rescue procedures in case of OSW farm incidents.

Without precedents from adjacent sectors such as oil and gas, South Africa's existing Maritime Health and Safety Regulations may not fully address the specific needs of OSW development and operation. These regulations have been designed for traditional maritime activities and may not encompass the broader range of risks and hazards associated with OSW farms, such as the transfer of personnel from a vessel to an offshore structure. As such, South Africa could follow international best practice relating to OSW maritime activities, namely the G+ Offshore wind farm transfer good practice guidelines.

It is recommended that South Africa, where practicable, follow internationally adopted best practice and health and safety standards. This provides consistency with other markets, ensures that the standards adopted are accepted and understood by the market, and allows the South African market to benefit from learnings and understanding developed in OSW markets that have already matured.

17.4. RECOMMENDATIONS

South Africa's current health and safety regulations lack specific guidance for OSW farm development. The following recommendations are provided to address this gap and enhance South African-specific health and safety regulations so that they are tailored to the OSW sector.

- **H&S1.** The Department of Employment and Labour (DoEL) should collaborate with relevant authorities, such as the South African Maritime Safety Authority, to update existing legislation (Occupational Health and Safety 1993, Maritime Health and Safety Regulations) or, if appropriate, develop new regulations and guidance to ensure that installation and O&M of OSW projects meet industry standards for health and safety. This could include efforts to:
  - Align with international best practices such as the G+ Offshore Wind Farm Transfer Good Practice Guidelines to address specific challenges like personnel transfer from vessels to offshore structures.
  - Introduce requirements similar to the UK's CDM Regulations 2015, mandating a pre-construction Health and Safety Information (HSI) package that identifies project-specific hazards across design, construction, and operation phases.
  - Establish specific regulations for helicopter operations associated with OSW farms, referencing international standards like CAP 437 for safe helicopter operations on offshore helidecks.
  - Collaborate with relevant authorities such as the South African Maritime Safety Authority to ensure effective search and rescue procedures and to adapt existing Maritime Health and Safety Regulations to cover the unique risks of OSW activities.
- **SC3 / H&S2.** Industry bodies, project developers, the Department of Higher Education, and institutions of higher learning and training, including TVET colleges and SETAs, should expand the existing GWO courses available in South Africa by introducing and offering additional training programs that align with international standards, including the GWO Basic Training designed for personnel involved in OSW operations. Require personnel involved in OSW operations to hold specific certificates that can be obtained from, for example, the Global Wind Organisation or equivalent.

18. PUBLIC AND CONCESSIONAL FINANCE

18.1. PURPOSE

Utilising public financial support (including concessional finance) in the establishment of South Africa's OSW market can signal to investors that the country is committed to OSW technology development, providing the market with greater certainty. Public finance can also help increase the attractiveness of the South African market for OSW developers and accelerate the deployment of OSW.

This chapter assesses the role of public finance in supporting offshore development in South Africa, explores the opportunities for leveraging public finance, and provides recommendations for the South African market.

18.2. METHOD

This chapter discusses the potential of using public financing for the solutions outlined in Chapter 11: Port infrastructure, Chapter 19: Bankability considerations, and, to a lesser extent, Chapter 12: Supply chain analysis. We define the successful criteria for public finance and apply this to identified investment opportunity areas. We explore critical considerations around using public financing, such as the relative importance of cost reduction versus local content/economic catalysation. We underpin our analysis with recent examples of public financing mechanisms used in South Africa for infrastructure development and those used for OSW projects globally.

18.2.1. Success criteria for public financing in OSW

Public financing plays a crucial role in reducing the expected costs of OSW, which are capital-intensive and expensive. It can fill the gap where private finance markets are not as well aligned to strategic national interests, delivering on public goods, or cannot cover the long payback periods expected in large renewable energy infrastructure projects. By prioritising the just allocation and utilisation of various public finance support mechanisms, South Africa can further its transition to renewable energy, including deploying OSW, which drives economic growth and environmental sustainability and upholds social justice and fairness principles. Understanding the success criteria for public finance involves several key considerations:

- **Necessity and benefits of public finance:** Public finance is essential for investments deemed too risky or costly for private sector involvement in early OSW markets. Private finance often lacks incentives or cannot provide the best overall benefits. In South Africa's OSW sector, public finance is critical for covering investment needs that the private industry either cannot or will not finance at this early stage.

- **Urgency of investment:** Some activities are required in the very early stages of an OSW market or have a long lead time. Therefore, these require a greater urgency of focus than others which could be addressed at a later stage.
- **The scale of investment required:** Public finance is used for small-to-medium-sized projects involving investments in the range of millions. This scale can realise substantial public benefits without imposing excessive financial burdens on taxpayers and prudently managing risk exposure.
- **Where does public finance add value?** These projects often unlock the highest return on investment where returns or added value can manifest in various forms, such as local job creation, economic catalysation, reduced subsidy requirements, increased value of the seabed or publicly owned assets, and enhanced deployment of reliable green energy. The relative merit of these impacts will depend on the local policy priorities — some policymakers will prioritise local economic benefit, whereas others will focus on cost reduction, for example.

We summarise these considerations into Table 51. These criteria support decision-makers in targeting areas with the highest impact, particularly high-risk projects with discrete budgets that can either initiate or de-risk specific projects or entire markets. It is crucial to ensure that the financial burden and risk do not fall disproportionately on consumers or taxpayers, although some risk is inherent.

Following these success criteria, public finance can effectively support high-risk and high-impact OSW projects, fostering sustainable development and economic growth.

TABLE 51: CRITERIA FOR SCORING WHETHER PUBLIC FINANCE SHOULD BE USED.

Criteria	Description	Scoring metric
Necessity of public finance	Assess whether private finance can adequately cover the investment.	High/Medium/Low
Urgency of investment	Investments or catalysation required earlier will be prioritised, as will actions essential for the industry's development.	High/Medium/Low
The scale of investment required	Consider the magnitude of investment needed and its feasibility within public finance constraints.	High (over US $50m)/ Medium ($5–$50m)/ Small (below $5m)
Added value	Evaluate if public finance provides added value in cost reduction, local benefits, or deployment capabilities.	High/Medium/Low

18.3. RESULTS AND DISCUSSION

This section examines how public finance has helped the development of OSW globally and includes examples of public finance used in South Africa for energy or other significant infrastructure projects.

Case Study: South African Renewable Energy Independent Power Producer Procurement Programme — South Africa.

The South African REIPPPP refers to the competitive tender process developed to spur private sector investment in grid-connected renewable energy production in South Africa. As part of REIPPPP, IPPs are invited to submit bids for various renewable energy projects. These bids are evaluated based on specific minimum compliance requirements and the bid tariff or price. IPPs who put forward successful bids are then recognised as preferred bidders and must sign a standardised and non-negotiable 20-year PPA with an appointed off-taker (to date, this has been Eskom, the state-owned national electricity company). Through this PPA, Eskom pays the IPP for electricity generated. To safeguard the economic viability of a renewable energy project through reliable payments from Eskom, the South African Government, through an agreement between the Department of Mineral Resources and Energy, National Treasury, Eskom, and the National Energy Regulator of South Africa (NERSA), has developed a Government Framework Support Agreement. This agreement, while not strictly a form of sovereign guarantee, allows for state financial support for Eskom to ensure that payments to IPPs continue in case of a default by Eskom.

Case Study: Atlantis Special Economic Zone (SEZ) — South Africa

The South African Government's Special Economic Zone Programme began in 2007 and has resulted in the development of designated areas of the country being set aside for specifically targeted economic activities supported through special arrangements and systems that differ from those in the rest of the country.[343] As part of this programme, the Atlantis Special Economic Zone (Atlantis SEZ) was established in 2011 as part of the City of Cape Town's initiative to develop a green economic hub and was created partly in response to the REIPPPP and the need for greater local manufacturing and renewable energy technological components. These include manufacturing solar PV components, wind turbine blades, towers, and solar water heaters. Several investments and economic incentives provided public financial support for the Atlantis SEZ. This included the provision of R114 million by the City of Cape Town for upgrades to electricity infrastructure in the SEZ, preferential corporate tax rates of 15%, building allowances, employment tax incentives, special incentive electricity tariffs as well as tax allowances to support greenfield and brownfield investments.[344] The Atlantis SEZ is expected to attract approximately R3.7 billion in investments over the next two decades.

Case study: Humber Offshore Wind Cluster — United Kingdom

The UK's largest Enterprise Zone (an area designated to stimulate economic growth) is the Humber Enterprise Zone (HEZ). The HEZ received public investment from the UK government (Department for Business, Energy and Industrial Strategy) in 2020 and 2021. The Offshore Wind Manufacturing Investment Support (OWMIS) scheme allocated US $104 million to the establishment of the Humber Industrial Cluster. This initial funding has attracted international companies, such as Siemens Gamesa Renewable Energy, which established a blade factory in Hull in 2016, investing over US $365 m in the area [345] and in 2024 applied to expand it.[346] In 2022, the Department of International Trade (DIT) further promoted investment opportunities through its High Potential Opportunity (HPO) initiative for the Offshore Wind Deepwater Ports Hub. This investment committed an additional GBP £95 million to construct two new OSW ports in the Humber and Teesside, complementing the existing Greenport site at Hull. These investments are set to nearly double the UK OSW workforce from 15,000 in 2021 to 27,000 by 2030, demonstrating the significant economic impact and job creation potential of public financing in the OSW sector.[347]

Case study: One-Stop-Shop with revenue support for early work — the Netherlands

The Netherlands Enterprise Agency (RVO) completes preliminary surveys and consultation activities to develop early stage permitting applications with the relevant documentation. Developers then complete these applications with their late-stage wind farm design work. The approach taken by the Dutch government to cover the costs and risks associated with early-stage activities, such as measurement campaigns and site investigations, can minimise permitting challenges for developers later down the line. In addition, RVO has designed its national OSW development process using a centralised model with streamlined processes managed through the RVO. The role of public financing in covering early-stage work is therefore further supported by efficient and well-designed government OSW engagement strategies, which are described as a 'one-stop-shop' service.

Case study: EU and World Bank fund Turkish offshore measurement campaign

The Turkish Ministry of Energy and Natural Resources (MENR) used EU and World Bank funds to support a measurement campaign to collect site data for OSW in the Sea of Marmara. The tender for collecting the data was launched in 2023.[348]

18.3.1. Key areas that would benefit from public financing for OSW development in South Africa

There are two critical categories of intervention. One addresses fundamental barriers to the industry, and without the removal of these barriers, OSW will not be deployed at scale (e.g. port infrastructure for floating OSW). The second category focuses on ensuring OSW is delivered in a way that brings local benefit, is economically optimal, and is part of the just transition (e.g. regional supply chain catalysation).

Key areas are highlighted; however, this list is not exhaustive. We have focussed on areas that could be of value, and merit additional investigation.

Data collection. Data is essential to de-risk OSW development, ensure timely deployment and allow developers to make informed investment decisions on siting and design. Public financing of critical areas, such as LiDAR data or geophysical/geotechnical surveys, can significantly impact costs, risk, developer interest and deployment timelines. This is especially important in South Africa, as these areas can be a cost-effective way to support the industry without a more formal subsidy regime. The data must often be collected over long timeframes and early in the development stage, ideally before a site lease is awarded. As such, there are limited incentives for the private sector to invest in early strategic data collection. However, undertaking these surveys can reduce risk and, hence, cost and accelerate deployment timelines.

- **Investment into upfront work to investigate the metocean conditions:** South Africa lacks preliminary research, such as the LiDAR or geophysical/geotechnical surveys required to collect metocean and site data, which are crucial for developing OSW projects. The lack of available data on ocean conditions presents a substantial barrier to entry. Public financing of site investigations can enhance transparency and increase market visibility, when the results of these publicly funded investigations are shared openly. South Africa can learn from other markets where similar interventions have been undertaken. Numerous emerging OSW markets are making early progress in critical areas ahead of private sector investment. These markets will be more attractive to international companies looking to invest, which will accelerate deployment, reduce costs, and increase the likelihood of economic benefits and local manufacturing in the future.
- **Data collection to understand environmental impact:** Baseline environmental data must be collected to fully assess any offshore development's impact on the local environment. Therefore, regional characterisation surveys should be undertaken, with a particular focus on seabirds, given the likely areas for development to determine high-risk species and further detail on habitats that need to be avoided or studied further.

Early investment in developing a local supply chain: Public financing can be directed toward high-priority areas, as Chapter 12: Supply chain analysis outlines. This targeted investment can stimulate local industry, reduce costs, and enhance the overall feasibility of South African OSW projects. By focusing public funds on infrastructure development, skills training, and early-stage project development, the government can create a supportive ecosystem that fosters the growth of the OSW sector and attracts further private investment.

- **Removal of infrastructure barriers to floating OSW, e.g. ports. Public financing can support the early development of floating OSW sites and infrastructure development in South Africa.** Port upgrades are a significant investment but essential for floating OSW deployments and are a vital barrier to commercialising floating OSW in South Africa. They also provide a significant opportunity to boost local content and local economic benefits of OSW as discussed in Chapter 11: Port infrastructure.
- **Creating industry hubs:** similar to the Humber Gateway in the UK, investing in the catalysation of industry hubs is another strategic use of public financing. These hubs can serve as central locations for manufacturing, assembly, and maintaining OSW components, driving local economic development and job creation while bolstering the supply chain. By funding the development of these hubs, the government can catalyse the growth of a robust OSW supply chain, ensuring that South Africa reaps the maximum economic benefits from its OSW resources.

- **Creating green hydrogen and NEV hubs:** Investigations are underway to develop green hydrogen hubs in South Africa for export and domestic use where appropriate for hard-to-abate sectors, i.e. green steel. Aligned with the objectives of the JET-IP, public financing to establish OSW farms co-located with ports and Special Economic Development Zones could catalyse this industry. Similarly, co-locating OSW to automobile manufacturing hubs presents a source of clean, reliable energy to power the continued production of vehicles in this region.

- **Supply chain catalysation:** Using public finance to catalyse investment, either through funding support or other incentives would encourage direct investment from international OEMs by establishing a presence in the local market. This approach can require significant upfront engagement and investment. As outlined in more detail in Chapter 12: Supply chain analysis, considerable opportunities for local investment exist in many areas, especially in manufacturing — the balance of plant. Early engagement with OEMs can catalyse early investment, create jobs, and lower the cost of local OSW developments.

- **Skills development**. Investment in catalysing local skills is required to achieve the regional benefits and cost reduction potential under all growth scenarios. For example, building specialist OSW skill development programmes under established frameworks such as EW SETA, SARTEC or Centre for Renewable and Sustainable Energy Studies (CRSES). Further discussion on this is in chapter 12: Supply chain analysis.

Other areas that could benefit from public financing for OSW development:

- **Just Energy Transition:** Public finance is catalytic in realising the success of the initiatives targeted in South Africa's Just Energy Transition Implementation Plan. Many of the programmes outlined in the JET-IP are aligned with the recommendations already made here for OSW development. For example, the JET-IP has identified large-scale and distributed renewable energy generation and transmission grid expansion as targeted programmes for electricity. The plan also identifies programmes for JET financing for new electric vehicles (as noted above) and green hydrogen. Five interventions are set out for skills development, including engagement with education and training institutions to align skills development needs, conduct skills assessments for new industries, and establish skills development zones linked to new green industries and special economic development zones.

- **Research to support robust policy development:** This is a broad topic; however, it is worth highlighting that there are many areas where policies need to be developed in more detail than currently stands. To support this and ensure policies are robust, there are many examples of where further data and research will be required. Although the details of this will not be clear now, it could include, but not be limited to, understanding the wider economic value of OSW, research on the co-existence of marine activities and OSW, detailed grid and network modelling, port needs analysis, and social impact and benefit studies.

Table 52 outlines the potential role of public finance in supporting each of these key areas.

TABLE 52: KEY BENEFIT AREAS SCREENED AGAINST PUBLIC FINANCE CRITERIA.

		Public Finance Criteria			
Key areas	**Relevance to South Africa**	**Necessity of public finance**	**Urgency of investment**	**Investment required**	**Added value expected**
Upfront measurement campaigns	**High.** There is currently limited offshore metocean and site data in South Africa.	**High.** Before site leasing or exclusivity, the private sector will unlikely fund such campaigns.	**High.** Measurement campaigns are essential and take time. However, they are an effective way of de-risking and accelerating deployment.	**Medium.** A floating LiDAR campaign will be in the low millions of US$; additional site investigations (if required), could push this up to the low tens of millions.	**High.** Data, especially wind data, is essential to inform an investment decision.
Industry hubs (incl. green hydrogen & NEV)	**Medium.** It is an early-stage market, so hubs are less relevant currently	**Medium.** Hubs do not happen organically. Investment is required to focus on local benefits.	**Low**. It is not a fundamental barrier to OSW deployment. Before a clear deployment pathway, industries are also unlikely to invest.	**Low.** Depends on the level of investment desired. Greater investment is likely to have a more significant and broad impact.	**Medium/High.** Catalysation of local supply chain and new industries, but other support needed in addition to hubs.
Local supply chain	**High**	**Low/Medium.** The supply chain will naturally be localised to some extent. The catalysation of the local supply chain should be focused on those areas that require local input and have the highest impact on cost reduction and economic benefits.	**Low.** It is not a fundamental barrier to OSW deployment — parts can be imported. Before a clear deployment pathway, industries are also unlikely to invest.	**Med/High.** Depending on the scale of investment appetite. e.g. low-cost and low-impact, such as preparation of information materials for local companies to increase awareness and knowledge about OSW or higher impact and investment, such as funding companies to set up manufacturing facilities	**High.** Importing components can be costly. Increasing local content can provide significant local economic benefits.
Remove infrastructure barriers for floating OSW, e.g. ports	**High.** Catalysing port investment enables floating OSW deployment.	**Medium.** Industry is likely to focus on some areas, whereas others, such as port upgrades, may require support.	**Medium.** Port infrastructure is a fundamental barrier to OSW deployment; however, before clearer deployment pathways are in place, the industry is unlikely to mobilise, so investment is not required before then.	**High.** Infrastructure and industrialisation of floating OSW are large-scale investments.	**High.** It is likely that without some external support, some elements, such as ports and large-scale manufacturing, may struggle to upgrade on time for floating OSW deployment.

18.4. RECOMMENDATIONS

The allocation of public financial support in establishing an OSW market must be equitable to ensure fairness, transparency, and inclusivity. Therefore, the government should focus funding on the most impactful areas by understanding the local challenges and aims (such as cost reduction vs. local content) and then concentrate on the most straightforward wins. Some opportunities for intervention are low-cost and will have a lower impact, but they can still help and provide a significant return on investment.

- **FIN1.** Key departments, such as the National Treasury, DEE, and the Presidency, should determine how to best leverage public and concessional financing opportunities for no-regret actions (primarily related to planning port and grid infrastructure) and align these with the JET-IP and other existing mechanisms.
- **FIN2 / MET1.** As a quick win, the government should leverage concessional and donor funding for offshore measurement campaigns. Key government departments such as DEE, DFFE or Department of Science and Innovation should collaborate to commission a comprehensive metocean measurement campaign at key offshore locations, critical for informed decision-making in the early phases of OSW development.
- **FIN3.** Key departments, such as the National Treasury, DEE, and the Presidency, should continually review investment priorities as the market matures and other areas need funding. As a priority, these departments should identify mechanisms to provide financial support to early-stage OSW projects. Public finance can play a crucial role in risk reduction; therefore, the options, barriers and benefits should be analysed frequently.
- **FIN4 – MED-HIGH.** DTIC should undertake further investigation into where the government can optimise funding to catalyse investment in the supply chain and reduce costs. This will help to understand the benefits and costs of other options, such as hubs and floating OSW needs.

19. BANKABILITY CONSIDERATIONS

19.1. PURPOSE

Underlying project risks impact the bankability of OSW projects. In South Africa, where the OSW market is yet to emerge, the key risk factors include 1) route-to-market and return on investment, 2) regulatory certainty, and 3) technical certainty. If these risks are deemed too high, OSW projects will not be bankable because they will not be able to attract financing. By addressing the risk factors comprehensively, South Africa can create a conducive environment for OSW projects to attract investment and become bankable.

This chapter identifies and ranks the key risks facing OSW projects in South Africa and provides prioritised mitigation measures and recommendations for action. Important to note is that these are only the challenges associated with market entry and not individual project development.

19.2. METHOD

19.2.1. Industry considerations for market entry and investment in emerging OSW markets

Understanding industry needs is essential for creating a supportive ecosystem that promotes OSW bankability, growth, and competitiveness in new markets. Furthermore, prioritising social inclusion, environmental sustainability, and economic growth in the development of OSW projects is essential for fostering a just energy transition in South Africa. Addressing challenges and engaging with stakeholders early to tailor solutions for market entry is also necessary.

Firstly, we will outline the key risks facing OSW projects in South Africa (Table 53). These risks will then be given a rating of how significant the challenge is for South Africa; low, medium, or high. An explanation of this rating is given in Table 54. This rating is important as some risk factors are largely outside of the control of local industry or policymakers (such as future weather, or investment in floating OSW cost reduction globally), ensuring that not only do we focus on those areas most crucial to the industry, but also those areas which local policymakers have most influence on.

Secondly, mitigating measures with then be identified for each of the risks. These measures will then be assessed and ranked based on their urgency, impact, and ease of implementation (Table 55), applying the RAG rating system outlined in Table 54. This will help identify both the quick wins — those no-regrets mitigating measures that are easy to implement, as well as the high urgency and importance mitigations which may be more challenging to undertake but are likely critical for the development of especially the more ambitious medium and high growth scenarios.

Finally, based on the outcome of the RAG rating, we will create a list of prioritised measures and recommendations for immediate action.

TABLE 53:KEY RISKS FACING OSW DEVELOPMENT AND HOW THEY RELATE TO SOUTH AFRICA KEY RISKS FACING OSW DEVELOPMENT AND HOW THEY RELATE TO SOUTH AFRICA.

Key risk	Specific challenge
Regulatory	The lack of a clear regulatory framework increases uncertainty and risk.
Market signals	Lack of OSW target visibility impacting investor and supply chain confidence and mobilisation.
Technology	Inherent risks associated with floating OSW and its lower Technology Readiness Level. South Africa is reliant on floating OSW technology, especially for medium and high-growth scenarios.
	More challenging metocean conditions, especially regarding currents, compared to established markets may require specialist component development.
Site	Very limited yield certainty and data available for offshore sites identified.
	Metocean conditions, bathymetry, geotechnical, and geophysical data not available in sufficient detail.
Grid capacity and connection	Capability of infrastructure to cope with the build-out of renewable energy, and clarity of plans for required upgrades.
Environmental and social	Understanding the potential scope/scale/severity of impact of the developments on biodiversity, including critical biodiversity areas.
Revenue certainty	There is currently no clear route to market for OSW power offtake at prices required to incentivise the high investment needed upfront.
	International supply chain and developers being exposed to local FX risk assuming revenue will be in local currency.
	Low credit ratings and low confidence in government increase the cost of capital.
Supply chain and infrastructure	Capability of local supply chain.
	Port infrastructure.

TABLE 54: METHODOLOGY FOR SIGNIFICANCE/IMPACT OF RISKS RAG ASSESSMENT.

Significance of challenge rating explanation	
Low	Low challenge for overall bankability, or very limited control of SA policies to influence.
Medium	Moderate challenge for overall bankability, or moderate influence of local policymakers to control.
High	Significant impact on bankability with a high degree of influence possible from local policymakers.

It is assumed that those measures prioritised (i.e. rated green) will be those which are easiest to implement, with the highest urgency and impact.

TABLE 55: METHODOLOGY FOR RAG RATING OF MITIGATION MEASURES.

RAG rating explanation		
Ease The level of simplicity or difficulty involved in implementing a task This criterion considers the resources required, the expected resistance, and the time needed for completion.	Easy	• Minimal resources required • Little to no resistance expected • Implementation can be completed in a short timeframe
	Moderate	• Considerable resources required • Some resistance expected • Implementation will take a moderate amount of time
	Complex	• Extensive resources required • High resistance expected from various quarters • Implementation will likely be onerous
Urgency The speed and priority with which a task or project needs to be addressed Reflects the necessity of immediate action to ensure the success of the project or to mitigate significant risk.	Low	• Likely to happen without intervention • Important for long-term goals but not time-sensitive • Can be prioritised after high and moderate-urgency tasks are addressed
	Moderate	• Action needed within a reasonable timeframe • Important for overall progress and to avoid potential issues • Should be addressed promptly but not immediately critical
	High	• Immediate action required • Critical to address the project's success or to mitigate significant risks • Must be prioritised and completed as soon as possible
Impact Measures the potential positive effect of a task or project on the overall success and performance of the project. Assessing the significance of the outcomes resulting from the implementation of the task.	Low	• Minor positive effect on the project or industry • Incremental improvements with limited scope • Useful but not critical for overall success
	Moderate	• Noticeable positive effect on the project or industry • Improvements in certain areas, contributing to overall progress • Important for achieving secondary goals and objectives
	High	• Significant positive effect on the project's success or the overall industry • Major improvements in efficiency, effectiveness, or outcomes • Essential for achieving critical goals and objectives

Overall rating score:

- The final rating combines ease, urgency, and impact assessments to determine a task or project's priority and importance.
- Measures with a green rating on ease should be prioritised as no-regrets options.
- Measures with green ratings on urgency and impact will be prioritised as high-impact options.

These prioritised measures will be discussed further in the recommendations section.

19.3. RESULTS AND DISCUSSION

19.3.1. Challenges towards OSW market entry in South Africa

The development of OSW projects in South Africa presents unique challenges that can impact their bankability. Table 56 lists specific challenges and rates their severity within the South African context (Low/Medium/High rating provided in Column 2) and explains these ratings.

Column 3 offers mitigation measures that the South African government can implement to enhance the viability and attractiveness of OSW investments. The mitigation measures are also rated on their ease of implementation, urgency, and impact, and an overall rating across these criteria is given. This is not an exhaustive list, and other measures should also be pursued.

These mitigation measures address the financial, regulatory, and infrastructural barriers to ensure successful OSW project deployment. The mitigation measures are classed by overall priority, with any quick wins identified.

TABLE 56: ASSESSMENT OF CHALLENGES TO OSW MARKET ENTRY IN SOUTH AFRICA.

Specific Challenge	Significance of challenge in South Africa	Mitigation measures for the South African government
Regulatory: There is a lack of a clear regulatory framework for OSW development.	**Significance of challenge: High:** updating the regulatory framework is well within the influence of local policymakers. South Africa's energy planning framework regarding RE requires greater recognition of OSW as a distinct option for RE generation. South Africa has established a designated authority and is developing marine spatial plans (MSPs). However, it does not designate specific OSW areas within these MSP processes. Grid connection agreements will need to be developed for OSW projects, and these will need to include procedures and protections for curtailment. There is a general lack of clear processes in various regulatory areas, including permitting, grid connection, etc.	Develop fit-for-purpose frameworks for OSW, especially regarding site development and marine spatial planning, as well as grid connection. A detailed discussion of regulatory frameworks is required in Chapter 15: Regulatory, legal and permitting framework This and general regulatory provisions should flow into the Energy One Stop Shop (EOSS) mandate to expedite and streamline the regulatory process for OSW. **Ease: Moderate Urgency: High** **Impact: High Overall: High priority**
Market signals: Lack of OSW target visibility	**Significance of challenge: High:** updating the regulatory framework is well within the influence of local policymakers. South Africa's Integrated Resource Plan (IRP) is the country's key electricity planning policy. It provides a strategic framework for planning and developing the country's electricity resources over a medium to long-term horizon. Currently, the IRP does not include explicit targets for OSW development.	Set explicit targets and formally implement them in legislation for transparency and a signal of commitment. Realistic but ambitious OSW targets should be included to signal that the government prioritises OSW as a renewable energy source. Engage with industry and experts from other markets to establish transparent and credible OSW targets. This could be achieved through a Joint Industry Initiative or linked to a study tour. **Ease: Moderate Urgency: High** **Impact: High Overall: High priority**

Specific Challenge	Significance of challenge in South Africa	Mitigation measures for the South African government
Technology: Inherent risks associated with floating OSW and its lower Technology Readiness Level	**Significance of challenge: Medium:** Technology Readiness Level and costs for floating OSW will be driven at a global scale, but a proportionally higher influence is possible from markets with significant floating OSW potential such as South Africa. Compared to fixed OSW, floating OSW is not fully commercialised as a technology. Open technical questions around rolling it out at scale pose risks to realising ambitious targets in South Africa, particularly as a new market. Developers have previously pulled out of more developed markets because of volatile risk portfolios. While this is out of the South African government's control and will organically reduce globally with technology learning rates over time, OSW targets and policy frameworks, particularly around technology innovation and targets should encourage floating OSW-focused investment.	Develop floating-specific OSW targets. While important, the limited fixed OSW sites would mean that wider OSW targets would have an implicit floating OSW target within that. However, it would be beneficial to specify floating OSW targets as this would help stimulate floating-specific OSW investment in areas such as ports. The ease of implementation would change to 'Easy' once the overall wind targets are set. **Ease: Moderate Urgency: Medium** **Impact: Medium Overall: Medium priority** Create policies that specifically support technology innovation and demonstration for floating OSW in South Africa. The impact would be linked to the investment; more impactful programmes would require more investment. Such programmes should be designed to complement rather than duplicate global floating OSW RD&D. **Ease: Complex Urgency: Medium** **Impact: Medium Overall: Medium priority**
Technology: Components designed to withstand South Africa specific site conditions	**Significance of challenge: High:** the current technology should withstand South African metocean conditions; however, careful consideration must be given to the slightly elevated metocean conditions found along the South African coastline. Industry standards are available to support the design of an OSW project according to these metocean conditions.	Spearhead a consortium among the various stakeholder sectors involved in the industry to fast-track initiatives, support efforts, and add weight to collective endeavours regarding the OSW market. This platform could be a joint industry partnership, enabling stakeholders to collaborate and prioritise areas needing attention. **Ease: Complex Urgency: Medium** **Impact: High Overall: Medium priority**
Development area conditions: Yield certainty and data	**Significance of challenge: Medium:** some degree of data collection is often led by the public sector in the early stages of development due to the long data collection timeframes required. South Africa has good wind conditions based only on modelled data (Global Wind Atlas), but measured wind data is lacking. Confirming the data with LiDAR measurement campaigns in the identified development areas is essential for more accurate yield assessment and LCOE modelling, which will help inform industry perception of project viability and investment decision in South Africa more generally.	Invest in commissioning wind measurement campaigns in identified development areas to signal a commitment to the industry and lower the initial burden on developers approaching the South African market. Develop policies to support and catalyse ongoing programmes for example the Wind Atlas for South Africa (WASA). Facilitate data access and sharing with developers who can incorporate the data in their assessments. **Ease: Moderate Urgency: High** **Impact: High Overall: High priority**

Specific Challenge	Significance of challenge in South Africa	Mitigation measures for the South African government
Development area conditions: Metocean, bathymetry, geophysical and geotechnical conditions	**Significance of challenge**: **Medium:** while important for developments, more detailed site data can be collected at a later stage in project development, which means developers can take more of a lead. Ultimately this will be driven by the preferred development model (centralised or decentralised).	Invest in commissioning representative measurement campaigns in identified development zones to ensure informed decision-making and detailed project planning at optimal sites. Note that this will be impacted by the development models adopted in SA. For example, the industry could take this forward in a decentralised model instead. **Ease: Moderate Urgency: Medium** **Impact: High Overall: Medium priority** Consolidate the research and development efforts of local research entities, such as universities, to coordinate and strengthen research initiatives to advance the OSW market. The Department of Science and Innovation (DSI) will likely drive this initiative. **Ease: Easy Urgency: High Impact: Medium** **Overall: Quick win; Medium priority**
Grid capacity and connection: Capability of infrastructure to cope with the build-out of large-scale renewable energy, and clarity to the market of how these will be achieved in advance of future build out	**Significance of challenge: High:** Grid strategy (including planned upgrades and build-out) needs to be coordinated centrally. Clarity on the plans to do so will provide additional confidence to the market in advance of upgrades being implemented. The current grid infrastructure lacks capacity, especially in the coastal provinces (except for KwaZulu-Natal), where most of the renewable energy potential is located. In these regions, power generated by OSW farms cannot be effectively evacuated to load points. Eskom's transmission function has been legally separated into the National Transmission Company, which will help streamline grid-related expansion and activities to ensure energy security and integrate other forms of energy into the grid. Chapter 9: Grid and transmission system highlights that when considering future grid upgrades according to the TDP 2023, sufficient capacity only exists for the low scenario. As such, additional grid upgrades are required. The transmission network's Transmission Development Plans (TDP) and Generation Capacity Connection Assessment (GCCA) are published to provide stakeholders with an indication of the available capacity for connecting new generation capacity to the transmission system. Currently, OSW is not considered in the plan.	Deliberate planning for OSW is essential in future iterations of the TDP. This would function as a market signal and indicate the government's commitment to OSW. **Ease: Complex Urgency: High** **Impact: High Overall: High priority** Engage with relevant stakeholders to include grid upgrades for identified OSW sites in future GCCA and TDP iterations, ensuring alignment with OSW energy targets. Prioritise grid upgrades in areas with promising floating OSW development first. **Ease: Complex Urgency: High** **Impact: High Overall: High priority** Continue developing options for developer or private sector ownership of some aspects of the transmission infrastructure, which can alleviate pressure on Eskom to build out infrastructure, such as Offshore Wind Transmission Operator (OFTO). Note, however, that this would require a trade-off in revenue and financial support. **Ease: Complex Urgency: Medium** **Impact: High Overall: High priority**

Specific Challenge	Significance of challenge in South Africa	Mitigation measures for the South African government
Environmental and social: Impact on biodiversity	**Significance of challenge: High:** biodiversity impacts are unique to each geography. Where biodiversity impacts are unclear, this can cause a risk to the project development which can stall in the planning phases if a challenge is brought against the development on such grounds. Many of the potential development sites identified are near critical biodiversity areas or have significant marine mammal and avian activity. Cumulative impacts, their identification, management and mitigations are strongly supported by the public sector. These issues are discussed in more detail in Chapter 5: Environmental and Social Constraints	Undertake studies to understand the likely impact of OSW development on biodiversity. **Ease: Easy Urgency: Medium** **Impact: Medium** **Overall: Quick win, Medium priority** Ensure that marine spatial planning and consent processes include a robust framework for assessing the environmental impacts of development, including appropriate monitoring methodologies, and identifying mitigating measures where possible to minimise the impact on both the environment and OSW deployment. Note that this is linked to the development of appropriate regulatory framework recommendations. **Ease: Moderate Urgency: Medium** **Impact: Medium Overall: Medium priority**
Revenue certainty: Route to market/ revenue certainty and value. PPAs Offtake by corporates	**Significance of challenge: High:** **REIPPPP:** The REIPPPP has been instrumental in attracting investment and promoting renewable energy in South Africa. However, it has faced several issues and challenges over the recent years, such as delays in launching new bid rounds, uncertainty regarding future program details and tariff structures, and challenges in securing timely grid connections for awarded projects. **Bi-lateral PPAs:** The scale of OSW development might be too large for most corporate buyers to enter a bi-lateral PPA with an OSW farm. Single large power users, such as smelters and potential green hydrogen/industry development, are currently limited.	Ensure consistent and predictable scheduling of bid rounds under the REIPPPP programme. Release dedicated OSW bid rounds that are aligned with the targets set in the IRP. Establish a clear timeline and regularity for future bid rounds to allow developers and financiers to plan investments and project preparations accordingly. **Ease: Complex Urgency: High** **Impact: High Overall: High priority** Utilise energy traders to aggregate demand for renewable energy. Energy traders have access to energy markets and platforms where they can aggregate demand from multiple buyers, such as industrial consumers, utilities, and commercial entities. Pooling demand can warrant a PPA with an RE project of an OSW farm scale. **Ease: Moderate Urgency: High** **Impact: High Overall: High priority** Foster the development of large-scale users who demand renewable energy, such as industry production, large creditworthy municipalities and green hydrogen development is proven cost competitive. **Ease: Complex Urgency: Medium** **Impact: Medium Overall: Medium priority** Collaborate with multilateral organisations that can catalyse climate finance. The investment required for any development at scale would likely be greater than the available capital from such sources therefore mechanisms for using concessional finance to mitigate investment risk should be explored alongside. **Ease: Moderate Urgency: Low** **Impact: Medium Overall: Low priority**

Specific Challenge	Significance of challenge in South Africa	Mitigation measures for the South African government
Revenue certainty: Foreign exchange rate (FX) and inflation risk	**Significance of challenge: Medium:** Underlying FX fluctuations are beyond OSW policy control, however mitigating measures can be implemented by policymakers. OSW projects require substantial upfront investment financed over long periods (e.g. 20 years). If funded with foreign capital, fluctuations in FX rates can significantly impact costs. Additionally, revenues are typically earned in the local currency where the project is located. For international investors, changes in FX rates can directly affect the profitability of these investments. In addition, inflation over the project's lifespan must be carefully considered to account for potential price increases.	South Africa's OSW route to market could also address the local FX and inflation risk. For example, revenue contracts could be designed to shield developers from some of this risk using hedges or index-linked revenue. Explore Rand-based financing options, for example, financing from South African financial institutions such as the Development Bank of Southern Africa, or other South African commercial banks. **Ease: Complex Urgency: Medium** **Impact: Medium Overall: Medium priority** Tariff indexation for foreign exchange rate variations should be included in standard-form PPAs. **Ease: Easy Urgency: Medium** **Impact: Low Overall: Low priority**
Revenue certainty: Government credibility and low credit ratings	**Significance of challenge: High:** South Africa's credit rating is BB-[349], which leads to higher borrowing costs when issuing debt securities in international markets and less investor confidence. Long-term exposure to adverse movements in the South African Rand makes investors more hesitant to hold assets denominated in local currency. Individual OSW policies will not improve government credit ratings; however, policymakers can implement measures to mitigate the impact of low credit ratings on OSW development in the country.	As OSW policymakers have no control over the *country*'s credit rating, they should focus on establishing frameworks and policies that help to reduce the cost of capital in other ways, for example, that ensure that any counterparties to the developer's revenue are chosen to minimise underlying revenue risk and exposure to low credit ratings. **Ease: Complex Urgency: High** **Impact: Medium Overall: High priority**
Supply chain and infrastructure: Capability of local supply chain	**Significance of challenge: Medium:** The global supply chain is driven primarily by industry but some policies can help incentivise the industry to invest in the local market. The supply chain for OSW development in South Africa is limited across many lifecycle stages. The market will rely on imports, at least in the early stages of development. As discussed in the Chapter 12: Supply Chain Analysis, many larger components such as the turbine are expected to be imported in the early stages of the market. South Africa benefits from a track record in manufacturing and onshore wind and some existing capabilities in related areas.	Much of the supply chain needs will be met by industry responding to market demand and will not require government intervention. However, the government may want to invest in catalysing local growth to maximise local economic benefit. **Ease**: **Moderate Urgency: Low** **Impact: Medium Overall: Medium priority** As the South African market is located relatively far from any established OSW markets, the local market needs to be attractive enough for international players to invest. Local tariffs and investment incentives should be explored to ensure that the global supply chain engages promptly to avoid unnecessary delays. Note that this is discussed in more detail in Chapter 18: Public and Concessional Finance **Ease**: **Easy Urgency: High Impact: Medium** **Overall: Quick win, Medium priority**

Specific Challenge	Significance of challenge in South Africa	Mitigation measures for the South African government
Supply chain and infrastructure: Port infrastructure	**Significance of challenge: Medium:** Port upgrades are driven in part by ports themselves, but further catalysation is likely required to meet the accelerated timescales required especially for floating OSW development. Current port capability is not sufficient to support floating OSW deployment, as outlined in Chapter 11: Port Infrastructure. Therefore, investment is required to ensure port facilities are available by the time they are required.	Develop policies that catalyse port upgrades, focusing on the most appropriate ports for fixed and floating OSW respectively. A more detailed discussion on this can be found in Chapter 11: Port Infrastructure. **Ease: Complex Urgency: High Impact: High Overall: High**

The most significant challenges to market entry/bankability arise from:

- **Lack of targets and a clear regulatory framework:** Targets should be ambitious and backed up by sufficient policies (such as the regulatory framework) to achieve them. This will provide a clear signal to the market on the government's ongoing intention to support OSW development locally. Further, the process of target setting for OSW development needs to be done in a just manner by being transparent and inclusive of key stakeholders. A clear regulatory framework for OSW development is necessary to facilitate site leasing, marine spatial planning, and grid connection, among other critical elements.
- **Capability of grid infrastructure:** Analysis has shown that the grid connection areas at the identified suitable site lack sufficient capacity to connect the identified capacity for floating OSW. Strategic planning and upgrades will be essential to accommodate future developments.
- **Lack of suitable routes to markets:** Clear routes to market, with defined revenue structures, are crucial for attracting developers. Predictable bid rounds and stable financial agreements will enhance market confidence and project bankability. For example, consistent and predictable scheduling of bid rounds under the REIPPPP for OSW based on the set targets provides certainty to the market and potential project developers. The development of well-designed CfD mechanisms in future would have a positive impact on the bankability of projects. In addition, indexing FX and inflation effect in REIPPPP offtake agreements to account for currency fluctuation and weaker performance of ZAR against most hard currencies gives developers the security of overall project revenue over a lifetime, lowering risks and increasing a project's perceived value and attractiveness. Financing in ZAR rather than foreign currencies reduces exposure to FX fluctuations, as repayments and project revenues are denominated in the local currency.
- **Lack of granular and high-quality wind speed data:** High-quality, bankable wind speed data is essential for informed decision-making in OSW projects. Without comprehensive measurements, the perceived risk to investors remains high. The longer the dataset for wind resources, the lower the risk perceived by investors. As there are currently no offshore datasets measured by bankable means (i.e. via LiDAR or meteorological mast), it would benefit the industry to deploy a campaign

as soon as funding can be sourced. A floating LiDAR measurement campaign, ideally at more than one site, would increase market confidence if the data was published for all developers to access. Such campaigns elsewhere globally have been successfully funded through development aid or similar and would therefore be of limited financial burden to the government. Ongoing data collection initiatives such as WASA should be considered as part of this wider package.

19.4. RECOMMENDATIONS

The South African government can provide strong market signals and incentives for developing OSW in the absence of other direct support such as subsidies or guarantees. Transparent policies and stable regulatory conditions are critical and can be addressed in the short-term, setting the required long-term certainty for the market. A key focus for government should be reducing risk and providing certainty where possible. The key recommendations to improve project bankability are:

- **BANK1.** Key departments such as DEE, DFFE, and DSI should collaborate to build up the evidence base for OSW development, as a quick win to improve bankability of initial projects and the market more broadly. Critical evidence can be gathered through the commissioning of LiDAR campaigns, targeted surveys and early-stage research on environmental receptors in South Africa, around the likely fixed OSW (Coega, Saldanha Bay — West Coast) and floating OSW (Saldanha Bay — West Coast, Durban — Richards Bay) development areas.

Several of the recommendations outlined in previous chapters will also support project bankability in South Africa. These include:

- GRD1, GRD2, MED-HIGH GRD3
- PRO1, PRO2, MED-HIGH PRO3
- PORT1, PORT2, PORT3
- REG1, REG3

APPENDICES



APPENDIX 1: GLOSSARY OF TERMS

Acronym/ Abbreviation	Term
AASA	Aquaculture Association South Africa
ADZ	Aquaculture Development Zones
AfDB	African Development Bank
AFOLU	Agriculture, Forestry and Other Land Use
APDP	Automotive Production and Development Programme
ASCAA	South African Civil Aviation Authority
Atlantis SEZ	Atlantis Special Economic Zone
B-BBEE	Broad-Based Black Economic Empowerment
BEIS	UK Department of Business, Energy and Industrial Strategy
BLSA	Birdlife South Africa
BQ	budget quotations
BST	Global Wind Organisation's Basic Safety Training
BTT	Basic Technical Training
BW6	Bid Window Round 6
BW7	Bid Window Round 7
CAP	Civil Aviation Publication
CAP 437	Standards for Offshore Helicopter Landing Areas
CAPEX	Capital Expenditure
CBAs	Critical Biodiversity Areas
CCDR	Country Climate Development Report
CDM	Construction Design and Management
CfD	Contracts for Difference
CFPP	Coal-fired power plant
CGS	Council for Geoscience
CPUT	Cape Peninsula University of Technology
CRF	capital recovery factor
CRSES	Centre for Renewable and Sustainable Energy Studies
CSAG	Climate Systems Analysis Group
CSIR	Council for Scientific and Industrial Research
CSP	Concentrated Solar Power
CTV	Crew Transfer Vessel
DBSA	Development Bank of Southern Africa
DFFE	Department of Forestry, Fisheries and the Environment
DFI	Development Finance Institutions
DHA	Department of Home Affairs

Acronym/ Abbreviation	Term
DIDSSA	Sustainable Infrastructure Development Symposium
DMRE	Department of Mineral Resources and Energy
DNV	Det Norske Veritas
DNVGL-ST-0119	Floating Wind Turbine Structures
DNVGL-ST-0126	Support Structures for Wind Turbines
DNVGL-ST-0145	Offshore Substations for Wind farms
DNVGL-ST-0437	Loads and Site Conditions for Wind Turbines
DoD	Department of Defence
DEE	Department of Electricity and Energy
DoT	Department of Transport
DTIC	Department of Trade, Industry and Competition
EAL	Eskom Academy of Learning
EBSA	Ecologically or Biologically Significant Marine Areas
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EN 50308	Wind Turbines - Protective Measures - Requirements for Design, Operation and Maintenance
EOSS	Energy One Stop Shop
ESA	*Ecological Support Area*
ESF	Environmental and Social Framework
EWT	Endangered Wildlife Trust
FiT	Feed-in Tariffs
FTE	Full-Time Equivalent
G+	Global Offshore Wind Health and Safety Organisation
G+ IOER	G+ Integrated Offshore Emergency Response
GCCA	Generation Connection Capacity Assessment
GEAPP	Global Energy Alliance for People and Planet
GEBCO	General Bathymetric Chart of the Oceans
GH_2	Green Hydrogen
GIS	Geographic Information System
GVA	Gross Value Added
GW	Gigawatt
GWEC	Global Wind Energy Council
GWh	Gigawatt Hours
HAZID	G+ Floating offshore wind hazard identification
HIS	Health and Safety Information
HPO	High Potential Opportunity
ICE	internal combustion engines
IDZ	Industrial Development Zone
IEA-RETD	International Energy Agency's Renewable Energy Technology Deployment
IEP	Integrated Energy Plan
IFC	International Finance Corporation

Acronym/ Abbreviation	Term
IMMA	Important Marine Mammal Areas
IRENA	International Renewable Energy Agency
IRP	Integrated Resource Plan
ISRA	Important Shark and Ray Areas
IUCN	International Union for the Conservation of Nature
JET	Just Energy Transition
JET-IP	Just Energy Transition-Implementation Plan
JT	Just Transition
KBA	Key Biodiversity Areas
KTF	Komati Training Facility
kV	Kilovolt
kWh	Kilowatt hour
LCLO	Local Community Liaison Officer
LCOE	Levelised Cost of Electricity
LCOH	Levelised Cost of Hydrogen
LCR	Local content requirements
LEDS	Long-term Emissions Development Strategy
LNG	Liquefied Natural Gas
MCEP	Manufacturing Competitiveness Enhancement Programme
MENR	Turkish Ministry of Energy and Natural Resources
MERSETA	Manufacturing, Engineering and Related Services Sector Education and Training Authority
MIBA	Marine Important Bird Areas
MLRA	Marine Living Resources Act No. 18 of 1998
MPA	Marine Protected Areas
MPRDA	the Minerals and Petroleum Resources Development Act
$MtCO_2$	million tonnes of CO_2
MVA	Megavolt-amps
MVAr	Megavolt-amps reactive
MW	Megawatt
MWh	Megawatt Hours
NCEP	National Centers for Environmental Prediction
NCMSBP	National Coastal Marine Biodiversity Spatial Plan
NDC	Nationally Determined Contribution
NDP	National Development Plan
NEM: ICMA	National Environmental Management: Integrated Coastal Management Act
NEM: PAA	National Environmental Management: Protected Areas Act
NEMA	National Environmental Management Act
NERSA	National Energy Regulator of South Africa
NEVs	new electric vehicles
NHRA	National Heritage Resources Act (No. 25 of 1999)
NOAA	US National Oceanic and Atmospheric Administration
NPAES	National Protected Areas Expansion Strategy

Acronym/ Abbreviation	Term
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
NRF	National Research Foundation
NSF	National Skills Fund
NTCSA	National Transmission Company of South Africa
O&G	Oil and Gas
O&M	Operation and maintenance
OEM	Original Equipment Manufacturers
OHSA	Occupational Health and Safety Act
OPEX	Operational Expenditure
OSW	Offshore Wind
OWMIS	Offshore Wind Manufacturing Investment Support
P2X	Power to X
PASA	Petroleum Agency of South Africa
PCC	Presidential Climate Commission
PEM	proton exchange membrane
PLI	Plant Location International
POS	points of supply
PPA	power purchase agreements
PRC	Production Rebate Certificate
PRCC	Production Rebate Credit Certificate
PV	Photovoltaic
QCTO	Quality Council for Trades & Occupations
RAG	Red-Amber-Green
REIPPPP	Renewable Energy Independent Power Producers Procurement Programme
RMY	representative meteorological year
RPS	renewable portfolio standards
RVO	Netherlands Enterprise Agency
SAAM	South African Automotive Masterplan
SABAA	South African Bat Assessment Association
SAHRA	South African Heritage Resources Agency
SAMSA	South African Maritime Safety Authority
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAREM	South African Renewable Energy Master Plan
SARETEC	South African Renewable Energy Technology Centre
SAWEA	South African Wind Energy Association
SDZ	Skills Development Zones
SEA	Strategic Environmental Assessment
SEMA	Specific Environmental Management Acts
SETA	Sectoral Education and Training Authority
SEZ	Special Economic Zone

Acronym/ Abbreviation	Term
SHEQ	Safety, Health, Environment, and Quality
SME	small and medium enterprises
SOLAS	Safety of Life at Sea Regulations
SOV	Service Operation Vessel
SPV	Special Purpose Vehicles
STEM	science, technology, engineering, and mathematics
TBC	The Biodiversity Consultancy
TDP	Transmission Development Plan
TEUs	twenty-foot equivalent units
TLPs	tension-leg platforms
TNPA	Transnet Ports Authority
TS	Electricity Transmission System
TVET	Technical and Vocational Education and Training
TWh	Terawatt-hour
UNFCCC	United Nations Framework Convention on Climate Change
UXO	Surveys for unexploded ordnance
VAA	Vehicle Assembly Allowance
VALA	Volume Assembly Localisation Allowance
WACC	weighted average cost of capital
WBG	World Bank Group
ZAR	South African Rand

APPENDIX 2: GEOSPATIAL ANALYSIS — ADDITIONAL MAPS

FIGURE 85: LEVELISED COST OF ENERGY FOR BOEGOEBAAI UNDER A MEDIUM COST SCENARIO.

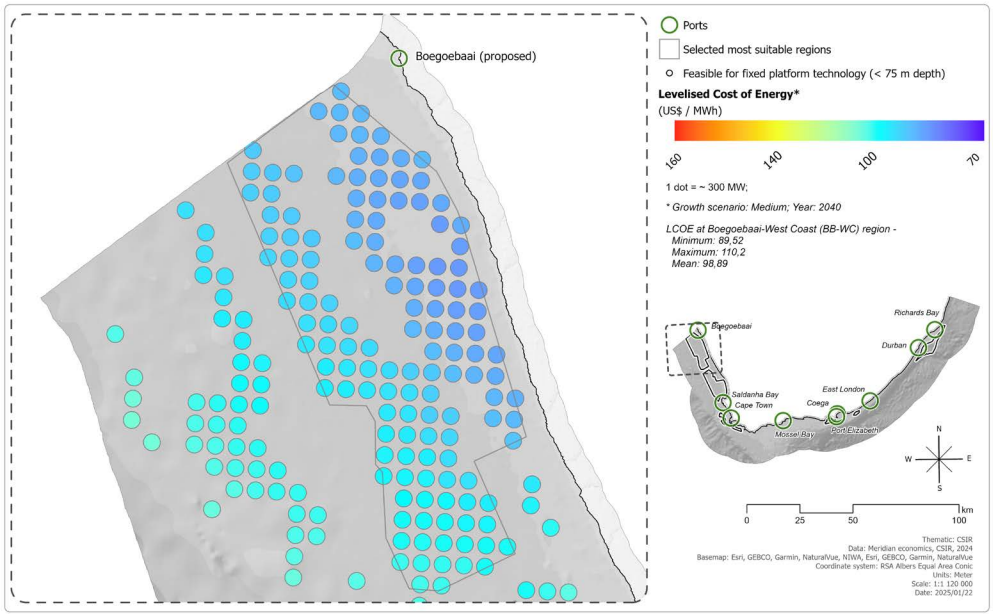


FIGURE 86: LEAST CONSTRAINED AND SELECTED SUITABLE SITES FOR BOEGOEBAAI IN RELATION TO WATER DEPTHS FOR FIXED AND FLOATING OSW (CURRENT AND FUTURE).

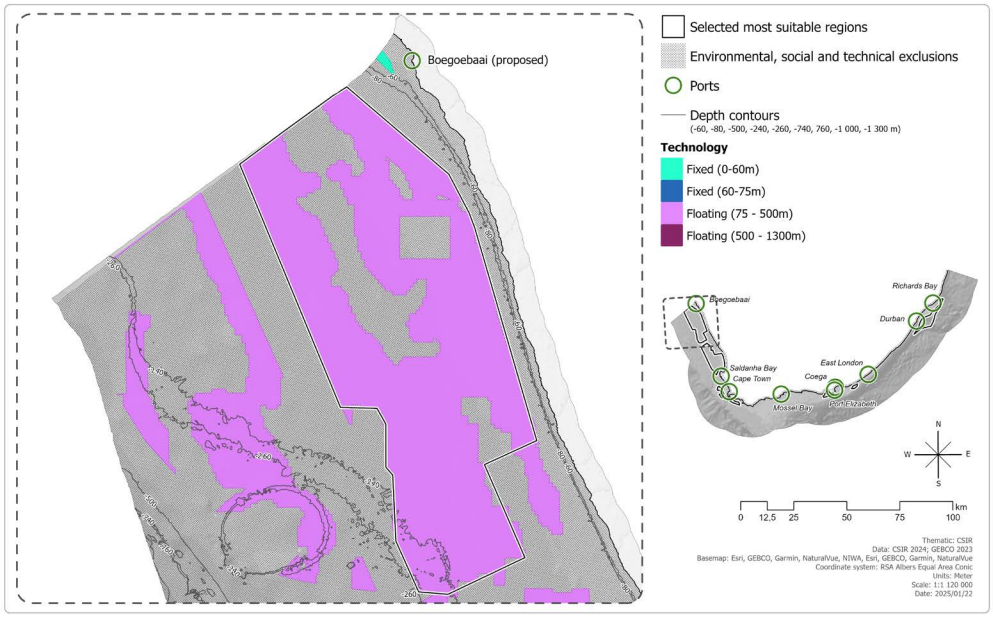


FIGURE 87: LEVELISED COST OF ENERGY FOR COEGA WEST AND EAST UNDER A MEDIUM GROWTH SCENARIO.

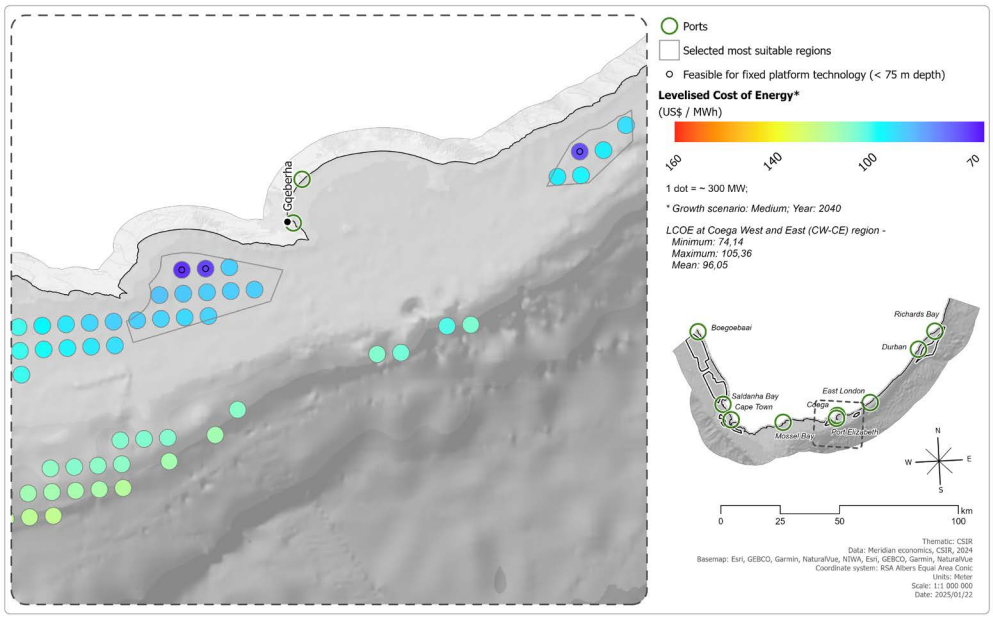


FIGURE 88: LEAST CONSTRAINED AND SELECTED SUITABLE SITES FOR COEGA EAST AND WEST IN RELATION TO WATER DEPTHS FOR FIXED AND FLOATING OSW (CURRENT AND FUTURE).

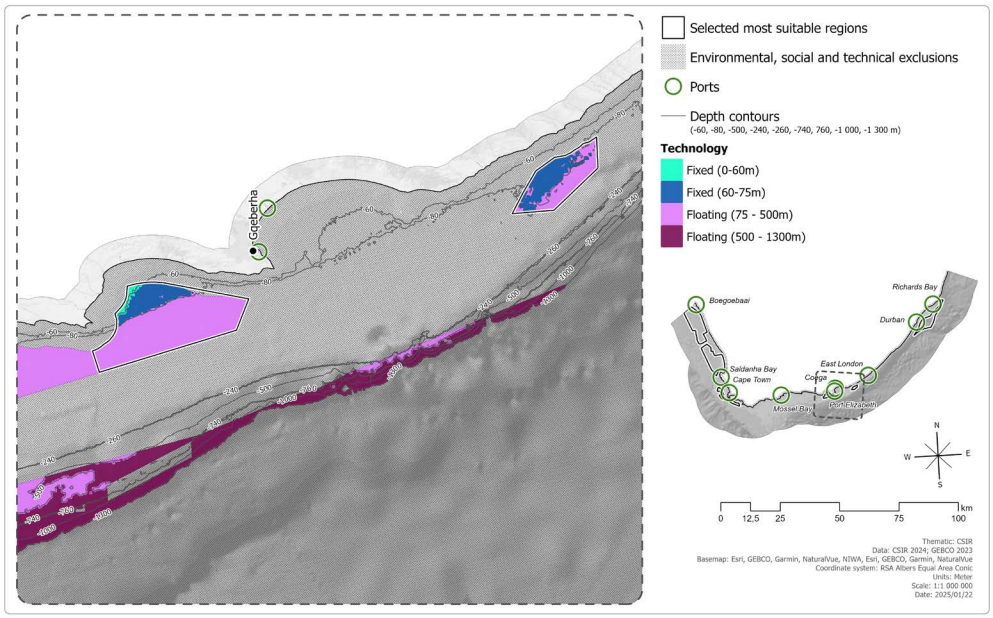


FIGURE 89: LEVELISED COST OF ENERGY FOR CAPE POINT WEST AND EAST UNDER A MEDIUM GROWTH SCENARIO.

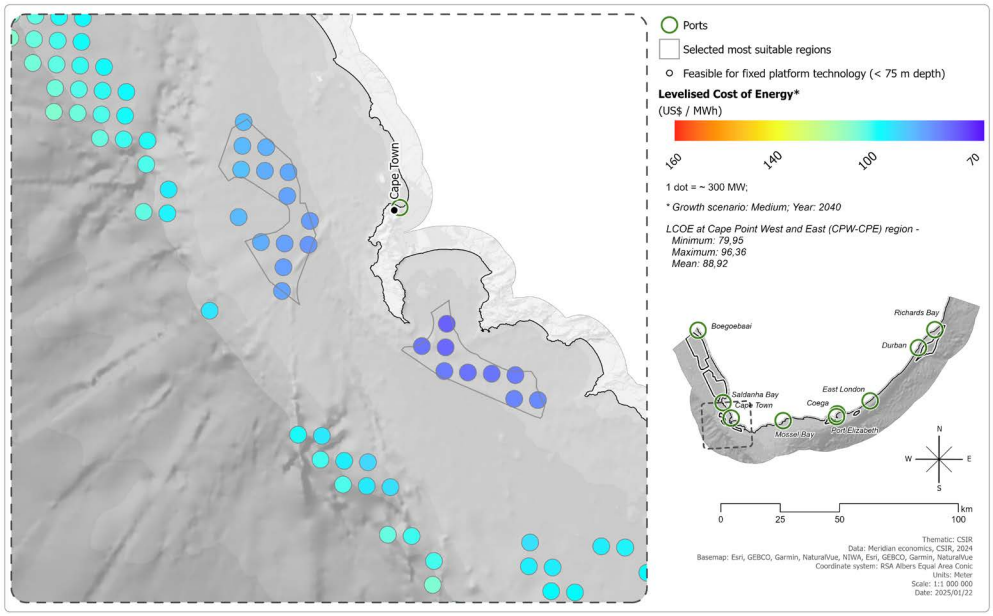


FIGURE 90: LEAST CONSTRAINED AND SELECTED SUITABLE SITES FOR CAPE POINT EAST AND WEST IN RELATION TO WATER DEPTHS FOR FIXED AND FLOATING OSW (CURRENT AND FUTURE).

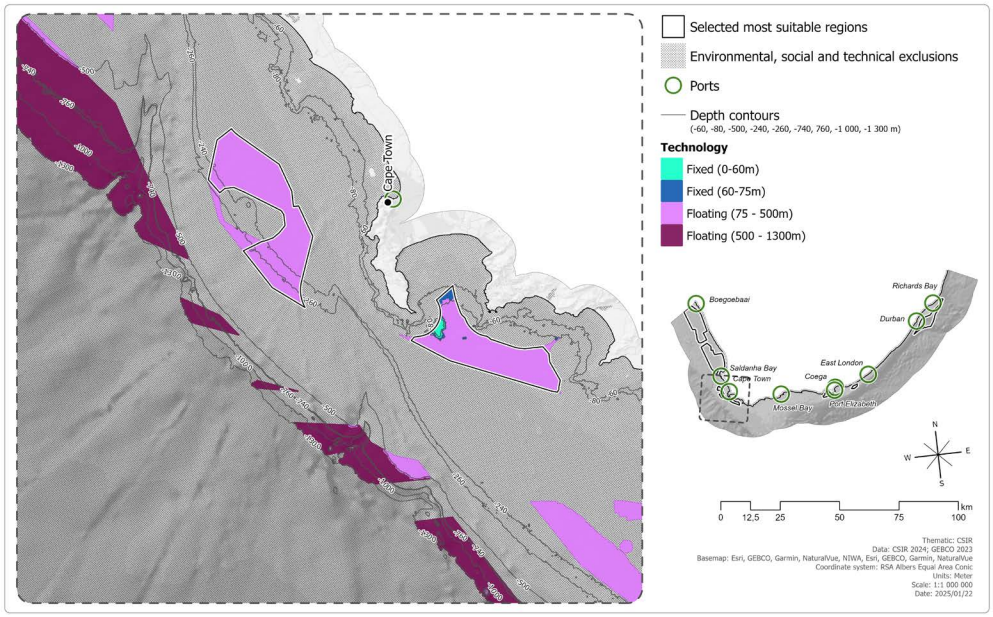


FIGURE 91: LEVELISED COST OF ENERGY FOR DURBAN- RICHARDS BAY UNDER A MEDIUM GROWTH SCENARIO.

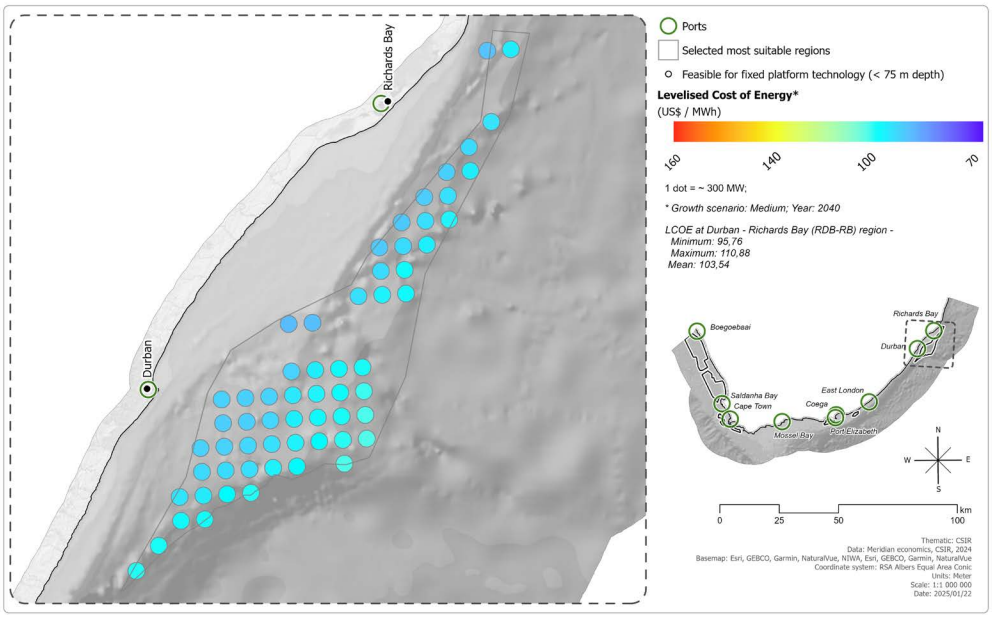


FIGURE 92: LEAST CONSTRAINED AND SELECTED SUITABLE SITES FOR DURBAN — RICHARDS BAY IN RELATION TO WATER DEPTHS FOR FIXED AND FLOATING OSW (CURRENT AND FUTURE).

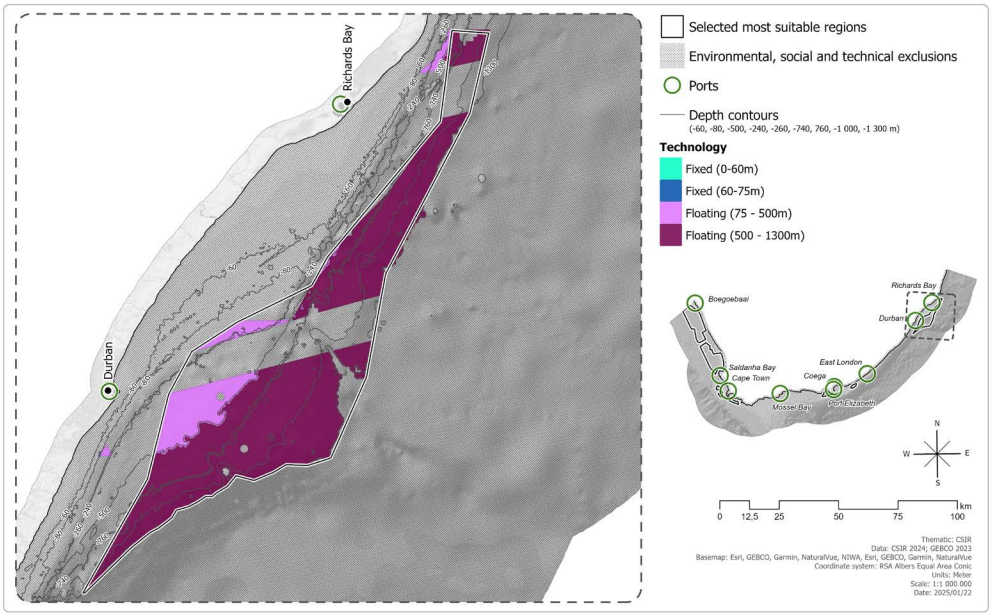


FIGURE 93: LEVELISED COST OF ENERGY FOR SALDANHA BAY-WEST COAST UNDER A MEDIUM GROWTH SCENARIO.

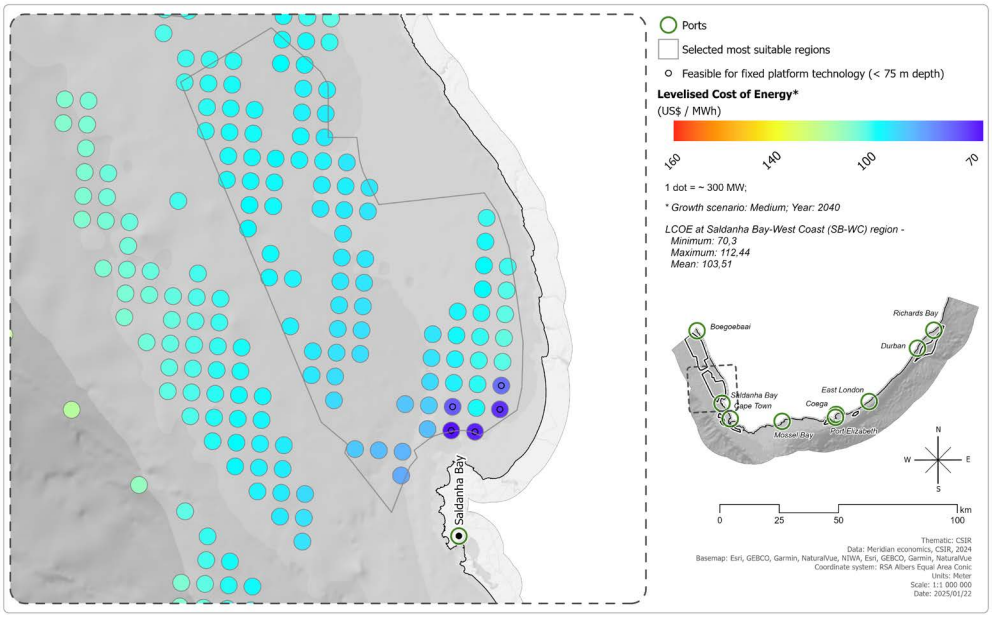
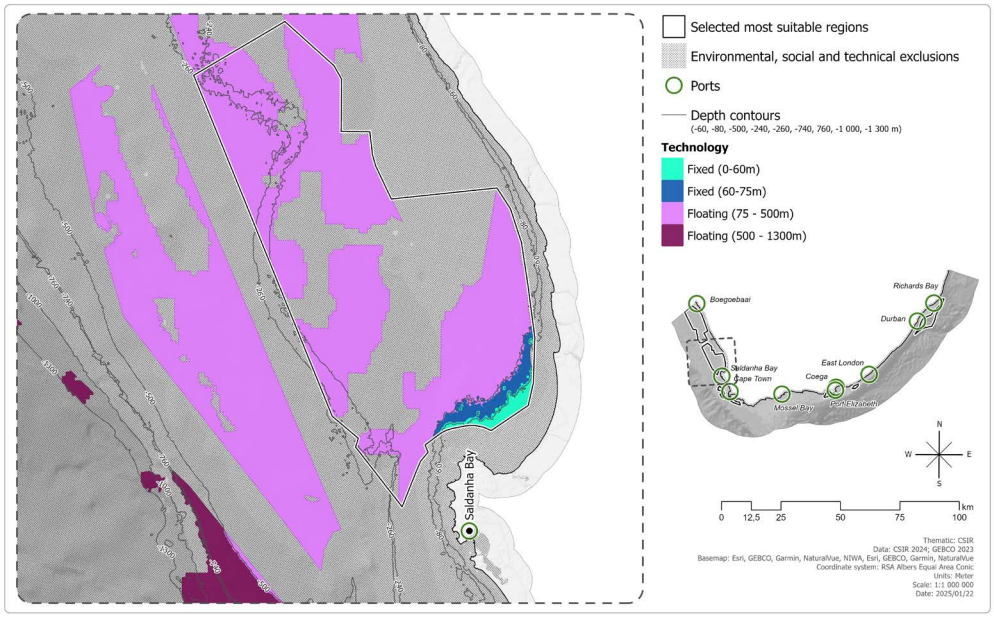


FIGURE 94: LEAST CONSTRAINED AND SELECTED SUITABLE SITES FOR SALDANHA BAY-WEST COAST IN RELATION TO WATER DEPTHS FOR FIXED AND FLOATING OSW (CURRENT AND FUTURE).



APPENDIX 3: SOUTH AFRICA'S PRIORITY BIODIVERSITY VALUES

INTRODUCTION

The World Bank Group (WBG) commissioned The Biodiversity Consultancy to provide environmental support for the WBG Offshore Wind Development Program. This support includes the completion of early-stage identification of priority biodiversity values and available spatial data to inform the offshore wind study for South Africa. Incorporating considerations of priority biodiversity values in the assessment of 'practical potential' for offshore wind development is essential to avoid adverse impacts from inappropriate development and provide a foundation for a pipeline of bankable projects eligible for funding by International Finance Institutions.

The World Bank (WB) and International Finance Corporation (IFC) environment and social requirements are integral to the Offshore Wind Development Program, and the production of *A Strategic Framework for Offshore Wind Development in South Africa*. They enable WB, IFC and client countries to better manage the environmental and social risks of projects, and to improve development outcomes. The WB Environmental and Social Framework, and the IFC Sustainability Framework promote sound environmental and social practices, transparency and accountability. These Frameworks define client responsibilities for managing risks and ensure that offshore wind sector preparatory work is aligned with good international industry practice (GIIP). Of particular relevance to this study are:

- WB Environmental and Social Standard 6 (ESS6): Biodiversity Conservation and Sustainable Management of Living Natural Resources (World Bank 2016), together with the associated Guidance Note ESS6 (World Bank 2018); and
- IFC Environmental and Social Performance Standard 6 (PS6): Biodiversity Conservation and Sustainable Management of Living Natural Resources [350], together with the associated Guidance Note 6.

The objective of this study is to identify priority biodiversity values and areas that support these values that should either be excluded from offshore wind development within the South African exclusive economic zone (EEZ) (i.e. areas of the highest biodiversity sensitivity), or require additional assessment through subsequent Marine Spatial Planning (MSP), site selection and Environmental and Social Impact Assessment (ESIA) processes. To meet GIIP, wind developments in areas supporting priority biodiversity values would likely be subject to restrictions in the form of greater requirements for baseline studies, as well more intensive mitigation measures to avoid, minimise and restore adverse environmental impacts. According to IFC PS6 and WB ESS6, projects situated within Critical Habitat are required to demonstrate that:

- No other viable alternatives within the region exist for development of the project on Modified or Natural Habitat that are not critical;
- The project does not lead to measurable adverse impacts on those biodiversity values for which the Critical Habitat was designated, and on the ecological processes supporting those biodiversity values;
- The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and
- A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program.

In addition, projects need to achieve net gains of those biodiversity values for which the Critical Habitat was identified.

This study has focused on the following key groups of priority biodiversity values, which have been identified through a review of the scientific literature and on experiences in well-developed offshore wind markets:

- Legally Protected Areas (LPAs) and Internationally Recognized Areas (IRAs)
- Marine Mammals
- Birds
- Marine reptiles
- Fish
- Natural Habitats

METHODOLOGY

For each group of priority biodiversity values, the available global and regional spatial datasets were identified and screened for inclusion in one of two spatial data layers for use in this *Strategic Framework for Offshore Wind Development in South Africa*:

1. Exclusion Zone (i.e. areas of the highest biodiversity sensitivity to exclude from the technical assessment of offshore wind resource); and
2. Restriction Zone (i.e. high risk areas requiring further assessment of risk during MSP, site selection and/or ESIA).

Numerous global and regional biodiversity datasets exist (primarily produced by academic, scientific, government, and non-governmental organisations) and are useful and important resources. Broadly, these datasets provide an indication of the distribution of given biodiversity values. For example, datasets show:

- Verified point records of species occurrence;
- Species range maps;

- The extent of a particular habitat or ecosystem type, or location of key habitat features;
- Modelled indicative habitat suitability;
- The boundaries of globally important LPAs and IRAs that represent areas of high biodiversity conservation value.

Threatened and range-restricted species are the focus of Criteria 1 and 2 for the determination of Critical Habitat, as defined by IFC PS6 and therefore represent priority biodiversity values. As a foundational stage, the IUCN Red List of Threatened Species was screened to identify all threatened and all range-restricted[36] marine species with global ranges that overlap with South Africa's Exclusive Economic Zone (EEZ). A full list of the identified threatened species is provided in Appendix A. A detailed literature search was completed to identify spatial data and additional contextual information on these species. In addition to identifying digitised spatial data, many supplementary data sources were identified that provide more detailed information on relevant priority biodiversity values. These sources provide a valuable resource for future MSP, site selection and ESIA stages of offshore wind development in South Africa and are listed in Table 11, along with a short commentary on each dataset highlighting its suitability for MSP.

Early and constructive stakeholder engagement is an essential component of identifying priority biodiversity values, verifying data and ensuring they are considered appropriately and proportionately in planning for offshore wind development. Stakeholder engagement should be an integral and important part of future MSP and ESIA processes. This study of priority biodiversity values has not included a list of relevant environmental stakeholders as a detailed stakeholder mapping exercise has already been conducted by Council for Scientific and Industrial Research (CSIR) as part of the wider offshore wind study for South Africa.

CRITICAL BIODIVERSITY AREAS IN SOUTH AFRICA

The first National Coastal and Marine Spatial Biodiversity Plan (NCMSBP) for South Africa was released in 2020, and updated in December 2022, to inform a range of national planning and decision-making processes, such as integrated coastal management, MSP and ESIA.[351] [352] The NCMSBP provides a robust, spatial prioritization of biodiversity that follows national and international best practice in systematic biodiversity planning. Recent terrestrial classification of Critical Biodiversity Areas (CBAs) in South Africa has typically been conducted at the State-level and been demonstrated to achieve 54-72% reductions in land clearing in CBAs compared to other natural areas.[353]

The output of the NCMSBP is a national Critical Biodiversity Areas map (Figure 1) including four composite spatial layers for the following categories:

- Marine Protected Areas
- Critical Biodiversity Areas – Natural
- Critical Biodiversity Areas – Restore
- Ecological Support Areas.

36 Range-restricted marine species are defined by IFC PS6 as having an Extent of occurrence less than 100,000 km2

Within the EEZ, MPAs comprise 5.4%, CBA Natural comprises 18%, CBA Restore comprises 3.6%, and ESAs comprise 6.6% of the extent.

The development of the map drew from 976 biodiversity features and involved extensive stakeholder engagement across hundreds of representatives of roughly 100 national and international organisations during 19 in-person and virtual meetings between June 2018 and June 2022.

The report includes sea-use guidelines grouping activities in 19 marine economic sectors including renewable energy by their broad sea use (e.g. conservation, or recreation and tourism), MSP zone (including 'Renewable Energy Zone) and assessing these activities according to compatibility with the management objective of the CBA. Sea-use activities were assessed as compatible, not compatible, or as having restricted compatibility with the management objective of each of the four composite CBA map categories.

The guidelines conclude that renewable energy installations are not compatible with CBA — Natural areas, and restricted compatibility with CBA — Restore areas and Ecological Support Areas. For Marine Protected Areas (MPA), which are all included as a separate layer in the CBA map, activities are assessed as dependent on gazetted MPA regulations. The evaluation of sector compatibility was based largely on an ecosystem-pressure matrix developed as part of the National Biodiversity Assessment in 2018.[354]

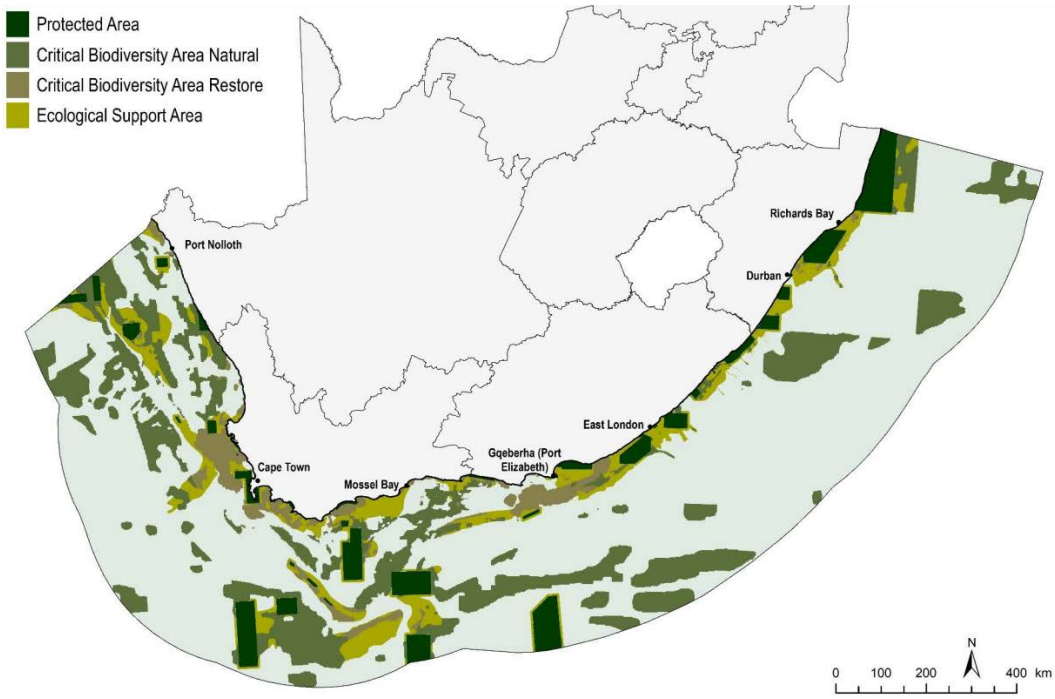
This review of priority biodiversity values to support this WBG offshore wind study for South Africa has not reviewed all 976 individual biodiversity features that informed the CBA map (several of these data layers are currently unpublished/not publicly accessible). However, biodiversity features included in the CBA map and reflected in the composite map categories include ecosystem types[37] (n = 190 features), distributions and areas of importance for species such as turtles, seabirds, dolphins, whales, seals, sharks and rays (n = 188 features), unique or special habitats or features (n = 15), ecological process (n = 18), ecological infrastructure[38] (n = 2) and existing priority areas (n = 24). There is overlap between many marine LPAs and IRAs mentioned in the CBA map but not for sensitive coastal (terrestrial) sites. This review of priority biodiversity values also includes some datasets not incorporated into the CBA map (e.g. Important Shark and Ray Areas- ISRAs).

Critical Biodiversity Areas — Natural have been included in the Exclusion Zone Layer for this report. Critical Biodiversity Areas — Restore and Ecological Support Areas have been included in the Restriction Zone Layer.

37 Comprised of 150 marine ecosystem types, the shores of 24 estuarine ecosystem types and 16 pelagic ecosystem types. There is overlap with Natural Habitat PBVs but most ecosystem features will be additional and worthy of inclusion via incorporation of the CBA layers into the Exclusion and Restriction Zones.

38 'natural and naturally functioning ecological systems or networks of ecological systems that deliver multiple services to humans and enable biodiversity persistence'.

FIGURE 95: NATIONAL COASTAL AND MARINE CBA MAP VERSION 1.2.



LEGALLY PROTECTED AREAS AND INTERNATIONALLY RECOGNIZED AREAS

Following the IUCN definition, an LPA is any clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.[355] IRAs are exclusively defined in IFC PS6 as UNESCO Natural World Heritage Sites, UNESCO Man and the Biosphere Reserves, Key Biodiversity Areas (KBAs), and wetlands designated under the Convention on Wetlands of International Importance (the Ramsar Convention).[356]

LPAs and IRAs represent high value areas designated for various biodiversity conservation objectives, and some should be excluded from consideration for offshore wind development because of this. For example, development in KBAs should be avoided because these sites represent the most important places in the world for particular species and their habitats.[357] Other types of identified areas, such as Other Effective Area-based Conservation Measures (OECMs) or Ecologically or Biologically Significant Marine Areas (EBSAs) may represent much larger spatial areas and offshore wind development may be feasible if it is carefully managed and development activities are coordinated to avoid key sensitive periods for biodiversity — although a site-specific assessment would be required to confirm this.

IFC standards prohibit development in UNESCO Natural and Mixed World Heritage Sites, and Alliance for Zero Extinction (AZE) sites (IFC 2019). There are ten AZE sites in South Africa [358] and five Natural or Mixed World Heritage Sites.[359] However, only three AZEs (Table 6) and one Natural and Mixed World Heritage Site (iSimangaliso Wetland Park) overlap with marine areas within South Africa's EEZ.

Nationally Protected Areas

Protected areas are afforded varying levels of legal protection in different national jurisdictions, often underpinned by commitments made under international conventions.

LPAs in South Africa comprise 9.26% and 15.5% of the country's total land, and marine areas respectively.[360] South Africa does not report IUCN Management Categories for protected areas, but various types of protected areas are listed in the South African Protected and Conservation Areas Database (SAPAD):

- National Parks
- Nature Reserves
- Special Nature Reserves
- Mountain Catchment Areas
- World Heritage Sites
- Protected Environments
- Forest Nature Reserves
- Forest Wilderness Areas
- Marine Protected Areas

Additionally, the South African Conservation Areas Database (SACAD) includes sites that are not necessarily legally protected but may contribute to national conservation goals (many overlap with OECMs:

- Biosphere Reserves
- Conservancies
- Botanical Gardens

The South African EEZ comprises areas in both the South Atlantic Ocean and the Indian Ocean with a meeting point between the two at Cape Agulhas. Within this area, there are 42 spatially-discrete MPAs covering a cumulative 23,905,000 ha (Table 57), as well as an additional 65 coastal 'Nature Reserve' and 'Protected Environment' protected areas covering 125,646 ha (Table 10).

MPAs in South Africa are assigned one or multiple types of zonation, predominantly designed to control fishing:

- **Controlled** (*an area within the MPA where limited fishing or any other activity in terms of section 48A(1) of the National Environmental Management: Protected Areas Act 2003 — 'the Act' may take place if authorized in terms of these regulations as contemplated in terms of section 48A(2) of the Act or if authorized in terms of regulation 4(7).)*
- **Controlled Catch and Release** (*as above, including small areas for catch and release fishing).*
- **Controlled Large Pelagic** (*as above, including pelagic fishing*).
- **Controlled-Pelagic Linefish with list** (*as above, where only pelagic linefishing may occur targeting species from a specified list of fish for that MPA*).
- **Restricted** (*an area within an MPA where no fishing may take place, but where any other activity in terms of section 48A(1) of the Act may take place if authorized in terms of these regulations as contemplated in terms of section 48A(2) of the Act*)'.
- **Sanctuary** (*an area within an MPA where no fishing or any other activity contemplated in terms of section 48A(1) of 'the Act' may take place, except for scientific research purposes as provided for in these regulations*).
- **Wilderness** (*an area within the MPA where no fishing may take place, but where ecotourism activities that maintain wilderness characteristics and attributes may take place if authorized by these regulations*).

Offshore wind developments may cause impacts on biodiversity not only in the marine environment but also in the nearby coastal zone where associated infrastructures (e.g. substation and power lines) will have to be built.[361] Consequently, it is unlikely that offshore wind development would be compatible with the conservation objectives proposed for the designated marine and coastal LPAs. Likewise, some of the priority biodiversity values of these areas are likely to be sensitive to impacts associated with offshore wind development. For these reasons, the list of LPAs with marine or coastal components (Table 57) was included in the Exclusion Zone layer. Due to their large size, Conservation Areas (specifically Biosphere Reserves) with coastal components (Table 58) were included in the Restriction Zone Layer.

TABLE 57: PROTECTED AREAS IN SOUTH AFRICA WITH MARINE OR COASTAL COMPONENTS [362] INCLUDED IN THE EXCLUSION LAYER.

Designation	Legally Protected Area	Total declared area (ha)	Zonation	Details [363]
UNESCO World Heritage Site (WHS)	Cape Floral Region Protected Areas	1,094,742	N/A	Includes 50 protected areas in 13 clusters. It is one of the world's six floral kingdoms, one of the world's 35 biodiversity hotspots, a Global Centre of Plant Diversity, a Global 200 priority ecoregion, and an Endemic Bird Area.
MPA UNESCO WHS	iSimangaliso Wetland Park Marine Protected Area	1,071,051	Controlled; Controlled Catch and Release; Controlled-Pelagic Linefish with list; Restricted; Wilderness	Safeguards feeding areas of Leatherback Turtles. Protects submarine canyons, refuges for Coelacanths. Alignment with world heritage site boundaries. Supports prawn trawl bycatch management. Protects Slinger Seabream and Rockcod aggregations to deliver fisheries benefits.
MPA	Addo Elephant Marine Protected Area	112,709	Controlled; Restricted	Protects a high biodiversity area with many endemic species. Protects estuary and supports the recovery of Dusky Kob. Protects overexploited abalone. Protects feeding areas of Endangered African Penguins. Protects feeding areas of Endangered Cape Gannets. Maintains attractions for marine ecotourism. Provides outdoor classroom and educational opportunities.
MPA	Agulhas Bank Complex Marine Protected Area	431,363	Controlled; Controlled-Pelagic Linefish with list; Restricted	Protects spawning and nursery area of commercially important fish, such as the Red Steenbras (world's largest seabream). Preserves attractions for ecotourism (catch and release marlin fishing and shark diving). Allows for the recovery of linefish and helps long-term sustainability of small-scale fisheries. Protects fishing areas from impacts of mining and petroleum industry.
MPA	Agulhas Front Marine Protected Area	625,554	Restricted	Protects core feeding area of Leatherback Turtles. Protects high diversity of deep-sea habitats. Preserves area important for the life history of large pelagic fish. Protects feeding areas of juvenile and adult Albatrosses.
MPA	Agulhas Muds Marine Protected Area	20,691	Sanctuary	Protects Critically Endangered good condition mud habitat in an area that has been disturbed by trawling and exploration for oil. Supports Hake fishery eco-certification. Supports recovery of Agulhas Sole. Provides baseline for research on mud habitats.

Designation	Legally Protected Area	Total declared area (ha)	Zonation	Details [363]
MPA	Aliwal Shoal Marine Protected Area	67,829	Controlled; Controlled-Pelagic Linefish with list; Restricted	Sustains fisheries by protecting habitats of Geelbek and Dusky Kob, and seasonal protection for spawning aggregations of threatened linefish. Increases social benefits by attracting tourism development linked to beaches, scuba diving and education. Supports shark diving ecotourism by preserving habitats for sharks and protecting these iconic predators.
MPA	Amathole Marine Protected Area	24,775	Controlled; Controlled-Pelagic Linefish with list; Restricted	Protects endemic reef fish. Strong support from the local ski-boat fishing community.
MPA	Amathole Offshore Marine Protected Area	421,328	Controlled; Controlled-Pelagic Linefish with list; Restricted	First protection for many unprotected ecosystem types trawled elsewhere in the Agulhas ecoregion. Threatened canyon and mud habitat in good condition. Sensitive lace corals are found only in this area. High habitat diversity. Linefish recovery.
MPA	Benguela Muds Marine Protected Area	9,249	Controlled Large Pelagic	Threatened habitat types in good condition. Protects sensitive ecosystems.
MPA	Betty's Bay Marine Protected Area	2,014	Controlled	Protection of overexploited reef fish. Protection of nesting Endangered African Penguins. Important site for eco-tourism and environmental education.
MPA	Browns Bank Corals Marine Protected Area	33,943	Controlled Large Pelagic	Cold water corals preserve records of past climates. Protects corals that are important for the eggs and larvae of fish. Protects Hake spawning area. Maintains Hake fishery eco-certification, providing food and job security.
MPA	Cape Canyon Marine Protected Area	58,332	Restricted	Safeguards threatened canyon habitat from trawling and mining. Protects feeding areas of whales and seabirds. Important for sustainability of small pelagic and hake fisheries. Ecotourism potential (e.g. whale watching).
MPA	Childs Bank Marine Protected Area	121,072	Controlled Large Pelagic	Protects unique and sensitive seabed feature — probable carbonate mound. Protects the only known location in South Africa of the habitat forming cold water coral *Desmosphyllum pertusum*. Supports hake fishery eco-certification by protecting vital habitat.
MPA	De Hoop Marine Protected Area	28,887	Restricted	Protects vulnerable reef fish. Provides a safe haven for breeding whales. Important area for tourism and environmental education.

Designation	Legally Protected Area	Total declared area (ha)	Zonation	Details [363]
MPA	Dwesa-Cwebe Marine Protected Area	26,508	Controlled; Restricted	Protects Dusky Kob nursery. Protects White Steenbras spawning area. Promotes nature-based tourism and boosts the local economy.
MPA	Goukamma Marine Protected Area	3,397	Controlled	Safeguards rocky and sandy shore habitats. Protects reef fish habitats. Enhances catches in adjacent fished areas through spill over.
MPA	Helderberg Marine Protected Area	240	Restricted	Protects unique sandy and rocky shore habitats in false bay. Ensures the spiritual landscape remains pristine.
MPA	Hluleka Marine Protected Area	4,086	Restricted	Protects rock lobsters heavily exploited elsewhere. Protects oysters and mussels important for neighbouring communities. Provides benchmark to study intertidal communities.
MPA	Jutten Island Marine Protected Area	111	Controlled	*See Sixteen Mile Beach.*
MPA	Langebaan Lagoon Marine Protected Area	4,672	Controlled; Restricted; Sanctuary	*See Sixteen Mile Beach.*
MPA	Malgas Island Marine Protected Area	66	Controlled	*See Sixteen Mile Beach.*
MPA	Marcus Island Marine Protected Area	25	Controlled	*See Sixteen Mile Beach.*
MPA	Namaqua Fossil Forest Marine Protected Area	49,423	Controlled; Restricted	Protects unique fossilized Yellowwood forest with sensitive cold-water corals, mud habitat and sponge gardens. Provides valuable information about past climate. Protects fishing grounds and Hake nursery area from mining and other activities that impact the seabed.
MPA	Namaqua National Park Marine Protected Area	54,940	Controlled	First protection for Namaqua ocean ecosystem types and a priority estuary. Protects Hake nursery habitat. Supports recovery of West Coast Rock Lobster. Important ecotourism area.
MPA	Orange Shelf Edge Marine Protected Area	184,222	Sanctuary	Protects only un-trawled shelf edge in region. Protects feeding areas for threatened Albatrosses. Protects important areas for the life history of pelagic sharks. Maintains Hake fishery eco-certification, supporting food and job security.
MPA	Pondoland Marine Protected Area	123,714	Restricted	Protects some of South Africa's healthiest estuaries. Protects linefish and allows for their recovery. Protects a wide diversity of endemic invertebrates and seaweeds.

Designation	Legally Protected Area	Total declared area (ha)	Zonation	Details [363]
MPA	Port Elizabeth Corals Marine Protected Area	27,040	Controlled; Large Pelagic	Protects important spawning area for kingklip — a valuable fisheries resource. Protects a unique geological feature and coral ecosystems. Maintains eco-certification of fishery by protecting important seabed features.
MPA	Prince Edward Island Marine Protected Area[39]	18,122,946	Controlled; Restricted	Protects Patagonian Toothfish (*Dissostichus eleginoides*) and allows for recovery. Protects feeding areas for seals, seabirds and killer whales. Protects South Africa's only sub-Antarctic benthic ecosystems. Home to 40% of the world's Wandering Albatrosses.
MPA	Protea Banks Marine Protected Area	119,012	Controlled; Controlled-Pelagic Linefish with list; Restricted	Protects seven shark species. Protects unique deep reefs and three submarine canyons. Protects spawning area for commercial linefish and allows recovery. Secures the value of the area for ecotourism (including the Sardine Run).
MPA	Robben Island Marine Protected Area	61,230	Controlled; Restricted	Protects breeding and feeding areas of endangered seabirds. Contributes to recovery of abalone and west coast rock lobster. Important tourism area for wildlife and cultural heritage.
MPA	Robberg Marine Protected Area	2,618	Controlled	Protects sandy and rocky shore ecosystems. Protects feeding areas of seals and seabirds. Preserves coast with rich human history.
MPA	Rocher Pan Marine Protected Area	151	Restricted	Safeguards sandy shore and nearshore habitat. Protects surf zone fish. Protects coastal seabirds.
MPA	Sardinia Bay Marine Protected Area	1,291	Restricted	Protects abalone. Protects linefish species such as musselcracker. Protects uniquely South African sponges, soft corals and seasquirts.
MPA	Sixteen Mile Beach Marine Protected Area	10,691	Controlled	Protects migratory wading birds. Protects nesting areas of endangered seabirds. Protects nursery area for fish and invertebrates.
MPA	Southeast Atlantic Seamounts Marine Protected Area	772,515	Controlled Large Pelagic; Restricted	Protects important seamount ecosystems. Takes care of sensitive habitats and slow growing creatures. Life history importance for seabirds and turtles.
MPA	Southwest Indian Seamount Marine Protected Area	755,810	Restricted	Protects a wide range of ecosystems from 200 m to 2000 m and enhances resilience to climate change. Protects three different fragile coral habitats. Provides first protection of an Indian Ocean seamount and deep abyssal plains. Protects vital nursery area for young mako sharks.

39 EEZ not contiguous with that of the South African mainland coastline.

Designation	Legally Protected Area	Total declared area (ha)	Zonation	Details [363]
MPA	Stilbaai Marine Protected Area	3,489	Controlled; Restricted	Protects the Goukou Estuary and its role as a fish nursery. Preserves historical marine artefacts and cultural assets. Allows for the recovery of overexploited fish species.
MPA	Table Mountain National Park Marine Protected Area	95,586	Controlled; Restricted	• Promotes tourism • Important refuge for abalone and west coast rock lobster • Allows for the recovery of reef fish • Protects historical marine sites
MPA	Trafalgar Marine Protected Area	829	Controlled	Protects healthy estuary. Protects intertidal fossils and diverse seaweeds. Allows for the recovery and spillover of reef fish into adjacent areas.
MPA	Tsitsikamma Marine Protected Area	29,366	Controlled; Restricted	Protects endemic fishes and allows for spillover into adjacent areas. Provides valuable benchmark for scientists to study healthy fish stocks. Preserves unique coastline that attracts tourists.
MPA	uThukela Marine Protected Area	409,944	Controlled; Controlled-Pelagic Linefish with list; Restricted	Protects rare and threatened seabed habitats (offshore paleo-estuarine habitat, reefs and submarine canyon). Preserves ecological processes and connectivity. Spawning & nursery areas for overexploited fish species. Protects linefish and allows for their recovery.
MPA	Walker Bay Whale Sanctuary Marine Protected Area	11,249	Restricted; Sanctuary	Safeguards an area for whales to rest without being disturbed. Protects rocky and sandy shore habitats. Protects kelp forests.

TABLE 58: CONSERVATION AREAS IN SOUTH AFRICA WITH MARINE OR COASTAL COMPONENTS [364], INCLUDED IN THE RESTRICTION LAYER.

Conservation Area Name	Total declared area (ha)
Cape West Coast Biosphere Reserve	386,151
Garden Route Biosphere Reserve	698,201
Gouritz Cluster Biosphere Reserve	3,189,553
Kogelberg Biosphere Reserve	108,288

Other Effective Area-based Conservation Measures

OECMs complement legally protected areas through sustained, positive conservation outcomes, even though they may be managed primarily for other reasons than biodiversity conservation. They are documented in the World Database on OECMs (WDOECM) [365] and, like LPAs, their conservation outcomes contribute to Target 3 of the Kunming-Montreal Global Biodiversity Framework of 'Conserving 30% of Land, Waters and Seas by 2030'.[366]

South Africa is one of the ten countries globally that have so far identified OECMs and the WDOECM currently features 17 sites in South Africa, four of which are coastal and cover significant stretches of coastline and overlap with the sites in the SACAD (Table 58, Table 59). Due to the very large spatial extent of the four coastal OECMs, these sites are included in the Restriction Zone Layer, except where they overlap with other LPA or IRA designations of the exclusion layer.

TABLE 59: OTHER EFFECTIVE AREA-BASED CONSERVATION MEASURES IN SOUTH AFRICA. [367]

Other Effective Area-based Conservation Measure	Total declared area (ha)
Cape West Coast Biosphere Reserve	386,161
Garden Route Biosphere Reserve	698,200
Gouritz Cluster Biosphere Reserve	3,189,557
Kogelberg Biosphere Reserve	108,288

Ramsar Sites

Ramsar sites are wetlands of international importance that have been designated under the criteria of the Ramsar Convention on Wetlands for containing representative, rare or unique wetland types, or for their importance in conserving biological diversity.

There are 29 Ramsar sites in South Africa, with 14 of these being coastal or marine sites therefore considered in this study [368][40] (Table 60). Due to the importance of the biodiversity values in these coastal ecosystems, coastal and marine Ramsar sites have been included in the Exclusion Zone layer.

TABLE 60: COASTAL RAMSAR SITES IN SOUTH AFRICA[41].

Ramsar site name	Total declared area (ha)
Berg Estuary Ramsar Site	1,162
Bot – Kleinmond Estuarine System	1,350
Dassen Island Nature Reserve	737
De Mond	986
Dyer Island Provincial Nature Reserve and Geyser Island Provincial Nature Reserve	289
False Bay Nature Reserve	1,543
Kosi Bay	17,335
Lake Sibaya	6,009
Langebaan	5,588

40 https://www.ramsar.org/country-profile/south-africa

41 Register of Protected Areas: https://dffeportal.environment.gov.za/portal/apps/webappviewer/index.html?id=7e27f116dd194c1f9d446dacc76fe483

Ramsar site name	Total declared area (ha)
Orange River Mouth	2,299
St. Lucia System	139,284
Turtle Beaches/Coral Reefs of Tongaland	74,641
Verlorenvlei	1,449
Wilderness Lakes	1,133

Key Biodiversity Areas

KBAs have been identified to represent the most important places in the world for particular species and their habitats. KBAs are identified using a global standard that includes objective criteria that were developed through a multi-stakeholder process.[42] These criteria include quantitative thresholds that mean KBAs are globally important for the long-term survival of biodiversity. KBA identification is rigorous, transparent and can be applied consistently in different countries and over time.

Sites qualify as KBAs if they meet one or more of 11 criteria, clustered into five higher level categories: threatened biodiversity, geographically restricted biodiversity, ecological integrity, biological processes, and irreplaceability (KBA Criteria n.d.). The KBA criteria are broadly aligned with IFC PS6 criteria for Critical Habitat, although KBA criteria are wider, and therefore not all KBAs will qualify as Critical Habitat. All BirdLife International Important Bird Areas (IBAs) are also classified as KBAs, although some 'legacy sites' identified prior to the publication of the global KBA standard may not meet the current criteria and therefore might be treated as regional or national KBAs. All existing Alliance for Zero Extinction (AZE) sites are also KBAs under Criterion A1e relating to a site that holds effectively the entire population of a Critically Endangered or Endangered species.

Marine IBAs

The BirdLife International Global Seabird Programme has identified Marine IBAs that include seabird breeding colonies, foraging areas around breeding colonies, non-breeding (usually coastal) concentrations, migratory bottlenecks and feeding areas for pelagic species. The methodology for the designation of marine IBAs is described in the marine IBA toolkit (BirdLife International 2010).

South Africa has 10 confirmed[43] Marine IBAs, as well as four Proposed sites and one Candidate site; and an additional seven coastal KBAs with relevant marine features (Table 61)[44]. All Confirmed and Proposed Marine IBAs, as well as coastal KBAs with relevant marine features are included in the Exclusion Zone Layer. Proposed Marine IBAs have been included due to their representation of important foraging areas for the PBV bird species and the fact that the currently confirmed Marine IBAs are limited to representing the colony sites themselves. The Candidate Marine IBA has not been included in the Exclusion or Restriction Layer as, whilst it has been identified during global-level analysis as potentially meeting IBA Criteria, further work is needed to build the case for this site.

42 https://portals.iucn.org/library/sites/library/files/documents/2016-048.pdf

43 Confirmed Marine IBAs are those that have been accepted following independent scientific review and are available to view on the World Database on Key Biodiversity Areas. Candidate and Proposed Marine IBAs have not yet been reviewed and are only available on the Marine IBA e-atlas.

44 https://maps.birdlife.org/marineibas/

TABLE 61: KBAS/IBAS IN SOUTH AFRICA WITH MARINE OR COASTAL COMPONENTS AND ASSOCIATED PRIORITY BIODIVERSITY[45].

KBA	Status	Area (ha)	KBA Triggers[46]	
			Threatened Species	Priority Marine Biodiversity / Congregations
Algoa Bay Islands: Addo Elephant National Park	Confirmed Marine IBA	40	**African Penguin** (*Spheniscus demersus*, EN) (21,200 breeding pairs, 60,000 non-breeding individuals); **Cape Gannet** (*Morus capensis*, EN) (59,000 breeding pairs, 140,000 non-breeding individuals).	Kelp Gull (*Larus dominicanus*, LC) (500-900 breeding pairs, 1,000-1,950 non-breeding individuals); Roseate Tern (*Sterna dougallii*, LC) (180 breeding pairs, 400 non-breeding individuals); Antarctic Tern (*Sterna vittate*, LC) (500 – 5,000 non-breeding individuals).
Agulhas Plain — Heuningnes Estuary	Confirmed Marine IBA	9,000	N/A	Kelp Gull (300-450 breeding pairs, 700-1,000 non-breeding individuals);
Berg River Estuary	Confirmed Marine IBA	6,621	N/A	Hartlaub's Gull (*Larus hartlaubii*, LC) (500-650 breeding pairs, 1,341-2030 non-breeding individuals); Kelp Gull (250-500 breeding pairs, 657-1,640 non-breeding individuals); Caspian Tern (*Hydroprogne caspia*, LC) (106-199 non-breeding individuals); Sandwich Tern (695-1,555 non-breeding individuals); Greater Crested Tern (*Thalasseus bergii*, LC) (160-646 non-breeding individuals).
Boulders Beach	Confirmed KBA	42	**African Penguin** (A1a, A1c,)	African Penguin (D1a).
Cape Whale Coast	Confirmed KBA	26,310	**Bot River Klipfish** (A1e)	N/A
Dassen Island	Confirmed Marine IBA	273	**African Penguin** (8,000-9,000 breeding pairs, 30,000 non-breeding individuals); **Cape Cormorant** (*Phalacrocorax capensis*, EN) (13,767-48,000 breeding pairs, 30,000-100,000 non-breeding individuals); **Bank Cormorant** (*Phalacrocorax neglectus*, EN) (30-50 breeding pairs, 50-200 non-breeding individuals);	Crowned Cormorant (*Microcarbo coronatus*, LC) (80-175 breeding pairs, 400 non-breeding individuals); Hartlaub's Gull (30-100 breeding pairs, 250 non-breeding individuals); Kelp Gull (5,000-7,500 breeding pairs, 12,000-18,000 non-breeding individuals); Greater Crested Tern (3,038 breeding pairs, 400-7,000 non-breeding individuals).

45 http://www.ibat-alliance.org/, https://www.keybiodiversityareas.org/kba-data

46 Biodiversity features triggering the qualification of the site under the Global Standard for the Identification of Key Biodiversity Areas.

KBA	Status	Area (ha)	KBA Triggers[46]	
			Threatened Species	Priority Marine Biodiversity / Congregations
Dyer Island Nature Reserve	Confirmed KBA	389	**Cape Cormorant** (A1a, A1c); African Penguin (A1a, A1c)	African Penguin (D1a, B1); Cape Cormorant (B1, D1a); Crowned Cormorant (B2, D1a); Hartlaub's Gull (D1a); African Oystercatcher (*Haematopus moquini*, LC) (D1a).
False Bay Nature Reserve	Confirmed Marine IBA	3,000	**Cape Cormorant** (1,000-15,000 breeding pairs, 2,665-40,000 non-breeding individuals);	Great Crested Grebe (*Podiceps cristatus*, LC) (25-51 non-breeding individuals); Black-necked Grebe (*Podiceps nigricollis*, LC) (328-1,380 non-breeding individuals); Hartlaub's Gull (1,156-3,506 non-breeding individuals); Kelp Gull (996 -3,685 non-breeding individuals); Sandwich Tern (3,027 non-breeding individuals); Greater Crested Tern (753 non-breeding individuals).
iSimangaliso Wetland Park	Confirmed KBA	217,970		Caspian Tern (170 breeding pairs, 850 non-breeding individuals).
Maitland — Gamtoos coast	Confirmed KBA	1,502	N/A	African Oystercatcher (D1a).
Orange River Mouth Wetlands	Confirmed KBA	2,307	**Cape Cormorant** (A1a, A1c)	Cape Cormorant (D1a); Hartlaub's Gull (D1a)
Prince Edward Islands Special Nature Reserve	Confirmed KBA	33,283	*N/A Only relevant to Prince Edward and Crozet Islands, not the South African continental coastline.*	*N/A. Only relevant to Prince Edward and Crozet Islands, not the South African continental coastline.*
Rietvlei Wetland: Table Bay Nature Reserve	Confirmed Marine IBA	527	N/A	Great Crested Grebe (54 non-breeding individuals); Hartlaub's Gull (150-375 breeding pairs, 543-1,102 non-breeding individuals); Kelp Gull (665 non-breeding individuals).
Robben Island	Confirmed Marine IBA	574	**African Penguin** (4,000-5,000 breeding pairs, 8,000-14,000 non-breeding individuals); **Cape Cormorant** (1,000-3,000 breeding pairs, 5,000-10,000 non-breeding individuals); **Bank Cormorant** (57-106 breeding pairs, 180-250 non-breeding individuals);	Crowned Cormorant (40-108 breeding pairs, 300 non-breeding individuals); Hartlaub's Gull (100-4,309 breeding pairs, 5,000-10,000 non-breeding individuals); Greater Crested Tern (2,300 breeding pairs, 500-3,000 non-breeding individuals).

KBA	Status	Area (ha)	KBA Triggers[46]	
			Threatened Species	Priority Marine Biodiversity / Congregations
Swartkops Estuary — Redhouse and Chatty Saltpans	Confirmed Marine IBA	926	N/A	Kelp Gull (430 breeding pairs, 1,112 non-breeding individuals);
West Coast National Park and Saldanha Bay Islands	Confirmed Marine IBA	27,600	**African Penguin**; **Cape Gannet** (20,200 breeding pairs, 40,000-50,000 non-breeding individuals); **Cape Cormorant** (4,000-10,000 breeding pairs, 12,000-32,000 non-breeding individuals); **Bank Cormorant** (220-300 breeding pairs, 500-600 non-breeding individuals);	Hartlaub's Gull (2,000-3,000 breeding pairs, 5,000-7,000 non-breeding individuals); Kelp Gull (500-3,347 breeding pairs, 1,407-8,000 non-breeding individuals); Common Tern (*Sterna hirundo*, LC) (1,299-9,658 non-breeding individuals); Greater Crested Tern (50-4,070 breeding pairs, 203-9,000 non-breeding individuals).
Woody Cape Section: Addo Elephant National Park	Confirmed Marine IBA	15,460	N/A	Damara Tern (no KBA assessment details regarding the breeding or non-breeding population)
Alexandria coastal belt / Algoa Bay Island Nature Reserve	Proposed Marine IBA	1,596,739	N/A	Seaward extensions around breeding colonies; Algoa Bay Island Nature Reserve, Alexandria coastal belt, Swartkops estuary, Redhouse and Chatty saltpans include key near-colony areas for breeding populations of Cape Gannet 88,500-150,450 individuals; African Penguin 50,880-60,420 individuals; Roseate Tern 351-513 individuals; Kelp Gull 1,995-3,791 individuals and Damara Tern.
Atlantic, Southeast 19	Proposed Marine IBA	1,084,339	**Indian Yellow-nosed Albatross** (*Thalassarche carteri*, EN) (423,014 non-breeding individuals)	N/A
Bird Island / Dassen Island / Heuningnes river and estuary system / Lower Berg river wetlands	Proposed Marine IBA	3,262,419	**African Penguin** (50,602); **Cape Gannet** (66,810); **Cape Cormorant** (301,266); **Bank Cormorant** (1,231).	Crowned Cormorant (3,054); Hartlaub's Gull; Kelp Gull (33,992); Damara Tern; Caspian Tern (82); Greater Crested Tern (27,668).

KBA	Status	Area (ha)	KBA Triggers[46]	
			Threatened Species	Priority Marine Biodiversity / Congregations
Lake St Lucia and Mkuze swamps	Proposed Marine IBA	285, 520	N/A	Grey-headed Gull (*Larus cirrocephalus*, LC) 733-1,332 non-breeding individuals; Caspian Tern (*Hydroprogne caspia*, LC) 180-300 breeding pairs.
Orange river mouth wetlands	Candidate Marine IBA	240,000	**Cape Cormorant** (14,250)	Kelp Gull (450); Damara Tern.

AZE Sites

The Alliance for Zero Extinction (AZE) was established to designate and conserve the most important sites for global biodiversity. AZE engages governments, multilateral institutions and non-governmental biodiversity conservation organisations working to prevent species extinctions. There are 899 globally identified AZE sites, which are the areas that hold the last-remaining populations of one or more species evaluated as Critically Endangered or Endangered by the IUCN Red List.[47]

IFC Guidance Note 6 considers "sites that fit designation criteria for the Alliance for Zero Extinction (AZE)" not acceptable for financing with a possible exception of projects designed to contribute to the conservation of the area[48].

There are 22 AZE sites in South Africa; three of which have coastal and marine components; **Cape Whale Coast**, **Port Nolloth / McDougall's Bay**, and **Woody Cape Section: Addo Elephant National Park**. Table 62 provides a list of these sites with species that trigger designation of each. AZE sites are included in the Exclusion Zone Layer.

TABLE 62: AZE SITES IN SOUTH AFRICA WITH COASTAL AND MARINE COMPONENTS.

AZE Site	Area (ha)	AZE Trigger Species (Criterion A1e)
Cape Whale Coast	26,310	Bot River Klipfish, (*Clinus spatulatus*, CR)
Port Nolloth / McDougall's Bay	795	De Winton's Golden Mole (*Cryptochloris wintoni*, CR)
Woody Cape Section: Addo Elephant National Park	136,417	Alexandria Cycad (*Encephalartos arenarius*, EN)

47 https://zeroextinction.org/

48 IFC 2019, GN6

Important Marine Mammal Areas

Important Marine Mammal Areas (IMMAs) are a joint project between the IUCN Species Survival Commission (SSC) and World Commission on Protected Areas (WCPA).[49] IMMAs are defined as discrete portions of habitat, important to marine mammal species that have the potential to be delineated and managed for conservation. IMMAs are designated using standard criteria:

- **Criterion A** – Species or Population Vulnerability: Areas containing habitat important for the survival and recovery of threatened and declining species.
- **Criterion B** – Distribution and Abundance (including small and resident populations, and aggregations).
- **Criterion C** – Key Life Cycle Activities (including reproduction, feeding and migration).
- **Criterion D** – Special Attributes (including distinctiveness and diversity).

The criteria have quantitative thresholds that are aligned with both IUCN standard for the identification of KBAs, and IFC PS6 criteria for Critical Habitat. Therefore, IMMAs should generally meet IUCN KBA and potentially IFC Critical Habitat criteria.

There are three overlapping IMMAs in South Africa: **Cape Coastal Waters**, **South East African Coastal Migration Corridor**, and **Southern Coastal and Shelf Waters of South Africa** (Table 63). These IMMAs cover the entirety of the assessed coastline; the waters off the Northern Cape have not yet been assessed for IMMAs. Due to the large spatial extent of the three IMMAs and lack of detailed spatial information on the distribution of their biodiversity values, current IMMAs are included in the Restriction Zone Layer (note that in places, IMMAs may overlap with, LPA or IRA designations included in the Exclusion layer). Additional survey data are required to better assess whether offshore wind development is appropriate within IMMAs. When the waters off the Northern Cape have been assessed for IMMAs, these should be considered for addition to the Restriction Zone Layer.

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TABLE 63: IMMAS IN SOUTH AFRICA.

IMMA	Area (ha)	Primary Species	IMMA Criteria[50]	Additional Species — (IMMA Criterion D (ii) Diversity)	Description
Cape Coastal Waters	635,900	Southern Right Whale (*Eubalaena australis*, LC)	Criteria B (2); C (1)	Indian Ocean Humpback Dolphin (*Sousa plumbea*, EN); Bottlenose Dolphin (*Tursiops truncates*, LC)	The Cape Coastal Waters IMMA serves as one of the world's three most important calving and nursery grounds for Southern Right Whales. Decades of aerial surveys reveal that the species is present between June and November each year, and that densities of cow-calf pairs are highest in the nearshore waters between Cape Agulhas and the eastern extent of St. Sebastian Bay, while unaccompanied adults are most common between Walker Bay and False Bay. Most mother-calf pairs are encountered within about 0.9 km from the shore, with an apparent preference for sheltered, shallow, waters of sedimentary substrate that are protected from open-ocean swell and seasonal winds.
South East African Coastal Migration Corridor	4,706,000	Humpback Whale (*Megaptera novaeangliae*, LC).	Criterion C (3)	Indian Ocean Humpback Dolphin; Southern Right Whale; Spinner Dolphin (*Stenella longirostris*, LC); Killer Whale (*Orcinus orca*, DD); Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus*, NT); Common Dolphin (*Delphinus delphis*, LC)	This IMMA serves as the primary migration route for Southern Hemisphere Humpback Whales that feed in (sub) Antarctic waters during the Austral summer (December – May). These whales have been shown to migrate to and from a breeding area off the coast of Mozambique. As they swim northward along the east coast of South Africa between June and August, they are funnelled closer to shore by the Agulhas Current. During the southward migration from September to November, they appear to swim slightly further offshore, but generally within 15 km of the coast.

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IMMA	Area (ha)	Primary Species	IMMA Criteria[50]	Additional Species — (IMMA Criterion D (ii) Diversity)	Description
Southern Coastal and Shelf Waters of South Africa	16,670,000	Indian Ocean Humpback Dolphin; Bryde's whale — (*Balaenoptera edeni*, LC); Indo-Pacific Bottlenose Dolphin; Common Dolphin; Cape Fur Seal (*Arctocephalus pusillus*, LC).	Criteria A; B (1); C (2)	Humpback Whale; Southern Right Whale; Killer Whale	The southern coast of South Africa represents one of the world's most productive marine regions, famed for its annual 'Sardine Run' which occurs along the southeast coast between May and June. This annual event supports a number of top predator marine mammals. The inshore waters, within 500 m of the coast and with water depths of less than 25 m, provide important year-round habitat for feeding and reproduction for Indian Ocean Humpback Dolphins. Furthermore, the waters over the continental shelf, present important habitat for the inshore form of Bryde's Whale.

Ecologically or Biologically Significant Areas

EBSAs are special areas in the ocean that support the healthy functioning of oceans and the many services that it provides. The Conference of the Parties (COP 9) to the Convention on Biological Diversity adopted the following seven scientific criteria for identifying EBSAs: *Uniqueness or Rarity; Special importance for life history stages of species; Importance for threatened, endangered or declining species and/or habitats; Vulnerability, Fragility, Sensitivity, or Slow recovery; Biological Productivity; Biological Diversity;* and *Naturalness.*

The identification of EBSAs and the selection of conservation and management measures is a matter for States and competent intergovernmental organizations, in accordance with international law (including the UN Convention on the Law of the Sea). The criteria do not include quantitative thresholds, but in principle they have a lot in common with the WBG/IFC Natural Habitats definition and Critical Habitat criteria, and could therefore constitute an important high-level planning consideration for offshore wind development.

South Africa currently has 12 EBSAs solely within its national jurisdiction, shares eight transboundary EBSAs with other countries and/or the high seas, and has three new proposed EBSAs (Table 64). Due to the large spatial extent of the EBSAs and lack of detailed spatial information on the distribution of their biodiversity values, all EBSAs (confirmed and proposed) are included in the Restriction Zone Layer (note that in places, EBSAs may overlap with LPA or IRA designations included in the Exclusion layer). Additional survey data are required to better assess whether offshore wind development is appropriate within EBSAs.

TABLE 64: EBSAS IN SOUTH AFRICA [51].

EBSA	Area (ha)	Status	Significance
Agulhas Bank Nursery Area	2,391,928	Confirmed – note changes to site extent[52]	The Agulhas Bank is a spawning ground and nursery area and is the centre of abundance for numerous warm temperate species. The area includes critically endangered mud habitats and unique high-profile volcanic offshore reefs that support cold-water coral communities. Overexploited and threatened fish that have spawning aggregations in this area include the endemic Dageraad (*Chrysoblephus cristiceps*, CR), Red Steenbras (*Petrus rupestris*, EN) and Black Musselcracker (*Cymatoceps nasutus*, VU). Key activities in the area include commercial demersal trawl and longline fisheries, a midwater trawl fishery, trap fisheries for rock lobster and linefishing.
Agulhas Front	420,726,631	Confirmed (transboundary)	The site has uniquely high productivity mainly within areas beyond national jurisdiction (ABNJ) of the Indian Ocean and supports a significant diversity of biota, including charismatic and threatened species such as Southern Bluefin Tuna (*Thunnus maccoyii*, EN), Southern Right Whale, pinnipeds and seabirds, including the endemic Endangered Amsterdam Albatross (*Diomedea amsterdamensis*, EN).
Agulhas Slope and Seamounts	2,564,724	Confirmed – note changes to name (Mallory Escarpment and Trough Complex AND Shackleton Seamount Complex) and site extent.[53,54]	These areas include three of four known seamounts within the Davie Seamount cluster and have high pelagic and benthic habitat heterogeneity. These seamounts are relatively isolated and are likely to host distinct communities. It is also the only trough system in the Benguela region, and slopes as steep as 20° are globally very rare. The area is recognised as a spawning area for sardine, anchovy, horse mackerel and hake. Eddies in this area help recirculate water inshore and link important nursery areas with spawning habitat on the shelf edge. The shelf edge constitutes a foraging area for offshore seabirds including Albatrosses.

51 https://www.cbd.int/ebsa/

52 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Agulhas-Bank-Nursery-Area

53 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Shackleton-Seamount-Complex-(Agulhas-Slope-and-Sea

54 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Mallory-Escarpment-and-Trough-(Agulhas-Slope-and-S

EBSA	Area (ha)	Status	Significance
Algoa to Amathole		Confirmed[55] – note changes from 'Offshore of Port Elizabeth' EBSA	There are 36 ecosystem types represented, with benthic features including stromatolites, canyons, steep shelf edge, deep reefs, outer shelf and shelf edge gravels, and reef-building cold-water corals ranging in depth between -100 and -1000 m. Algoa Bay hosts the largest pods of Bottlenose Dolphins, largest colony of African Penguins, and largest colony of Cape Gannets in the world. The new delineation of this EBSA to include priority estuaries, now includes breeding sites of the Critically Endangered, and locally endemic pipefish: Estuarine Pipefish (*Syngnathus watermeyeri*, CR). Habitats may support fragile habitat-forming species. Cold-water corals (*Goniocorella Dumosa* and *Solenosmilia variabilis*) have been recorded in the area.
Benguela Upwelling System	49,561,696	Confirmed (transboundary)	The Benguela upwelling system is bounded in the north and south by warm water current systems and characterized by very high primary production (>1000 mg C/ m_2/day). This high biological productivity supports numerous commercial, artisanal and recreational fisheries. It includes important spawning and nursery areas for fish (sardine, horse mackerel, anchovy), as well as foraging areas for endangered and threatened bird species including African Penguin, Cape Gannet, Bank Cormorant, and Cape Cormorant, as well as a number of albatross, petrel and shearwater species. In South Africa the system encompasses a key foraging area for populations of Southern Right Whale (*Eubalaena australis*, LC) and Humpback Whale.

55 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Algoa-to-Amathole-(Offshore-of-Port-Elizabeth)

EBSA	Area (ha)	Status	Significance
Browns Bank	991,398	Confirmed – note changes to site extent[56].	Browns Bank includes benthic and pelagic habitats of the outer shelf and shelf edge along the western continental margin of South Africa. The area includes reef-building cold-water corals and untrawled hard grounds. The biodiversity at Browns Bank includes benthic macrofaunal communities characterized by high abundances of brittle stars and many species of polychaetes; cold-water corals, brisingid starfish, and 77 morphospecies of macroinvertebrates have also been collected within the area. It is an important fish spawning area for demersal and pelagic species. The spawning area is linked to nursery grounds on the inshore area of the west coast and the Agulhas Bank. he area is important for threatened habitats and species, including a Critically Endangered benthic ecosystem type (Southern Benguela Rocky Shelf Edge Mosaic) and overlapping substantially with two proposed marine IBAs, namely for Cory's Shearwater (*Calonectris borealis*, LC) and Atlantic Yellow-nosed Albatross (*Thalassarche chlororhynchos*, EN). The area is also important for juvenile Cape Rock Lobsters (*Jasus lalandii*, LC).
Cape Canyon and Surrounds	2,084,356	Confirmed – note changes to name (Cape Canyon and Associated Islands, Bays and Lagoon) and site extent[57].	The area is also important for threatened ecosystem types; there are nine Endangered and 12 Vulnerable ecosystem types, and two that are Near Threatened. There is evidence that the submarine canyon hosts fragile habitat-forming species, and there are other unique and potentially vulnerable benthic communities in the area. The submarine canyon, sand and mud habitats, patches of low oxygen water, bays, islands and the adjacent lagoon system contribute to the high habitat diversity in this area. The hard ground areas, particularly those outside of the trawl footprint, are also likely to be susceptible to damage. There are several small coastal MPAs within the EBSA. The area encompasses a key foraging area for marine mammals including Cape Fur Seal, Southern Right Whale and Humpback Whale. This is also the only place where two genomic clusters for dwarf eelgrass *Zostera capensis* are present (in Langebaan).

56 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Browns-Bank

57 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Cape-Canyon-and-Associated-Islands,-Bays-and-Lagoo

EBSA	Area (ha)	Status	Significance
Childs Bank	1,979,946	Confirmed – note changes to name (Childs Bank and Shelf Edge) and site extent[58].	Childs Bank and Shelf Edge is a unique submarine bank feature occurring within South Africa's EEZ, rising from -400 m to -180 m on the western continental margin on South Africa. This area includes seven ecosystem types, including those comprising the bank itself, the outer shelf and the shelf edge, supporting hard and unconsolidated ecosystem types. Two of these ecosystem types are Vulnerable and five are Least Concern. There are several very fragile, vulnerable and sensitive species present in the area. Hydrocorals (e.g. *Stylaster* sp.), cold-water coral fragments, gorgonians (*Acbaria rubra*) and glass sponges (*Rossella antarctica*), most of which will not have IUCN Red List assessments.
Delagoa Shelf Edge, Canyons and Slope	2,487,322	Confirmed (transboundary)	This area extends south, north and offshore of the existing Maputaland and St Lucia marine protected areas in the iSimangaliso Wetland Park World Heritage Site, and also encompasses the Ponta do Ouro Partial Marine Reserve, to capture the full extent of offshore benthic and pelagic habitat types, providing for coastal and offshore connectivity and covering the important offshore habitats of Leatherback Turtles (*Dermochelys coriacea*, VU). The area includes a key migratory route for Humpback Whale a nursery area for Bull Shark (*Carcharhinus leucas*, VU), spawning areas for endemic sparids and sharks e.g. Dusky Shark (*Carcharhinus obscurus*, EN) and Sand Tiger Shark (*Carcharias taurus*, CR), and includes habitat of other threatened species including Coelacanth (*Latimeria chalumnae*, CR) and marine mammals like Sperm Whale (*Physeter macrocephalus*, VU). Potential vulnerable marine ecosystems include numerous submarine canyons, paleo shorelines, deep reefs and hard shelf edge with reef-building cold-water corals also recovered at depths of more than 900 m. Whale Sharks (*Rhincodon typus*, EN) feed in this area in summer.
Kingklip Corals	544,250	Proposed	*See Offshore of Port Elizabeth.*
Mozambique Channel	201,099,342	Confirmed (transboundary)	Much of this large EBSA occurs in Mozambique, Madagascar and further north. For the portion bordering South Africa, see the overlapping 'Delagoa Shelf Edge, Canyons and Slope' EBSA.

58 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Childs-Bank-and-Shelf-Edge-(Childs-Bank)

EBSA	Area (ha)	Status	Significance
Namaqua Coastal Area	215,513	Confirmed – see changes to site extent[59].	The area is important for several threatened habitat types represented there including 'Namaqua Inshore Hard Grounds', 'Namaqua Inshore Reef' and 'Namaqua Sandy Inshore' that have all been classified as Critically Endangered. The area is also considered to be important for the conservation of estuarine areas and of coastal fish species.
Namaqua Fossil Forest	24,728	Confirmed	The Namaqua Fossil Forest is a small (2 km^2) seabed outcrop composed of fossilized yellowwood trees in the 136-140 m depth range approximately 30 km offshore on the west coast of South Africa. The fossilized tree trunks have been colonised by fragile, habitat-forming scleractinian corals, confirmed by images from submersible surveys.
Natal Bight	950,623	Confirmed – area proposed to be extended and modified to incorporate KwaZulu-Natal Bight and uThukela River[60]	The turbid, nutrient-rich conditions are important for life-history phases (breeding, nursery and feeding) for crustaceans, demersal fish, migratory fish, turtles and sharks, some of which are threatened like the Scalloped Hammerhead (*Sphyrna lewini*, CR), Great Hammerhead (*Sphyrna mokarran*, CR) and Seventy-four Seabream (*Polysteganus undulosus*, CR). This is a feeding area for Leatherback Turtle. Potential vulnerable marine ecosystems include submarine canyons, cold-water corals. Rare gravel and mud habitat types occur in this area, with the remaining portions of such habitats in good condition.
Offshore of Port Elizabeth	2,801,096	Confirmed – area proposed to be modified to 'Kingklip Corals'[61] and 'Algoa to Amathole'[62]. See also Tsitsikamma-Robberg	This area includes foraging areas for African Penguin and Cape Gannet. BirdLife International data also indicates importance for Damara Tern (*Sternula balaenarum*, LC), Kelp Gull and Roseate Tern.
Orange Cone	381,058	Confirmed (transboundary)	The coastal area includes a Critically Endangered habitat type (Namaqua Sandy Inshore). The marine environment experiences slow, variable currents and weaker winds, making it potentially favourable for reproduction of pelagic species.
Orange Shelf Edge	3,466,863	Confirmed (transboundary) – note changes to site name (Orange Seamount and Canyon Complex) and site extent[63].	The area includes a high diversity of shelf and shelf-edge habitats with hard or unconsolidated (sand) substrates. Threatened ecosystem types include the Endangered Namaqua Shelf Edge and Vulnerable Southern Benguela Rocky Shelf Edge and Southern Benguela Sandy Shelf Edge. The area is a persistent hotspot of species richness for demersal fish species.

59 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Namaqua-Coastal-Area

60 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/KwaZulu-Natal-Bight-and-uThukela-River-(Natal-Bigh

61 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Kingklip-Corals-(Offshore-of-Port-Elizabeth)

62 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Algoa-to-Amathole-(Offshore-of-Port-Elizabeth)

63 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Orange-Seamount-and-Canyon-Complex-(Orange-Shelf-E

EBSA	Area (ha)	Status	Significance
Prince Edward Islands, Del Cano Rise and Crozet Islands	N/A	Confirmed	Only relevant to Prince Edward and Crozet Islands, not the South African continental coastline.
Protea Banks and Sardine Route	1,009,773	Confirmed	This area includes a key component of the migration path for several fish (known as the sardine run) and an offshore area of high habitat complexity. Benthic features include a unique deep-reef system known as Protea Banks, steep shelf edge and slope, and four submarine canyons. The sardine run is a temporary feature associated with foraging top predators, including seabirds, mammals, sharks and gamefish. BirdLife data indicates that this area is important for foraging White-chinned Petrels (*Procellaria aequinoctialis*, VU), and the sardine run is a key ecological event providing forage fish for Cape Gannet.
Protea Seamount Cluster	901,950	Proposed[64]	Given this position, and its location relative to the Agulhas basin and Agulhas continental shelf, local productivity is high at the site. Consequently, it serves as an important aggregation site for migratory species, such as sharks, seabirds, and tuna. Further, adult female Leatherback Turtles have been satellite tracked to these seamounts and surrounds following nesting. There is a known presence locality of fragile, vulnerable and sensitive habitat-forming species.

64 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Protea-Seamount-Cluster

EBSA	Area (ha)	Status	Significance
Seas of Good Hope	674,550	Proposed[65]	The proposed EBSA extends from the shore to depths that are mostly shallower than 150 m. There are areas of high productivity formed by relatively rare surf diatom accumulations and kelp beds. The area is important for many commercially important fish species and forms part of their spawning grounds. Consequently, it provides key foraging habitat for numerous top predators, including sharks, whales, seals and seabirds. The EBSA also contains important breeding and resting sites for these top predators, both on the mainland, in bays and on several islands. For example, it contains island-based and the only mainland-based colonies of breeding African and Seal Island, Geyser Rock and Quoin Rock support breeding colonies of Cape Fur Seals, with Dyer Island and Geyser Island (Rock) being a Ramsar site[66]. The EBSA may also include areas where Southern Right Whales give birth to and nurse their calves, and possibly mate. The area includes a very high diversity of threatened ecosystem types. Of the 34 ecosystem types in the EBSA, 23 are threatened, including one Critically Endangered, eight Endangered and 14 Vulnerable ecosystem types. Further, the reefs and hard grounds contain fragile species that are slow growing, and sensitive to disturbance.
Subtropical Convergence Zone (STCZ)	222,668,435	Confirmed (transboundary)	STCZ is a high productivity oceanographic feature in the South East Atlantic Ocean with distinct oceanographic signatures, such as strong gradients in salinity, temperature and nutrients (strong surface nitrate gradient). The enhanced productivity supports a high diversity of epipelagic species. The area supports species such as Southern Bluefin Tuna (*Thunnus maccoyii*, EN), Southern Right Whale and seabirds recognized as threatened by IUCN, including the Critically Endangered Tristan Albatross (*Diomedea dabbenena*, CR). The poorly known True's Beaked Whale (*Mesoplodon mirus*, LC) and Shepherd's Beaked Whale (*Tasmacetus shepherdi*, DD) occur in the area.

65 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Seas-of-Good-Hope

66 https://rsis.ramsar.org/ris/2384

EBSA	Area (ha)	Status	Significance
Tsitsikamma-Robberg	264,360	Proposed[67]	Includes Tsitsikamma MPA, Robberg MPA, Goukamma MPA, and part of the Garden Route Biosphere Reserve. The EBSA status of this site is largely underpinned by the inshore reefs, and those in Tsitsikamma MPA have been protected since the 1964, making it the oldest marine reserve in Africa. Echo-sounder and stereo-BRUV data show that reefs within the EBSA have high structural complexity (which tends to be associated with higher diversity and abundance of fish), and in some places include boulder reefs that appear to be a unique ecosystem type in South Africa, supporting abundant Carpenter Seabream (*Argyrozona argyrozona*, NT), Panga Seabream (*Pterogymnus laniarius*, LC) and Giant Octopus (*Enteroctopus magnificus*, LC) communities. In turn, the area supports key populations of top predators, including Cape Fur Seal, sharks, seabirds and cetaceans by providing breeding and foraging habitat for them. Inclusion of the Keurbooms and Knysna Estuaries in the EBSA means that it also contains two of only three estuaries in South Africa where the Knysna Seahorse (*Hippocampus capensis*, EN) is found.

Important Shark and Ray Areas

Important Shark and Ray Areas (ISRAs) are discrete, three-dimensional portions of habitat, important for one or more species of shark, ray, or chimaera species, that have the potential to be delineated and managed for conservation[68]. The ISRA Criteria were developed by a consultative process led by the IUCN SSC Shark Specialist Group, IUCN Ocean Team, and IUCN Marine Mammal Protected Areas Task Force. ISRAs are based on qualitative criteria designed to encompass the broad range of habitat needs and the biological or ecological complexities of sharks. Four criteria incorporating seven sub-criteria were defined. These ISRA Criteria were designed to consider the complex behaviours, ecology, and biological needs of sharks including species' vulnerability, range restriction, key life-history activities, distinctiveness, and diversity.

The identification of ISRAs has taken place in the Western Indian Ocean but not yet in the South East Atlantic ('African Atlantic'). South Africa currently has eight ISRAs within the EEZ (Table 65). Due to the large spatial extent of ISRAs and lack of detailed spatial information on the distribution of their biodiversity values, all ISRAs are included in the Restriction Zone Layer (note that in places, ISRAs may overlap with LPA or IRA designations included in the Exclusion layer).

67 https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/Tsitsikamma-Robberg

68 https://sharkrayareas.org/e-atlas/

TABLE 65: ISRAS IN SOUTH AFRICA.

ISRA	Area (ha)	Significance
Greater Aliwal Shoal	72,138	It hosts both shallow and mesophotic reefs, sandy substrates, estuaries, and pelagic waters. Within this area there are: threatened species (e.g. Copper Shark, *Carcharhinus brachyurus*, VU); reproductive areas (Shorthorned Pygmy Devil Ray, *Mobula kuhlii*, EN); feeding areas (e.g. Spinner Shark, *Carcharhinus brevipinna*, VU); resting areas (Sand Tiger Shark); undefined aggregations (Spotted Eagle Ray, *Aetobatus ocellatus*, VU); and areas with distinctive attributes (Shorthorned Pygmy Devil Ray). This area also overlaps with the Sardine Run (Sardine Route EBSA) and Protea Banks EBSA.
Greater Protea Banks	59,256	There is a network of scattered reefs, roughly following the 50 m isobath contour; the Protea Banks is one such reef system and comprises a series of submerged, fossilised sand dunes, ~8 km offshore of Shelly Beach, extending ~6 km in length and ~800 m in width. Apart from the prominent rocky reefs, the area also includes submarine canyons, deep reefs, cold-water corals, estuarine environments, and pelagic waters. This area presents high marine diversity and key ecological processes such as the annual Sardine Run. Within this area there are threatened species (e.g. Sand Tiger Shark); range restricted species (e.g. Flapnose Houndshark, *Scylliogaleus quecketti*, VU, and Austin's Guitarfish, *Rhinobatos austini*, DD); feeding areas (Dusky Shark); and undefined aggregations (e.g. Scalloped Hammerhead).
iSimangaliso	11,194	The area is characterised by several coastal reef systems including some of the highest latitude shallow-water hard coral reefs in the world. The area overlaps with the iSimangaliso MPA, two EBSAs, and a KBA. Within this area there are: threatened species (e.g. Oman Cownose Ray, *Rhinoptera jayakari*, EN); reproductive areas (Sand Tiger Shark); feeding areas (Reef Manta Ray, *Mobula alfredi*, VU); and undefined aggregations (e.g. Spotted Eagle Ray, *Aetobatus ocellatus*, VU). This area is also covered by Thongaland Transboundary Corridor ISRA.
Natal Southcoast Corridor	192,755	The area lies along a narrow continental shelf and is influenced by the warm Agulhas Current. This area is known for its marine diversity and for the Sardine Run. This area overlaps with three Marine Protected Areas (Protea Banks, Trafalgar, and Aliwal Shoal), and partly overlaps with the Protea Banks and Sardine Route EBSAs. Within this area there are: threatened species (e.g. Dusky Shark) and movement areas (e.g. Tiger Shark, *Galocerdo cuvier*, NT). This area encompasses all of Greater Aliwal Shoal ISRA and most of Greater Protea Banks ISRA.
St Lucia Estuary	1,159	The area comprises coastal waters, the estuary mouth, and the lower estuarine system. The area overlaps with the iSimangaliso MPA and partially overlaps the iSimangaliso Wetland Park KBA. Within this area there are: threatened species and reproductive areas (Bull Shark). This area is also covered by Thongaland Transboundary Corridor ISRA.

ISRA	Area (ha)	Significance
Thongaland Transboundary Corridor	855,960	The area overlaps with two marine protected areas: the Maputo National Park in southern Mozambique and the iSimangaliso Wetland Park in South Africa. It also overlaps with three Ecologically or Biologically Significant Marine Areas (Delagoa Shelf Edge, Canyons and Slope; Incomati River to Ponta do Ouro; and Mozambique Channel) and with two Key Biodiversity Areas (Ponta do Ouro Marine Reserve and iSimangaliso Wetland Park). The area is characterised by some of the highest latitude hard coral reefs in the world and some of the deepest nearshore canyons that break into the narrow continental shelf. Reef growth primarily takes place on fossilised coastal dunes running parallel to the coast consisting of Late Pleistocene beach rock. The general sub-tidal reef habitat is diverse with a mix of sand dominated substrate, low profile sparse reef, alcyonarian coral dominated reef, or scleractinian coral dominated reef. Within this area there are: threatened species (e.g. Sand Tiger Shark and Bull Shark) and areas important for movement (e.g. Blacktip Shark *Carcharhinus limbatus*, VU). The Reef Manta Ray is also a qualifying species at this site based on the importance of the site for their movements tracked by acoustic and PSAT satellite tags.
uThukela	478,176	Estuaries support mangroves, reed marshes, and seagrass meadows. Within this area there are: threatened species (e.g. Dusky Shark); range-restricted species (e.g. Twineye Skate, *Raja ocellifera*, EN); reproductive areas (e.g. Spinner Shark, and Scalloped Hammerhead); and undefined aggregations (e.g. Milk Shark *Rhizoprionodon acutus*, VU).

LPA / IRA summary

In total, there are 146 LPAs and IRAs with marine or coastal components in South Africa (not including Prince Edward Islands), of various designations, many overlapping each other. These are summarised in Table 0, with their corresponding national and international designations.

TABLE 66. SUMMARY OF LPA AND IRA IN THE SOUTH AFRICAN EEZ WITH MARINE OR COASTAL COMPONENTS.

Site[69]	Legally Protected Areas (LPAs)		Internationally Recognized Areas (IRAs)					EBSA	IMMA	ISRA
	National Park or similar	MPA	OECM/ Conservation Area	KBA	IBA	AZE Site	Ramsar Site			
Addo Elephant		■								
Agulhas Bank Complex		■						■		
Agulhas Front		■						■		
Agulhas Muds		■								
Agulhas Plain — Heuningnes Estuary				■	■					
Agulhas Slope and Seamounts								■		
Alexandria coastal belt / Algoa Bay Island Nature Reserve					■					
Algoa Bay Black Rocks Provincial Nature Reserve	■									
Algoa Bay Islands: Addo Elephant National Park				■	■					
Algoa Bay Seal Island Provincial Nature Reserve	■									
Algoa to Amathole								■		
Aliwal Shoal		■								
Amathole		■								
Amathole Offshore		■								
Annex Arch Rock Private Nature Reserve	■									

69 LPAs and IRAs that overlap in most of their marine or coastal area were aggregated in the same row, using the nomenclature of the largest. Otherwise, both areas were addressed separately.

Site[69]	Legally Protected Areas (LPAs)		Internationally Recognized Areas (IRAs)					EBSA	IMMA	ISRA
	National Park or similar	MPA	OECM/ Conservation Area	KBA	IBA	AZE Site	Ramsar Site			
Atlantic, Southeast 19					■					
Beachwood Mangroves Nature Reserve	■									
Benguela Muds		■								
Benguela Upwelling System								■		
Berg River Estuary				■	■		■			
Betty's Bay		■								
Bird Island / Dassen Island / Heuningnes river and estuary system / Lower Berg river wetlands					■					
Blaauwberg Conservation Area Local Nature Reserve	■									
Bojaansklip Private Nature Reserve	■									
Bot — Kleinmond Estuarine System							■			
Boulders Beach				■	■					
Browns Bank Corals		■						■		
Buitenverwachting Private Nature Reserve	■									
Cape Canyon and Surrounds		■						■		
Cape Coastal Waters									■	
Cape Floral Region Protected Areas WHS	■									
Cape Peninsula Nature Area	■									
Cape Recife Nature Reserve	■									
Cape St. Francis Provincial Nature Reserve	■									

Site[69]	Legally Protected Areas (LPAs)		Internationally Recognized Areas (IRAs)					EBSA	IMMA	ISRA
	National Park or similar	MPA	OECM/ Conservation Area	KBA	IBA	AZE Site	Ramsar Site			
Cape West Coast Biosphere Reserve			■							
Cape Whale Coast				■		■				
Childs Bank		■						■		
Columbine Nature Reserve	■									
Dassen Island	■			■	■		■			
De Hoop Nature Reserve	■									
De Hoop Marine Protected Area		■								
De Mond							■			
Delagoa Shelf Edge, Canyons and Slope								■		
Die Duine Private Nature Reserve	■									
Doorspring Private Nature Reserve	■									
Duikerklip Provincial Nature Reserve	■									
Duivenhoksriviermond Private Nature Reserve	■									
Dwesa-Cwebe		■								
Dyer Island Nature Reserve	■			■	■		■			
Elephant Rock Provincial Nature Reserve	■									
False Bay Nature Reserve	■			■	■		■			
False Bay Seal Island Provincial Nature Reserve	■									
Featherbed Private Nature Reserve	■									

Site[69]	Legally Protected Areas (LPAs)		Internationally Recognized Areas (IRAs)					EBSA	IMMA	ISRA
	National Park or similar	MPA	OECM/ Conservation Area	KBA	IBA	AZE Site	Ramsar Site			
Garden Route Biosphere Reserve			■							
Geyser Island Provincial Nature Reserve	■									
Goukamma Provincial Nature Reserve	■									
Goukamma		■								
Gouritz Cluster Biosphere Reserve			■							
Great Fish River Mouth Wetland Nature Reserve	■									
Greater Aliwal Shoal										■
Greater Protea Banks										■
Groenkant Private Nature Reserve	■									
Groot Dam Private Nature Reserve	■									
Groot Paternoster Private Nature Reserve	■									
Helderberg		■								
Hluleka		■								
Huisklip Nature Reserve	■									
iSimangaliso Wetland Park Marine Protected Area, WHS	■	■		■	■		■			■
Jacob's Rock Provincial Nature Reserve	■									
Joan Muirhead Nature Reserve	■									
Keurbooms River Nature Reserve	■									
Kingklip Corals								■		

Site[69]	Legally Protected Areas (LPAs)		Internationally Recognized Areas (IRAs)					EBSA	IMMA	ISRA
	National Park or similar	MPA	OECM/ Conservation Area	KBA	IBA	AZE Site	Ramsar Site			
Knysna National Lake Area	■									
Kogelberg Biosphere Reserve			■							
Kosi Bay							■			
Lake Sibaya							■			
Lake St Lucia and Mkuze swamps					■					
Lambert's Bay Penguin Island Provincial Nature Reserve	■									
Langebaan							■			
Maitland — Gamtoos coast				■	■					
Mossel Bay Seal Island Provincial Nature Reserve	■									
Mozambique Channel								■		
Mpenjati Nature Reserve	■							■		
Nahoon Nature Reserve	■									
Namaqua Coastal Area								■		
Namaqua Fossil Forest		■						■		
Namaqua National Park		■								
Natal Bight								■		
Natal Southcoast Corridor										■
Offshore of Port Elizabeth								■		
Orange Cone								■		

Site[69]	Legally Protected Areas (LPAs)		Internationally Recognized Areas (IRAs)					EBSA	IMMA	ISRA
	National Park or similar	MPA	OECM/ Conservation Area	KBA	IBA	AZE Site	Ramsar Site			
Orange River Mouth Wetlands		■		■	■		■	■		
Orange Shelf Edge		■						■		
Paternoster Rocks Provincial Nature Reserve	■									
Pondoland		■								
Port Elizabeth Corals		■								
Port Nolloth / McDougall's Bay				■		■				
Postberg Nature Reserve	■									
Protea Banks and Sardine Route		■						■		
Protea Seamount Cluster								■		
Quenera Nature Reserve	■									
Quoin Rock Provincial Nature Reserve	■									
Richards Bay Game Reserve	■			■	■					
Rietvlei Wetland: Table Bay Nature Reserve		■		■	■					
Robben Island		■								
Robberg Coastal Corridor Protected Environment		■								
Rocher Pan Nature Reserve	■									
Rocher Pan		■								
Rooisand Provincial Nature Reserve	■									
Sardinia Bay Nature Reserve	■									

Site[69]	Legally Protected Areas (LPAs)		Internationally Recognized Areas (IRAs)					EBSA	IMMA	ISRA
	National Park or similar	MPA	OECM/ Conservation Area	KBA	IBA	AZE Site	Ramsar Site			
Sardinia Bay		■								
SAS Saldanha Provincial Nature Reserve	■									
Seal Ledges Provincial Nature Reserve	■									
Seas of Good Hope								■		
Seekoei River Nature Reserve	■									
Sixteen Mile Beach (including Jutten Island, Langebaan Lagoon Ramsar, Malgas Island, and Marcus Island MPAs)		■								
Skuilte Private Nature Reserve	■									
Sodwana Bay National Park	■									
Soopjeshoogte Private Nature Reserve	■									
South East African Coastal Migration Corridor									■	
Southeast Atlantic Seamounts		■								
Southern Coastal and Shelf Waters of South Africa									■	
Southwest Indian Seamount		■								
St Lucia Estuary	■	■					■			■
Stag Island Provincial Nature Reserve	■									
Stilbaai		■								
Subtropical Convergence Zone (STCZ)								■		
Swartkops Estuary — Redhouse and Chatty Saltpans				■	■					
Sylvic Nature Reserve	■									

Site[69]	Legally Protected Areas (LPAs)		Internationally Recognized Areas (IRAs)					EBSA	IMMA	ISRA
	National Park or similar	MPA	OECM/ Conservation Area	KBA	IBA	AZE Site	Ramsar Site			
Table Mountain National Park	■									
Table Mountain National Park MPA		■								
Tharfield Private Nature Reserve	■									
Thongaland Transboundary Corridor										■
Trafalgar		■								
Tsitsikamma		■						■		
Umhlanga Lagoon Nature Reserve	■									
Umlalazi Nature Reserve	■									
uThukela		■								■
Verlorenvlei							■			
Walker Bay Whale Sanctuary		■								
West Coast National Park and Saldanha Bay Islands				■	■					
Wilderness Lakes							■	■		
Wolfgat Nature Reserve	■									
Woody Cape Section: Addo Elephant National Park				■	■	■				
Yzerfontein Local Nature Reserve	■									
Zeven Puts Private Nature Reserve	■									

MARINE MAMMALS

The South African EEZ is important for several marine mammal species, for example as indicated by the 23 EBSAs. Based on the IUCN Red List spatial data, there are six globally threatened species of marine mammal present in the EEZ:

- Blue Whale (*Balaenoptera musculus*, EN)
- Dugong (*Dugong dugon*, VU)
- Fin Whale (*Balaenoptera physalus*, VU)
- Indian Ocean Humpback Dolphin (*Sousa plumbea*, EN)
- Sei Whale (*Balaenoptera borealis*, EN)
- Sperm Whale (*Physeter macrocephalus*, VU)

The Indian Ocean Humpback Dolphin occurs from Cape Town to the Mozambique Border and up the East African coast. Depth (shallow bathymetry) and distance (near) to shore are strong predictors of occurrence (Purdon *et al.* 2020a). In South Africa the Indian Ocean Humpback Dolphins have long-term site fidelity and form a single population; however, individuals roam between 30-500 km. National population estimates are as low as 500 individuals (Vermeulen *et al.* 2017). Groups range from 3-24 individuals although seem to be declining in average number, threats include noise pollution and coastal development and disturbance (Plön *et al.* 2015).

In South Africa, Dugong only occurs near the border of Mozambique within iSimangaliso MPA. The Eastern Africa subpopulation of Dugong is classed as Critically Endangered with 145 individuals between iSimangaliso and the northern extent of their range at the Kenyan-Somali border.

Fin Whales, Sei Whales, and Blue Whales are rarely sighted in South Africa and are not a feature of any current IMMAs, however, they are present in the Benguela region from May to August (peaking in July) as confirmed by acoustic monitoring (Shabangu *et al.* 2019). Sperm Whales are more frequently encountered and are a feature of the Delagoa Shelf Edge, Canyons and Slope EBSA. They can be encountered across the majority of the EEZ, frequently found in deeper waters off the west coast, and avoiding shallow regions along the continental shelf.

Whilst not a threatened species, the Cape Fur Seal (a subspecies of Afro-Australian Fur Seal - *Arctocephalus pusillus ssp. pusillus*, LC) has 24 island and 16 mainland breeding colonies along the south and west coasts of southern Africa (Kirkman *et al.* 2013) and can travel up to 220 km offshore in search of prey (Huisamen *et al.* 2012) Plettenberg Bay, on the south-east coast of South Africa, between the 17th and early 20th centuries. Seals returned to Robberg in small numbers during the early 1990s and their numbers subsequently increased. We studied the diet of this increasing population using faecal (scat) analysis. A number of these colonies would represent critical habitat under IFC PS6 Criterion 3: Migratory and Congregatory Species. Fur Seals are also a considerable tourist attraction and represent a species of stakeholder concern. Breeding Fur Seals may be susceptible to disturbance and are at risk of collision from wind farm maintenance vessel traffic. Whilst there is no scientific literature on the interactions between Fur Seals and wind farms due to

the lack of historical wind farm development within their ranges, parallels can be drawn with Phocid seals in the Northern Hemisphere. Operational wind farms can increase seal prey stocks (due to the reduction in commercial fishing effort) and seals have been recorded using GPS tracking data to favour wind farms for foraging opportunities (Russell *et al.* 2014). Any disturbance impacts are likely to be short-term, around the construction period (Edrén *et al.* 2010).

Except for the data incorporated into the National Coastal and Marine Spatial Biodiversity Plan CBA map discussed in Section 3 (including predicted distributions of Humpback Dolphins, key bay habitats for nearshore whales (Purdon *et al.* 2020a, 2020b), Cape Fur Seal colonies and foraging areas (Kirkman *et al.* 2013), no better digitized spatial data have been identified in relation to marine mammals. Whilst knowledge of marine mammal movements in South Africa is good, additional spatial data should be sought for Data Deficient (DD) species like Killer Whale.

BIRDS

Nearshore species

African Penguin, Bank Cormorant, Cape Cormorant and Cape Gannet are the primary threatened nearshore species of concern, all being globally Endangered. These species are present in many LPAs and IRAs and will commute between these sites along much of the South Africa's coastline.

Cape Cormorants have four key breeding colonies in South Africa at Dyer Island, Jutten Island, Malgas Island and Stony Point (all covered by protected area designations and KBA/IBAs, except for Stony Point). Cormorant movements can be significant with continuous streams of birds passing nearshore for long durations e.g. an estimated 50,800 Cape Cormorant passing Dyer Island in February 2021.[70] Cape Cormorants can also be encountered up to 70 km offshore (Siegfried 1975; Cook *et al.* 2012).[71]

African Penguins have been tracked from a number of colonies in South Africa (identified as KBA/IBAs and covered by protected area designations) revealing wide-scale movements. For example, dispersal of juvenile penguins of over 1,000 km from their colonies including distances of 100 km within the first 6 days (Sherley *et al.* 2013). Adult African Penguin foraging differs considerably between pre-and post-moult periods and the breeding season with foraging ranges around the time of moult some 600 km, compared to 50 km during breeding. Even during the non-breeding season, waters between 20-50 km of breeding colonies represent important foraging areas. Penguins in the Western Cape travelled significantly further than those in the Eastern Cape which is likely a reflection of the poor availability of sardines (*Sardinops sagax*) and anchovies (*Engraulis encrasicolus*) along the west coast of South Africa (Carpenter-Kling *et al.* 2022). African Penguins, like all penguins, are flightless and collision risk with offshore wind farms will not be a risk. However, disturbance from wind farms will be a novel risk in need of further studies and there is likely to be a collision risk linked to vessel traffic.

Cape Gannets breed at only six islands globally: Bird Island (Lambert's Bay), Malgas and Bird Island (Algoa Bay) in South Africa (identified as KBA/IBAs and covered by protected area designations), and Mercury, Ichaboe and Possession Islands in Namibia. Adult Cape Gannets have been GPS tracked from Algoa Bay, Malgas Island and Lambert's Bay with tracks describing foraging trips within the vicinity

70 https://ebird.org/checklist/S80445718

71 http://seabirds.saeon.ac.za/smap.aspx

of those colonies during the breeding season[72]. Cape Gannets often travel up to 400 km in search of sardines and anchovies (Pichegru *et al.* 2007; Botha & Pistorius 2018).

The National Coastal and Marine Spatial Biodiversity Plan CBA map includes generalised foraging areas, core use areas, and core home ranges for Cape Cormorants, African Penguins and Cape Gannets drawing from data from BirdLife South Africa and (Majiedt *et al.* 2013) — there may be additional data that were not included but are available upon request from the Seabird Tracking Database.

Pelagic Species

Most other threatened marine seabirds in South Africa are Albatross and Petrel species, including Tristan Albatross (*Diomedea dabbenena*, CR), Amsterdam Albatross, Atlantic Yellow-nosed Albatross, Indian Yellow-nosed Albatross, Sooty Albatross (*Phoebetria fusca*, EN), Northern Royal Albatross (*Diomedea sanfordi*, EN), Grey Headed Albatross (*Thalassarche chrysostoma*, EN), Barau's Petrel (*Pterodroma baraui*, EN) and Atlantic Petrel (*Pterodroma incerta*, EN).

Analysis of GPS tracking data within the South African EEZ has found a correlation between White-capped Albatross (*Thalassarche steadi*, NT) foraging areas and the bathymetry and the location of fishing trawl sets. In contrast, Black-browed Albatross (*Thalassarche melanophris*, LC) foraged to a greater extent on natural prey, undertaking oceanic foraging trips (Petersen *et al.* 2008). However, for albatross species in general, the presence of fishing trawlers is a strong predictor of their distribution. These data enable offshore wind siting decisions to consider where there may be lower risk locations for siting between nearshore threatened seabirds and offshore aggregations of pelagic seabirds (and other constraints like fishing). These data have not been included in the Exclusion or Restriction Zone layers as additional analyses would need to be performed by a spatial ecologist to identify hotspots of activity based on the Utilization Distribution (probability distribution) of the birds. Additionally, data on seabird colonies, home ranges and foraging areas are included in the National Coastal and Marine Spatial Biodiversity Plan CBA map.

Birds summary

Except for the data incorporated into the National Coastal and Marine Spatial Biodiversity Plan CBA map discussed in Section 3, no better digitized spatial data have been identified (other than raw GPS tracking data) in relation to threatened marine bird species. Additional spatial data should be sought, for example for Bank Cormorant (which does not have a detailed home range map), if they are published.

A full list of the identified threatened bird species is provided in Appendix 1.

72 https://data.seabirdtracking.org/, http://seabirds.saeon.ac.za/smap.aspx

MARINE REPTILES

Five species of sea turtles occur in the South African EEZ according to IUCN Red List spatial data:

- Hawksbill Turtle, *Eretmochelys imbricata* (CR),
- Green Turtle, *Chelonia mydas* (EN);
- Olive Ridley Turtle, *Lepidochelys olivacea* (VU);
- Leatherback Turtle, (*Dermochelys coriacea* (VU); and
- Loggerhead Turtle, *Caretta caretta* (VU).

The Leatherback and the Loggerhead Turtles nest on the beaches of northern KwaZulu-Natal, the Green Turtle is a non-breeding resident, and the Olive Ridley is a rare occurrence. In a 2009 study, ten Leatherback Turtles were tracked from their nesting beaches on the east coast for a total of 1,406 days. Results showed most nearshore movements around the northern KwaZulu-Natal coast with other hotspots of activity far offshore to the south of the continental shelf (Petersen *et al.* 2009).

Leatherback and Loggerhead Turtle movements were found to contrast strongly, with Leatherbacks exhibiting more variability in movement and nest placement, likely influenced by ocean currents as hatchlings. Consequently, they are less well protected by MPAs compared to Loggerhead Turtles (Harris *et al.* 2015).

The locations of sea turtle nesting beaches were mapped using the information from the Global Distribution of Marine Turtles Nesting Sites.[73] However, more recent sources indicate that turtle nesting beaches in South Africa are found across a stretch of 200 km exclusively along the coast of iSimangaliso MPA from the Mozambican border to the Cape St. Lucia lighthouse (Sizo 2014). Nesting beaches are covered by LPAs and IRAs, as well as the National Coastal and Marine Spatial Biodiversity Plan CBA map and therefore have not been added as a separate layer in the Exclusion Zone Layer.

FISH

Bony fish

Based on the range data from the IUCN Red List, 30 globally threatened bony fish species occur within the South Africa EEZ. Several highly threatened fish species are also range restricted and dependent on intact natural habitats. These include the Estuarine Pipefish (*Syngnathus watermeyeri*, CR), Knysna Seahorse (*Hippocampus capensis*, EN), Bot River Klipfish (*Clinus spatulatus*, EN) and Eightgilled Hagfish (*Eptatretus octatrema*, EN).

73 https://data.unep-wcmc.org/datasets/22

Spatial data for commercial bony fish species include scientific papers on reproductive habitats e.g. Hutchings *et al.* 2002, maps of commercial fisheries (FAO 2010), and distribution maps including those for threatened seabream species Red Steenbras and Seventy-four Seabream. Whilst these polygons are simple and could be digitized manually, they are relatively coarse and represent useful contextual sources of data. Additional contextual information available via Global Fishing Watch[74] indicates the location of apparent fishing effort describing where the main fish stocks are located and consequently where aggregations of foraging seabirds and marine mammals are also likely to occur because both fishing vessels and seabirds will target shoals of e.g. sardines and anchovies.

Seasonal aggregations of millions of sardines (*Sardinops sagax*) occur off KwaZulu-Natal between May and July each year. This event, termed the 'Sardine Run' is a spawning event for sardines and leads to predictable congregations of marine predators including Cape Gannet, Cape Cormorant, as well as numerous species of dolphins and whales.

The area of the Sardine Run is covered by Southern Coastal and Shelf Waters of South Africa IMMA, Natal Southcoast Corridor, Greater Aliwal Shoal Greater Protea Banks ISRAs, and Protea Banks and Sardine Route EBSAs. Furthermore, the threatened and restricted range fish species mentioned are specific features of interest of EBSAs, except for Eightgilled Hagfish which occurs within Agulhas Bank Nursery Area EBSA but not as a named species.

Whilst the ranges of the four restricted range and highly threatened fish species are partially covered by LPAs and IRAs, some of their distributions are unprotected. Consequently, the IUCN Red List range maps of Estuarine Pipefish, Knysna Seahorse, Bot River Klipfish and Eightgilled Hagfish have been added to the Restriction Zone Layer.

Cartilaginous fish

South Africa is a hotspot for chondrichthyan diversity and sharks, especially the White Shark (*Carcharodon carcharias*, VU) represent a considerable tourist attraction. Overall, 82 threatened species of shark and ray occur in the South African EEZ, seven of these endemic to South Africa and four additionally endemic to Southern Africa (Faure Beaulieu *et al.* 2023). Knowledge and spatial data relating to threatened shark and ray distributions in South Africa is less comprehensive compared to other groups due to their wide-ranging distributions. However, modelled distribution data were developed for 87 species in South Africa (Faure Beaulieu *et al.* 2023) and 64 of these are included in the National Coastal and Marine Spatial Biodiversity Plan CBA map. Additionally, the recently-identified suite of ISRAs will represent many of these sharks and rays in the Restriction Zone Layer.

A full list of the identified threatened marine fish species is provided in Appendix 1.

74 https://globalfishingwatch.org/map-and-data/

NATURAL HABITATS

Coral reefs

Warm-water corals are only found in north-east South Africa in the iSimangaliso Wetland Park WHS, in the Delagoa Bioregion.[75] These are the highest latitude shallow-water hard coral reefs in the world. There are 90 species of hard coral, 40 species of soft coral and at least 30 species each of ascidians (sea squirts) and sponges (Muthiga *et al.* 2008), nine of these are globally Vulnerable according to the IUCN. The reef communities cover an area of 4,000 ha in three main complexes — the Northern, Central and Southern Reef Complexes. They consist of a mixture of tropical and temperate Indo-Pacific fauna and include numerous endemic invertebrate and fish species. Coral communities do not form true coral reefs but grow as a veneer on sandstone, with soft corals dominating most of the reefs.

South Africa also has several cold-water corals extending down the east coast and occurring in deeper waters around the diverse benthic features in the region (e.g. sea mounts), persisting especially in un-trawled areas. For example, within iSimangaliso MPA, which contains cold water corals and sponge aggregations extending to around 2000 m depth. The available spatial data are 'point data' representing occurrences and as such may represent larger areas of cold-water coral communities.[76] Unpublished data from the ACEP Deep Secrets expedition, mapping features between 5 and 70 m depth, are included in the National Coastal and Marine Spatial Biodiversity Plan CBA map (Harris *et al.* 2022) but data for cold water coral distribution in any deeper regions are not included.

The mapped areas of warm-water coral reef in the Allen Coral Atlas are included in the Exclusion Zone Layer. Cold water corals are included in the in the National Coastal and Marine Spatial Biodiversity Plan CBA map based on data from South African National Biodiversity Institute (SANBI).

Mangroves

Mangroves are amongst the most biologically productive ecosystems in the world and play an important role in the sustainability of fisheries, protection of shorelines from coastal erosion, and the provision of wood as a natural resource (Díaz & Acero 2003).

Mangroves in South Africa occur at one of the most southerly locations in the world and occupy 37 estuaries, lagoons and tidal basins across KwaZulu-Natal and the Eastern Cape with the southernmost extent reaching Nahoon Nature Reserve protected area in East London. The total mangrove cover in South Africa is estimated at 1,921 ha, comprised of 5 main species: *Avicennia marina, Bruguiera gymnorrhiza, Ceriops tagal, Lumnitzera racemose*, and *Rhizophora mucronata* (Naidoo 2016).

The mapped areas of mangrove provided by Global Mangrove Watch are included in the Exclusion Zone Layer.[77]

75 https://allencoralatlas.org/atlas/#8.05/-27.5673/32.9250

76 https://data.unep-wcmc.org/datasets/3

77 https://www.globalmangrovewatch.org/country/ZAF?bounds=[[20.064261267456004,-33.93221165321027],[36.999571030183034,-26.399242552405674]]&active=[%22mangrove_habitat_extent%22]

Seagrass beds

Seagrass beds are unique ecosystems with relatively high rates of primary production which support detritus-based food chains. These ecosystems provide habitats for a wide variety of marine organisms, promote sediment stabilization, and maintain a dynamic environment for nutrient cycling (Díaz & Acero 2003). In South Africa threatened and endemic species including the Knysna Seahorse, Estuarine Pipefish and Bot River Klipfish are dependent on these habitats.

South Africa has both temperate and tropical seagrass species from the genera *Halodule, Halophila. Ruppia, Syringodium, Thalassodendron* and Zostera growing between 0 and 33 m below sea level. Cape Dwarf-eelgrass (*Zostera capensis*, VU) is the dominant seagrass in South Africa, occurring in waters 6 m or shallower across 62 out of a total of approximately 300 estuaries along the coastline from KwaZulu-Natal to the Western Cape (Adams 2016). The species is severely fragmented and is experiencing continuing decline: although it grows fast, the plant does not colonize quickly. Cape Dwarf-eelgrass is listed as Vulnerable on the IUCN Red List (the global area of occupancy is less than 2,000 km^2, meeting the threshold for IUCN Criterion B2).

Available spatial data for seagrass are point data (Ocean Data Viewer[78]), or of limited accuracy across the entire coastline (Allen Coral Atlas). The National Coastal and Marine Spatial Biodiversity Plan CBA map does not include a specific spatial layer for seagrass but much of this habitat will be covered under the layer for 'Priority Estuaries', as well as other coastal ecosystem types (Harris *et al.* 2022).

78 https://data.unep-wcmc.org/datasets/7

SUMMARY

The preceding sections provide rationale for the digitised spatial data included within the Exclusion and Restriction Zone layers, to be taken into account within *A Strategic Framework for Offshore Wind Development in South Africa*. These are summarised below in Table 67 along with the sources of the relevant digitised spatial data.

TABLE 67: SUMMARY TABLE OF DIGITISED SPATIAL DATA TO BE INCLUDED AS EXCLUSION AND RESTRICTION ZONES. DATASETS MARKED WITH AN ASTERISK * INCLUDE POINTS RATHER THAN POLYGONS AND THE TRUE EXTENT OF THE PBV WILL BE MUCH LARGER IN MANY CASES.

Zone	Priority biodiversity value	Available digitized spatial data layer	Source
Exclusion Zone	National Coastal and Marine Spatial Biodiversity Plan	Critical Biodiversity Areas (Natural)	https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/National-Coastal-and-Marine-Spatial-Biodiversity-P/CBA-Map-and-Sea-use-Guidelines-Version-1#Sea-use%20guidelines
	LPAs and IRAs	National Parks or similar	https://dffeportal.environment.gov.za/portal/apps/webappviewer/index.html?id=7e27f116dd194c1f9d446dacc76fe483
		Coastal KBAs, including Confirmed and Proposed Marine IBAs and AZE Sites	www.ibat-alliance.org https://maps.birdlife.org/marineibas/
		Ramsar Sites	www.ibat-alliance.org
	Natural Habitats	Coral reefs	https://allencoralatlas.org/
		Mangroves	https://www.globalmangrovewatch.org/
Restriction Zone	National Coastal and Marine Spatial Biodiversity Plan	Critical Biodiversity Areas (Restore)	https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/National-Coastal-and-Marine-Spatial-Biodiversity-P/CBA-Map-and-Sea-use-Guidelines-Version-1#Sea-use%20guidelines
		Ecological Support Areas, including proposed and confirmed sites.	https://cmr.mandela.ac.za/Research-Projects/EBSA-Portal/South-Africa/National-Coastal-and-Marine-Spatial-Biodiversity-P/CBA-Map-and-Sea-use-Guidelines-Version-1#Sea-use%20guidelines
	LPAs and IRAs	EBSAs	https://www.cbd.int/ebsa/
		IMMAs	https://www.marinemammalhabitat.org/imma-eatlas/
		ISRAs	https://sharkrayareas.org/e-atlas/
		Conserved Areas (Biosphere Reserves)	https://dffeportal.environment.gov.za/portal/apps/webappviewer/index.html?id=7e27f116dd194c1f9d446dacc76fe483
		OECMs	https://www.protectedplanet.net/en/thematic-areas/oecms?tab=OECMs
	Species	Range maps of Estuarine Pipefish, Knysna Seahorse, Bot River Klipfish and Eightgilled Hagfish	www.ibat-alliance.org

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APPENDIX A. LIST OF THREATENED MARINE SPECIES OCCURRING IN SOUTH AFRICA EEZ[79]

Class	Scientific Name	Common Name	IUCN Status	Range Area (km²)
Marine Mammals				
MAMMALIA	*Balaenoptera musculus*	Blue Whale	EN	434,753,529
MAMMALIA	*Dugong dugon Eastern Africa subpopulation*	Dugong	VU (CR subpopulation)	6,469,966 (230,303 subpopulation)
MAMMALIA	*Balaenoptera physalus*	Fin Whale	VU	206,326,476
MAMMALIA	*Hippopotamus amphibius*	Hippopotamus	VU	1,233,050
MAMMALIA	*Sousa plumbea*	Indian Ocean Humpback Dolphin	EN	493,077
MAMMALIA	*Balaenoptera borealis*	Sei Whale	EN	316,105,796
MAMMALIA	*Physeter macrocephalus*	Sperm Whale	VU	347,262,854
Seabirds				
AVES	*Spheniscus demersus*	African Penguin	EN	330,024
AVES	*Phalacrocorax neglectus*	Bank Cormorant	EN	107,866
AVES	*Phalacrocorax capensis*	Cape Cormorant	EN	503,853
AVES	*Morus capensis*	Cape Gannet	EN	1,102,839
AVES	*Diomedea amsterdamensis*	Amsterdam Albatross	EN	11,226,044
AVES	*Procellaria conspicillata*	Spectacled Petrel	VU	12,020,564
AVES	*Thalassarche chlororhynchos*	Atlantic Yellow-nosed Albatross	EN	21,606,510
AVES	*Diomedea dabbenena*	Tristan Albatross	CR	38,653,794
AVES	*Thalassarche carteri*	Indian Yellow-nosed Albatross	EN	35,244,001
AVES	*Pterodroma incerta*	Atlantic Petrel	EN	19,851,740
AVES	*Phoebetria fusca*	Sooty Albatross	EN	61,333,618
AVES	*Thalassarche salvini*	Salvin's Albatross	VU	66,984,623
AVES	*Pterodroma baraui*	Barau's Petrel	EN	26,303,813
AVES	*Diomedea exulans*	Wandering Albatross	VU	97,773,635
AVES	*Procellaria aequinoctialis*	White-chinned Petrel	VU	107,318,399
AVES	*Hydrobates leucorhous*	Leach's Storm-petrel	VU	110,016,669
AVES	*Pterodroma arminjoniana*	Trindade Petrel	VU	47,405,599
AVES	*Diomedea epomophora*	Southern Royal Albatross	VU	56,489,212
AVES	*Diomedea sanfordi*	Northern Royal Albatross	EN	65,339,604
AVES	*Thalassarche chrysostoma*	Grey-headed Albatross	EN	83,991,951
Reptiles				
REPTILIA	*Lepidochelys olivacea*	Olive Ridley	VU	79,530,390
REPTILIA	*Chelonia mydas*	Green Turtle	EN	176,482,666
REPTILIA	*Dermochelys coriacea*	Leatherback	VU	216,124,441
REPTILIA	*Caretta caretta*	Loggerhead Turtle	VU	271,358,117

79 Based on spatial data from the IUCN Red List of Threatened Species. Threatened species lacking spatial data may be omitted from this list.

Class	Scientific Name	Common Name	IUCN Status	Range Area (km^2)
REPTILIA	*Eretmochelys imbricata*	Hawksbill Turtle	CR	276,653,106
Marine Fish				
CHONDRICHTHYES	*Galeus polli*	African Sawtail Catshark	VU	330,049
CHONDRICHTHYES	*Holohalaelurus punctatus*	African Spotted Catshark	EN	16,935
CHONDRICHTHYES	*Oxynotus centrina*	Angular Roughshark	EN	2,218,891
ACTINOPTERYGII	*Trachurus trachurus*	Atlantic Horse Mackerel	VU	9,315,506
CHONDRICHTHYES	*Cetorhinus maximus*	Basking Shark	EN	221,820,483
ACTINOPTERYGII	*Arothron inconditus*	Bellystriped Blaasop	VU	99,680
CHONDRICHTHYES	*Mobula thurstoni*	Bentfin Devil Ray	EN	213,269,951
CHONDRICHTHYES	*Alopias superciliosus*	Bigeye Thresher	VU	200,525,954
ACTINOPTERYGII	*Thunnus obesus*	Bigeye Tuna	VU	219,006,709
ACTINOPTERYGII	*Chelonodontops pleurospilus*	Blaasop Beauty	EN	27,297
ACTINOPTERYGII	*Cymatoceps nasutus*	Black Musselcracker	VU	171,810
CHONDRICHTHYES	*Carcharhinus melanopterus*	Blacktip Reef Shark	VU	5,899,761
CHONDRICHTHYES	*Carcharhinus limbatus*	Blacktip Shark	VU	9,993,934
CHONDRICHTHYES	*Taeniurops meyeni*	Blotched Fantail Ray	VU	12,682,132
ACTINOPTERYGII	*Makaira nigricans*	Blue Marlin	VU	184,823,762
ACTINOPTERYGII	*Pomatomus saltatrix*	Bluefish	VU	7,820,131
ACTINOPTERYGII	*Clinus spatulatus*	Bot River Klipfish	EN	8,743
CHONDRICHTHYES	*Rhina ancylostoma*	Bowmouth Guitarfish	CR	5,182,345
CHONDRICHTHYES	*Echinorhinus brucus*	Bramble Shark	EN	4,527,329
CHONDRICHTHYES	*Notorynchus cepedianus*	Broadnose Sevengill Shark	VU	4,487,898
CHONDRICHTHYES	*Haploblepharus fuscus*	Brown Shyshark	VU	4,263
CHONDRICHTHYES	*Bathytoshia lata*	Brown Stingray	VU	3,590,688
CHONDRICHTHYES	*Carcharhinus leucas*	Bull Shark	VU	9,018,500
CHONDRICHTHYES	*Himantura uarnak*	Coach Whipray	EN	2,445,016
CHONDRICHTHYES	*Myliobatis aquila*	Common Eagle Ray	CR	2,379,110
CHONDRICHTHYES	*Mustelus mustelus*	Common Smoothhound	EN	1,701,126
CHONDRICHTHYES	*Alopias vulpinus*	Common Thresher	VU	18,051,423
CHONDRICHTHYES	*Carcharhinus brachyurus*	Copper Shark	VU	3,017,727
ACTINOPTERYGII	*Chrysoblephus cristiceps*	Dageraad	CR	174,867
CHONDRICHTHYES	*Aetomylaeus bovinus*	Duckbill Eagle Ray	CR	1,064,157
ACTINOPTERYGII	*Mycteroperca marginatus*	Dusky Grouper	VU	4,718,666
ACTINOPTERYGII	*Argyrosomus japonicus*	Dusky Meagre	EN	2,954,187
CHONDRICHTHYES	*Carcharhinus obscurus*	Dusky Shark	EN	15,765,442
MYXINI	*Eptatretus octatrema*	Eightgilled Hagfish	CR	4,374
CHONDRICHTHYES	*Centrophorus moluccensis*	Endeavour Dogfish	VU	439,270
ACTINOPTERYGII	*Syngnathus watermeyeri*	Estuarine Pipefish	CR	5,561

Class	Scientific Name	Common Name	IUCN Status	Range Area (km²)
ACTINOPTERYGII	*Clinus latipennis*	False Bay Klipfish	EN	29,649
CHONDRICHTHYES	*Scyliogaleus quecketti*	Flapnose Houndshark	VU	9,669
CHONDRICHTHYES	*Sphyrna mokarran*	Great Hammerhead	CR	31,445,766
CHONDRICHTHYES	*Pristis zijsron*	Green Sawfish	CR	5,794,498
CHONDRICHTHYES	*Carcharhinus amblyrhynchos*	Grey Reef Shark	EN	5,939,686
CHONDRICHTHYES	*Acroteriobatus leucospilus*	Greyspot Guitarfish	EN	162,155
CHONDRICHTHYES	*Centrophorus granulosus*	Gulper Shark	EN	2,898,533
CHONDRICHTHYES	*Haploblepharus edwardsii*	Happy Eddie	EN	61,581
CHONDRICHTHYES	*Holohalaelurus favus*	Honeycomb Izak Catshark	EN	48,508
CHONDRICHTHYES	*Pateobatis jenkinsii*	Jenkins' Whipray	VU	8,857,706
CHONDRICHTHYES	*Dalatias licha*	Kitefin Shark	VU	6,893,074
ACTINOPTERYGII	*Hippocampus capensis*	Knysna Seahorse	EN	303
CHONDRICHTHYES	*Pristis pristis*	Largetooth Sawfish	CR	6,403,275
CHONDRICHTHYES	*Centrophorus squamosus*	Leafscale Gulper Shark	EN	3,980,354
CHONDRICHTHYES	*Acroteriobatus annulatus*	Lesser Guitarfish	VU	31,057
CHONDRICHTHYES	*Centrophorus uyato*	Little Gulper Shark	EN	1,028,242
CHONDRICHTHYES	*Isurus paucus*	Longfin Mako	EN	185,106,241
CHONDRICHTHYES	*Mobula eregoodoo*	Longhorned Pygmy Devil Ray	EN	2,776,661
CHONDRICHTHYES	*Deania quadrispinosa*	Longsnout Dogfish	VU	347,473
CHONDRICHTHYES	*Torpedo marmorata*	Marbled Torpedo Ray	VU	1,190,342
CHONDRICHTHYES	*Rhizoprionodon acutus*	Milk Shark	VU	7,178,978
CHONDRICHTHYES	*Haploblepharus kistnasamyi*	Natal Shyshark	VU	5,125
ACTINOPTERYGII	*Mola mola*	Ocean Sunfish	VU	57,060,250
CHONDRICHTHYES	*Mobula birostris*	Oceanic Manta Ray	EN	203,755,004
CHONDRICHTHYES	*Carcharhinus longimanus*	Oceanic Whitetip Shark	CR	200,950,876
CHONDRICHTHYES	*Rhinoptera jayakari*	Oman Cownose Ray	EN	2,639,551
CHONDRICHTHYES	*Alopias pelagicus*	Pelagic Thresher	EN	132,386,857
CHONDRICHTHYES	*Carcharhinus amboinensis*	Pigeye Shark	VU	4,128,514
CHONDRICHTHYES	*Lamna nasus*	Porbeagle	VU	93,415,753
CHONDRICHTHYES	*Urogymnus asperrimus*	Porcupine Ray	VU	12,963,835
ACTINOPTERYGII	*Petrus rupestris*	Red Steenbras	EN	185,588
ACTINOPTERYGII	*Chrysoblephus gibbiceps*	Red Stumpnose Seabream	EN	112,297
CHONDRICHTHYES	*Mobula alfredi*	Reef Manta Ray	VU	98,003,781
ACTINOPTERYGII	*Acanthopagrus vagus*	Riverbream	VU	251,100
CHONDRICHTHYES	*Centroscymnus owstonii*	Roughskin Dogfish	VU	3,767,380
ACTINOPTERYGII	*Istiophorus platypterus*	Sailfish	VU	225,977,714
CHONDRICHTHYES	*Carcharias taurus*	Sand Tiger Shark	CR	8,018,523
CHONDRICHTHYES	*Carcharhinus plumbeus*	Sandbar Shark	EN	8,381,722

Class	Scientific Name	Common Name	IUCN Status	Range Area (km^2)
CHONDRICHTHYES	*Sphyrna lewini*	Scalloped Hammerhead	CR	31,603,907
ACTINOPTERYGII	*Polysteganus praeorbitalis*	Scotsman Seabream	VU	198,750
ACTINOPTERYGII	*Polysteganus undulosus*	Seventy-four Seabream	CR	177,205
CHONDRICHTHYES	*Isurus oxyrinchus*	Shortfin Mako	EN	222,540,198
CHONDRICHTHYES	*Mobula kuhlii*	Shorthorned Pygmy Devil Ray	EN	10,281,673
CHONDRICHTHYES	*Mobula tarapacana*	Sicklefin Devil Ray	EN	216,443,327
CHONDRICHTHYES	*Carcharhinus falciformis*	Silky Shark	VU	173,880,025
ACTINOPTERYGII	*Argyrosomus inodorus*	Silver Kob	VU	330,675
CHONDRICHTHYES	*Carcharhinus albimarginatus*	Silvertip Shark	VU	8,879,912
ACTINOPTERYGII	*Lethrinus mahsena*	Sky Emperor	EN	3,336,366
CHONDRICHTHYES	*Odontaspis ferox*	Smalltooth Sand Tiger	VU	7,833,841
CHONDRICHTHYES	*Sphyrna zygaena*	Smooth Hammerhead	VU	17,880,511
CHONDRICHTHYES	*Hemipristis elongata*	Snaggletooth Shark	VU	9,208,477
ACTINOPTERYGII	*Thunnus maccoyii*	Southern Bluefin Tuna	EN	66,241,727
CHONDRICHTHYES	*Mobula mobular*	Spinetail Devil Ray	EN	200,430,791
CHONDRICHTHYES	*Carcharhinus brevipinna*	Spinner Shark	VU	6,230,596
CHONDRICHTHYES	*Squalus acanthias*	Spiny Dogfish	VU	5,974,824
CHONDRICHTHYES	*Aetobatus ocellatus*	Spotted Eagle Ray	VU	22,704,231
ACTINOPTERYGII	*Argyrosomus thorpei*	Squaretail Kob	EN	163,093
CHONDRICHTHYES	*Nebrius ferrugineus*	Tawny Nurse Shark	VU	4,753,673
ACTINOPTERYGII	*Hippocampus histrix*	Thorny Seahorse	VU	14,550,771
CHONDRICHTHYES	*Halaelurus natalensis*	Tiger Catshark	VU	92,050
CHONDRICHTHYES	*Galeorhinus galeus*	Tope	CR	5,755,915
CHONDRICHTHYES	*Raja ocellifera*	Twineye Skate	EN	72,093
CHONDRICHTHYES	*Rhincodon typus*	Whale Shark	EN	171,328,569
CHONDRICHTHYES	*Carcharodon carcharias*	White Shark	VU	273,105,045
CHONDRICHTHYES	*Rostroraja alba*	White Skate	EN	3,271,708
ACTINOPTERYGII	*Lithognathus lithognathus*	White Steenbras	EN	227,632
ACTINOPTERYGII	*Rhabdosargus globiceps*	White Stumpnose	VU	354,034
ACTINOPTERYGII	*Mycteroperca albomarginatus*	White-edged Rockcod	VU	158,844
CHONDRICHTHYES	*Rhynchobatus djiddensis*	Whitespotted Wedgefish	CR	522,768
CHONDRICHTHYES	*Triaenodon obesus*	Whitetip Reef Shark	VU	7,786,144
CHONDRICHTHYES	*Leucoraja wallacei*	Yellowspotted Skate	VU	255,624
CHONDRICHTHYES	*Stegostoma tigrinum*	Zebra Shark	EN	16,086,945

Class	Scientific Name	Common Name	IUCN Status	Range Area (km^2)
Plants				
LILIOPSIDA	*Zostera capensis*	Cape Dwarf-eelgrass	VU	622,695
Marine Invertebrates				
GASTROPODA	*Haliotis midae*	Perlemoen	EN	203,222
GASTROPODA	*Conus immelmani*		VU	21,374
ANTHOZOA	*Anomastraea irregularis*		VU	2,865,324
HOLOTHUROIDEA	*Holothuria nobilis*	Black Teatfish	EN	3,667,576
HOLOTHUROIDEA	*Thelenota ananas*	Pineapple Sea Cucumber	EN	15,843,064
ANTHOZOA	*Acropora anthocercis*		VU	14,612,940
ANTHOZOA	*Alveopora allingi*		VU	17,567,973
ANTHOZOA	Acropora horrida		VU	19,255,901
ANTHOZOA	*Acropora retusa*		VU	9,708,025
ANTHOZOA	*Turbinaria mesenterina*		VU	20,441,655
ANTHOZOA	*Heliopora coerulea*	Blue Coral	VU	19,092,116
ANTHOZOA	Acropora willisae		VU	11,616,088
ANTHOZOA	*Acropora verweyi*		VU	16,236,285
HOLOTHUROIDEA	*Stichopus herrmanni*	Curryfish	VU	13,818,715

ACRONYM TABLE

Acronym	Definition
AZE	Alliance for Zero Extinction site
CBA	Critical Biodiversity Areas
CH	Critical Habitat
COP	(UN Convention on Biological Diversity) Conference of the Parties
CR	Critically Endangered
DD	Data Deficient
E&S	Environmental and Social
EBSAs	Ecologically or Biologically Significant Marine Areas
EEZ	Exclusive Economic Zone
EN	Endangered
ESIA	Environmental and Social Impact Assessment
ESS6	Environmental and Social Standard 6
GIIP	Good International Industry Practice
GIS	Geographic Information System
GN	(IFC) Guidance Note
ha	Hectares
IBA	Important Bird and Biodiversity Area
IBAT	Integrated Biodiversity Assessment Tool
IFC	International Finance Corporation
IMMA	Important Marine Mammal Area
IRA	Internationally Recognised Areas
IUCN	International Union for Conservation of Nature
ISRA	Important Shark and Ray Areas
KBA	Key Biodiversity Area
km	Kilometres
LC	Least Concern
LPA	Legally Protected Area
MH	Modified Habitat
MPA	Marine Protected Area
MSP	Marine Spatial Planning
NCMSBP	National Coastal and Marine Spatial Biodiversity Plan
NH	Natural Habitat
NT	Near Threatened
OECM	Other Effective Area-based Conservation Measure
OWF	Offshore wind farm
PA	Protected Area
PS6	(IFC) Performance Standard 6
RR	Restricted Range
SANBI	South African National Biodiversity Institute
SAPAD	South African Protected and Conservation Areas Database
TBC	The Biodiversity Consultancy
UNEP-WCMC	UN Environment Programme World Conservation Monitoring Centre
VU	Vulnerable
WBG	World Bank Group
WHS	(UNESCO) World Heritage Site

APPENDIX 4: METOCEAN CONDITIONS

PURPOSE

Existing OSW projects have been designed to meet site-specific conditions and industry standards in other parts of the world. Given the nascency of the OSW market in South Africa, detailed assessments of South Africa's metocean conditions with respect to OSW development have not yet been conducted.

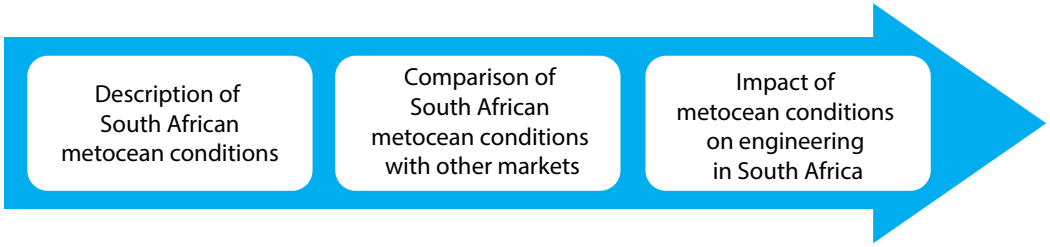
This chapter assesses whether current OSW energy technologies would be viable in the South African context, based on a preliminary assessment of its metocean conditions relative to conditions in areas of existing OSW projects.

METHOD

Overview of methodology

In this section, we outline the approach taken to understand the difference between conditions in the South African EEZ and those in areas with existing OSW development and provide a commentary on the impact of these differences with respect to OSW engineering considerations in South Africa.

FIGURE 96: OVERVIEW OF THE METHODOLOGY.



The methodology comprises the following three steps:

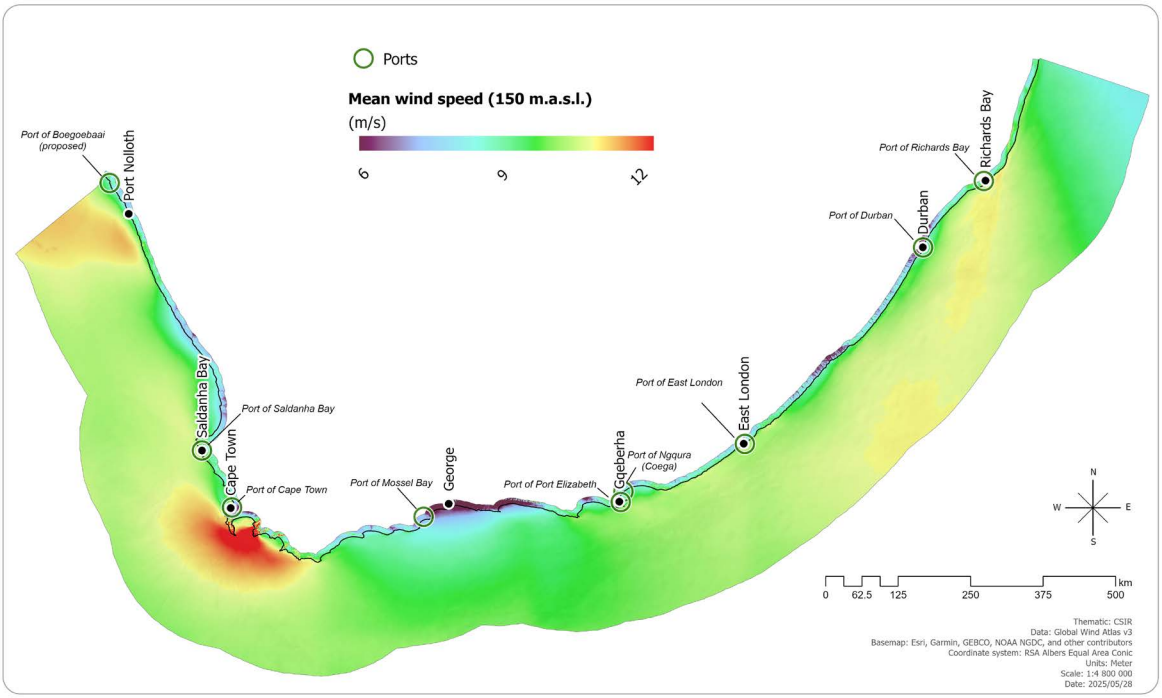
- Understand the metocean conditions in predetermined sites within the South African EEZ;
- Analyse the metocean conditions of existing wind projects using case studies;
- Comment on the impact of metocean condition on engineering and design for projects in South Africa.

Description of South African metocean conditions

To understand the prevailing metocean conditions within the most suitable regions for OSW development identified in Chapter 6: Geospatial Analysis, (Figure 96), statistical data was obtained for a limited number of locations within each site (Figure 97) based on:

- Size of the preferred site to ensure a suitable overview of the prevailing conditions at the site; and
- Water depth with a view to the limitations of existing wind turbine technologies (fixed or floating OSW).

FIGURE 97: LOCATION OF PREFERRED AREAS FOR WIND ENERGY PROJECTS ALONG THE SOUTH AFRICAN COASTLINE.

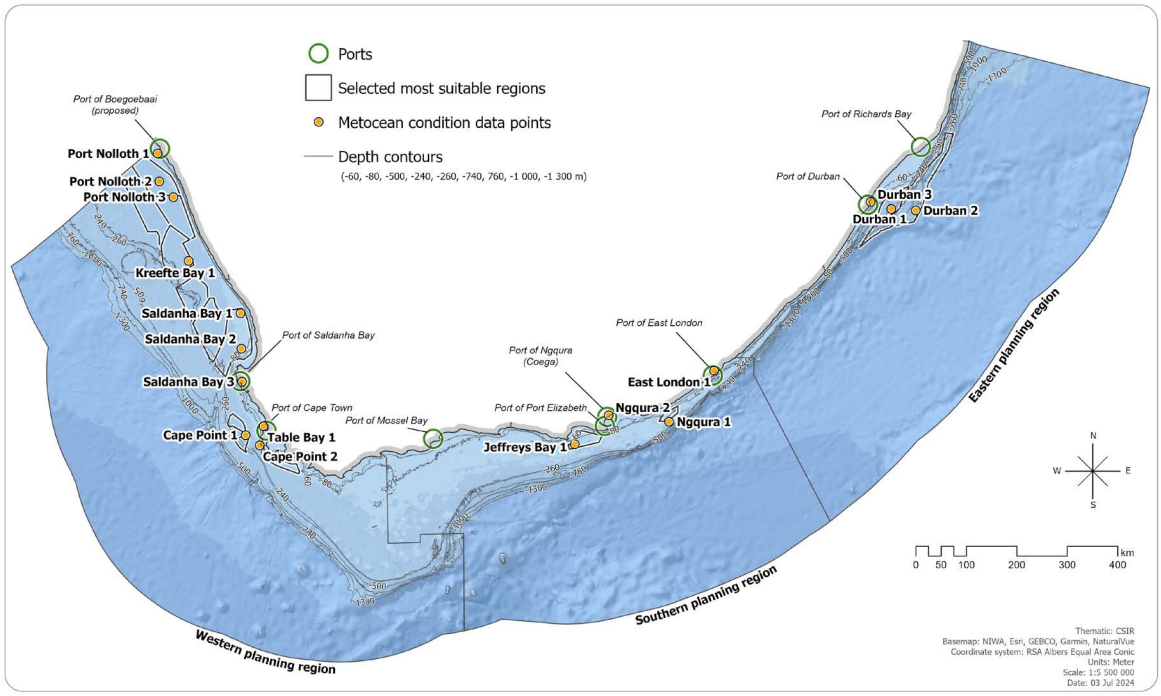


Data for the locations was made available by the Council for Scientific and Industrial Research (CSIR). The CSIR obtained data from two sources:

- WaveWatch III (WAVE-height, 0),[369] a third-generation wave model developed by the US National Oceanic and Atmospheric Administration (NOAA); and
- National Centers for Environmental Prediction (NCEP), an arm of the NOAA's National Weather Service. The data extracted spans 10 years from 2009.

The data included: measured wave data in close proximity to ports in water depths ranging from 21 to 100 m with measurement periods varying between three and nine years; and measured wind data at ports with sensor heights ranging from 20 to 65 m above sea level with measurement periods varying between eight and 30 years.

FIGURE 98: LOCATIONS OF SITES USED TO ANALYSE METOCEAN CONDITIONS.



Following analyses by the CSIR, statistical data was obtained for:

- Wave height (significant, maximum, and return intervals of 50 and 100 years)
- Wave period (average and maximum)
- Wind speed (average and maximum)
- Water depth

Information on current velocity was obtained from satellite data hosted on Copernicus, the earth observation programme run by the European Commission and European Space Agency.[370] Copernicus hosts data from more than 30 satellites.

Given these sources, the information and data contained in this chapter should not be used towards detailed research or in engineering design efforts in wind energy project development.

Metocean conditions of existing wind projects

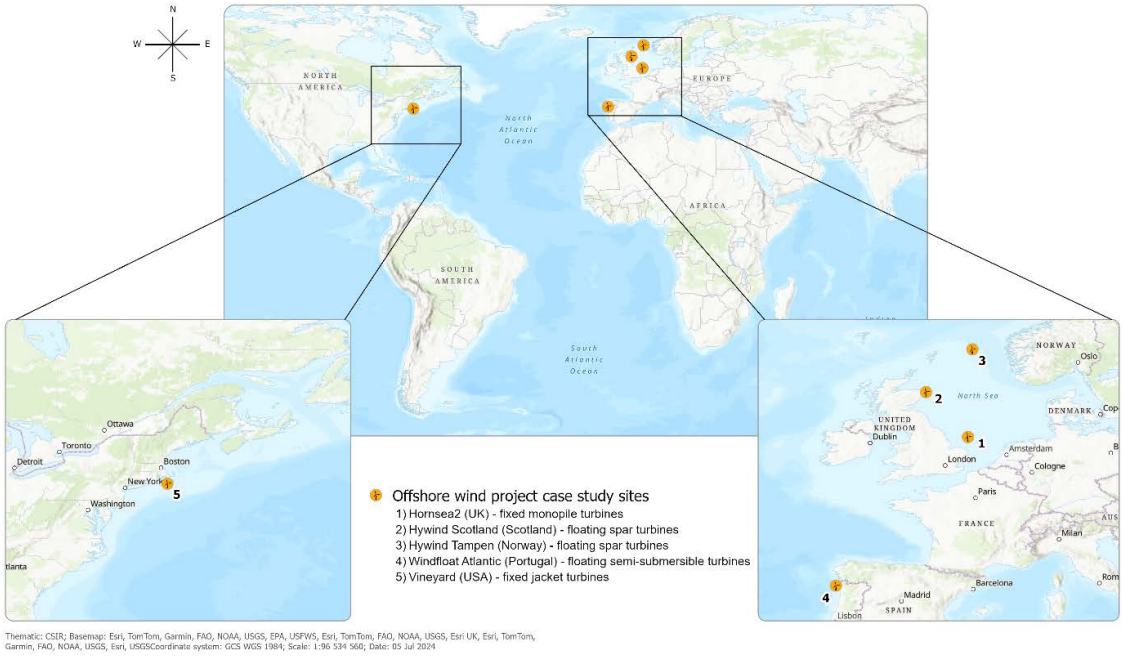
To assess the coastal conditions that current wind energy technologies in the market withstand, desktop research was conducted on existing OSW energy projects and the metocean conditions at each project site.

OSW projects were selected based on the types of turbines and foundations installed. Information on the turbine and foundation type as well as the water depths in which these projects are located was obtained from developer websites. Information on the wave, wind speeds and current velocities were obtained utilising primarily satellite data from Copernicus. Where absolute site specific metocean data was available, this was included.

The wind projects selected are:

- Hornsea 2 (UK);[371] fixed monopile turbines
- Vineyard Wind (USA);[372] fixed jacket turbines
- Hywind Scotland (Scotland);[373] floating spar turbines
- Hywind Tampen (Norway);[374] floating spar turbines
- Windfloat Atlantic (Portugal);[375] floating semi-submersible turbines

FIGURE 99: PROVIDES A GEOGRAPHICAL ILLUSTRATION OF THESE PROJECT SITES.



Thematic: CSIR; Basemap: Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS, Esri, TomTom, FAO, NOAA, USGS, Esri UK, Esri, TomTom, Garmin, FAO, NOAA, USGS, Esri, USGSCoordinate system: GCS WGS 1984; Scale: 1:96 534 568; Date: 05 Jul 2024

Impact of metocean conditions on engineering

The phases of a wind energy project were used as a framework to identify those engineering elements of a wind energy project where metocean conditions and associated data are critical. In this regard, the project phases as described in Det Norske Veritas (DNV) GL (2018) [376] were referenced.

RESULTS AND DISCUSSION

South African metocean conditions

Table 68 presents the statistical data of metocean parameters of waves (height and period), wind, water depth as well as current velocity for each of the predetermined locations within the selected sites. (Locations with an asterisk indicate data retrieved from measured data. Table 69 presents a synthesis of the highest wave, longest wave period, strongest wind speed and current velocity ("maximum conditions") grouped by the range of water depths suitable for fixed and floating OSW.

TABLE 68: STATISTICAL METOCEAN DATA OF THE SELECTED OSW LOCATIONS.

Site name	Depth (m)	Wave height (m)				Wave period (s)		Wind (m/s)		Current velocity (m/s)	
		Hs	Hs_{max}	H_{50}	Hs_{100}	Tp	Tp (max)	Ave	Max	Ave	Max
Durban 1	595	2.3	7.5	8.0	8.2	9.6	25.0	8.2	25.6	0.3	1.0
Durban 2	1294	2.5	8.4	9.7	10.1	10.0	25.0	8.5	24.7	0.5	1.2
Durban 3 (*)	30	1.7	5.7	7.1	7.6	9.0	25.0	6.5	30.5	0.2	1.0
East London (*)	27	1.8	8.0	8.9	9.7	10.9	20.0	6.0	31.5	0.4	1.6
Ngqura 1	449	2.8	7.9	9.2	9.5	11.0	20.0	8.1	30.6	0.5	1.3
Ngqura 2 (*)	21	1.2	7.2	8.7	9.7	10.6	20.0	6.3	26.3	0.1	0.3
Jeffries Bay	202	2.9	8.9	9.7	10.0	11.3	20.0	8.0	26.6	0.3	1.2
Cape Point 1	198	2.8	10.5	10.5	10.9	11.6	25.0	7.6	22.3	0.3	1.0
Cape Point 2 (*)	70	2.5	11.6	11.6	12.3	11.5	33.3	–	–	0.2	0.6
Table Bay (*)	33	1.7	10.0	12.7	13.8	11.7	20.0	6.5	37.1	0.2	0.6
Saldanha Bay 1	116	2.9	8.7	9.9	10.6	11.8	25.0	5.9	20.2	0.2	0.7
Saldanha Bay 2	72	1.7	7.7	8.9	9.6	11.7	25.0	5.9	20.3	0.1	0.4
Saldanha Bay 3 (*)	23	1.3	8.5	7.9	8.5	11.7	20.0	7.1	29.4	0.2	0.6
Kreefte Bay	205	2.5	9.6	10.2	10.8	11.8	25.0	6.4	18.4	0.2	0.7
Port Nolloth 1	121	2.3	8.0	8.3	8.7	11.8	25.0	6.0	17.2	0.2	0.5
Port Nolloth 2	72	2.4	8.7	9.1	9.6	11.8	25.0	6.7	18.0	0.2	0.6
Port Nolloth 3 (*)	100	2.1	6.4	7.6	7.8	11.2	25.0	–	–	0.2	0.7

TABLE 69: SYNTHESIS OF MAXIMUM METOCEAN CONDITIONS BY DEPTH RANGES RELATIVE TO FIXED AND FLOATING OSW.

Depth range (m)	Wave height (m)			Wave period (s)		Wind speed (m/s)		Current velocity (m/s)	
	Hs (Ave)	Hs (Max)	Hs (1:50)	Tp (Ave)	Tp (Max)	Ave	Max	Ave	Max
0-60	1.8	10	12.7	11.7	25	7.1	37.1	0.4	1.6
60-75	2.5	11.6	11.6	11.8	33.3	6.7	20.3	0.2	0.6
75-500	2.9	10.5	10.5	11.8	25	8.1	30.6	0.5	1.3
500-1300	2.5	8.4	9.7	10	25	8.5	25.6	0.5	1.2

In terms of wave height, with respect to water depths suitable to fixed OSW (i.e. less than 60 m), the maximum significant wave height is 10.0 m. The wave height at the 50-year return interval is 12.7 m.

Nearshore (60 and 75 m), the maximum significant wave height is 11.6 m, with a 50-year return interval wave height of 11.6 m.

In terms of water depths between 70 and 500 m, the maximum significant wave height is 10.5 m. The associated wave height at the 50-year return interval is 10.5 m.

In deeper waters, greater than 500 m, the maximum significant wave height is 8.4 m, with a 50-year return interval wave height of 9.7 m.

The average peak wave period around the coast ranges between 10 and 11.8 s, with a maximum peak period of 25 s occurring in most depth categories. The outlier, 33.3 s in the 60-75 m water range is a measured value at Cape Point. We have concerns with this particular outlier and regard the lower peak period values more reliable.

The average wind speed around the coast ranges between 6.7 and 8.5 m/s. Noteworthy, wind speeds are highest nearshore with a maximum of 37.1 m/s measured in Table Bay which is notorious for its energetic wind regime.

For all depth ranges, the average current velocities range between 0.2 and 0.5 m/s with maxima ranging between 0.6 and 1.6 m/s. The greatest velocities occur in shallower waters, within the 0-60 m water depth range.

Metocean conditions of existing OSW projects

Table 70 lists the metocean conditions for the selected wind projects. Information on significant wave height, maximum wave height, wave period, wind speeds, and current velocities were retrieved from satellite data hosted on Copernicus. Where extreme conditions experienced by projects were described and absolute values of metocean parameters was publicly available, for example Hywind Scotland, values were included and sources of this information provided.

TABLE 70: METOCEAN CONDITIONS OF SELECTED OSW PROJECTS.

Wind project	Country	Foundation design	Depth (m)	Wave height (m)	Wave period (s)	Wind speed (m/s)	Current velocity
Hornsea 2	United Kingdom	Fixed, monopile	30-40	1.4 (Hs, ave) 6.0 (Hs, max) 20.5 (max)	6.9 (Tp ave) 17.8 (Tp max)	7.4 (ave) 21.5 (max)	0.1 (ave) 0.5 (max)
Vineyard Wind	United States of America	Fixed, Jacket	60	1.4 (Hs, ave) 7.1 (Hs, max) 12.4 (max) 12.4 (Hs, 1:50) [377]	7.8 (Tp ave) 18.9 (Tp max)	7.3 (ave) 21.2 (max) 41.7 (1:50) [378]	0.1 (ave) 0.5 (max)
Hywind Scotland	Scotland	Floating, spar	95-120	1.5 (Hs, ave) 7.8 (Hs, max) 20.8 (max)[379]	7.8 (Tp ave) 17.6 (Tp max)	1.8 (ave) [380] 40.0 (max) [381]	0.2 (ave) 0.7 (max)
Hywind Tampen	Norway	Floating, spar	260-300	2.6 (Hs, ave) 10.1 (Hs, max) 18.2 (max)	9.9 (Tp ave) 21.1 (Tp max)	8.9 (ave) 22.0 (max)	0.1 (ave) 0.5 (max)
Windfloat Atlantic	Portugal	Floating, semi-submersible	100	2.0 (Hs, ave) 7.0 (Hs, max) 21.7 (max)	11.0 (Tp ave) 20.9 (Tp max)	7.4 (ave) 16.0 (max) 38.8 (max)[382]	0.2 (ave) 0.9 (max)

Comparison of metocean conditions

Based on the available data, for fixed OSW (depth range of 0 to 60 m), extreme metocean conditions around the South African coast somewhat exceed the prevailing conditions of existing wind projects. The average significant wave heights are within the same range but maximum significant wave heights along the South African coastline are significantly higher. However, evidence exists of the successful performance of fixed OSW in extreme conditions with the 1:50 year wave height experienced by Vineyard Wind only 0.3 m less than the 1:50 year wave height for South Africa. Average wind speeds are comparable, however the maximum wind speeds experienced along the South African coastline are stronger. However, the Vineyard Wind project has experienced a 1:50 year wind speed (41.7 m/s) far exceeding the South African maximum wind speed (37.1 m/s). Finally, the maximum current water velocity experienced at this depth range is significantly greater than the maximum velocities experienced at existing wind projects. However, the average water velocities are on par.

With respect to the intermediary depth range (60-75 m), none of the existing wind projects provide a direct comparison. Compared to the conditions of existing wind projects with fixed OSW, the average and maximum significant wave heights are greater, over 1 m and 4 m respectively. In terms of wind speeds, the findings are similar to that of inshore fixed OSW within the 0-60m depth range.

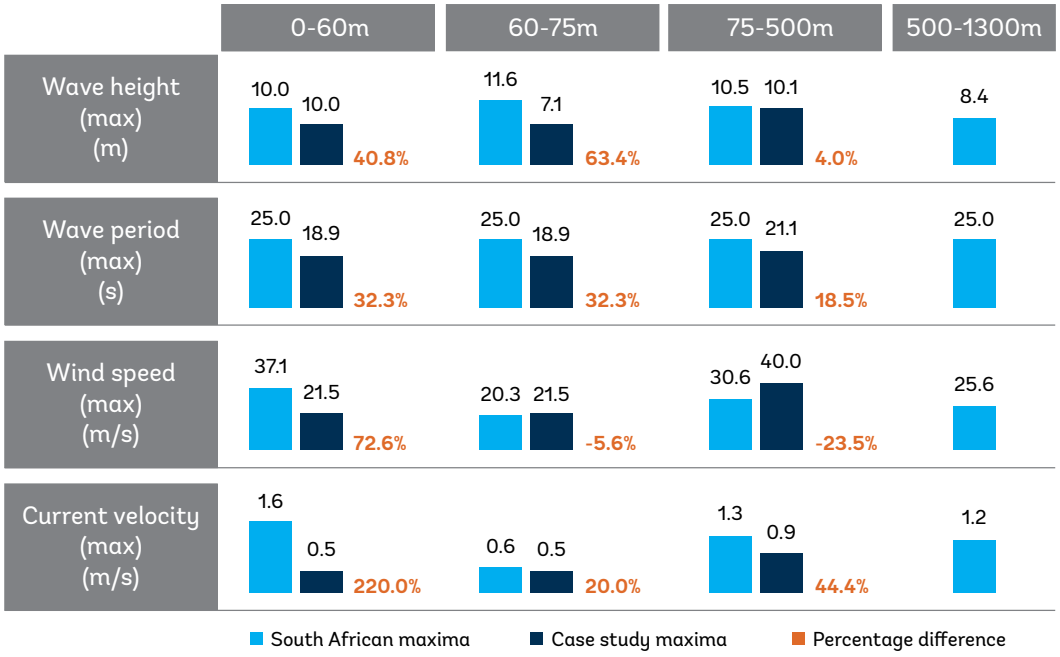
With a view to floating OSW located in water depths ranging between 60 and 75 m, referencing Hywind Scotland (in 95-120 m water depths) and Windfloat Atlantic (in 100 m water depths), while South African average and maximum significant wave heights are higher, each of the existing wind projects have experienced wave heights significantly greater than the South African 1:50 year wave height of 11.6 m. Average and maximum wind speeds experienced at the Windfloat Atlantic wind project are comparable to South African conditions in locations of water depths between 60 and 75 m.

In deeper waters, greater than 75 m, the Hywind Tampen project experiences metocean conditions comparable to South African conditions in terms of average and maximum significant wave height, wave period and wind speed.

The primary caveats relate to wave period and current velocity. In general, wave periods experienced along the South African coasts are generally long due to the relative 'isolation' of the coastline. Meteorological conditions at distance initiate waves which, over distance, develop into long period swells that approach the South African coastline unimpeded. Current velocities, both average and maximum, are greater than those of the existing wind projects. Water speeds are dependent on a number of factors, both localised and at distance and the reasoning for greater water speeds cannot be generalised.

Figure 99 provides a graphical summary of the differences between the maximum conditions experienced along the South African coastline and those of the existing wind projects.

FIGURE 100: COMPARISON OF MAXIMUM CONDITIONS EXPERIENCED ALONG THE SOUTH AFRICAN COASTLINE WITH MAXIMUM CONDITIONS EXPERIENCED BY THE VARIOUS WIND PROJECTS.



Engineering implications of metocean data

The drive to shift OSW projects further offshore increases the complexity of planning, design, construction, operations and maintenance, and decommissioning of the project. Using the project process outlined in Figure 100, below we identify the engineering components of each project phase where metocean data are crucial.

FIGURE 101: PHASES OF A WIND ENERGY PROJECT (DNV GL, 2018).



In the planning stage, metocean data are used in the assessment of the wind resource and energy yield (adequacy of the wind resource), the feasibility assessment and conceptual design of a project. While not directly linked to engineering considerations but included in this phase, environmental impact assessments would require metocean data as well. From a site selection and feasibility assessment perspective, detailed wind speed and direction data help identify the most productive sites for wind energy generation. Understanding wave heights, periods, and ocean currents is crucial to evaluate the suitability of a location for the activities of installing turbines and associated infrastructure.

Design phase

In the design phase, metocean data are key to inform structural and foundation design to ensure the structures can withstand metocean conditions. During this phase of the project, it is important to have a detailed understanding of normal metocean conditions, informing long-term fatigue loading, and extreme metocean conditions, informing extreme loading. High wind speeds and turbulence impose significant forces on turbine blades, towers, and foundations. Waves, especially during storms, generate dynamic forces that affect the stability and integrity of the structures. Ocean currents can exert continuous forces on the foundations and influence sediment transport around the structures.

In terms of structural design, metocean data informs the design of wind turbine structures to ensure they can withstand local environmental conditions, including extreme weather events. In terms of foundation design, wave loads, and current forces influence the design of turbine foundations. From the perspective of dynamic response analysis, metocean data are used to analyse the dynamic response of wind turbines and support structures under various loading conditions.

Furthermore, metocean data is also used in designing the configuration of a set of wind turbines of a site. The data are used to assess optimal distance between structures with due consideration of wind, wave and current wakes and compounding loads of nearby structures.

Transportation and installation phase

In the transportation and installation phase, metocean data are required to inform construction and installation planning, and implementation. The need is to understand the availability of safe and favourable operating conditions (windows) for these activities with a view to establishing 1) technology specifications (e.g. vessels, jacks or cranes) and 2) the duration of transportation and installation. Technology specifications and duration of construction and installation have significant implications on the cost of the project.

Specialised ships and installation technologies are required for the construction, transportation, and installation of a wind project. The selection of the technologies is informed by the selected wind farm components (e.g. turbine and foundation), and by the prevailing metocean conditions. High winds, rough seas, and strong currents pose significant risks to safety during OSW farm equipment transportation and installation. These adverse conditions affect the stability of equipment, compromising the precision and safety of installation activities and would thus result in a period of downtime. A comprehensive understanding of the availability of safe operating windows, based on sound analysis of metocean data, provides for informed planning of the transportation and installation phase of the project, minimising the risk of project delays.

Depending on the technology required, the unit cost of specialised maritime equipment can be significant. The cost of the transportation and installation phase of the project will be driven, amongst other determinants, by the number of operational hours and waiting times for suitable weather conditions. Again, a thorough understanding of the availability of safe operating windows, based on sound analysis of metocean data, contributes to a rigorous assessment of the cost of the project, minimising the risks of exceeding expected costs.

Operations and maintenance phase

The requirement for metocean data during the operation and maintenance phase of a project is similar to that of the transportation and installation phase. The timing of activity within this phase is determined by availability of favourable metocean conditions, of a long enough duration, to 1) undertake the task and 2) to ensure the safety of personnel.

Decommissioning phase

The final phase of a wind energy project is decommissioning, which has similar requirements for metocean data as the previous two phases.

DISCUSSION

Feasibility of existing wind technologies in the South African context

Metocean conditions around the South African coastline are marginally more challenging (greater and longer waves, greater wind speeds and greater current velocities) than those experienced in locations of existing wind projects. However, maximum conditions experienced in those locations (Table 70) are on par with South Africa's metocean conditions particularly at depths greater than 60 m (Figure 99).

Wind energy technologies in the current market will likely withstand metocean conditions in locations along the South African coastlines. Considering the available wind energy technologies, floating OSW currently in operation (e.g. Hywind Tampen, Hywind Scotland and Windfloat Atlantic) are suitable in the South African context.

With reference to the caveats mentioned in above, the longer wave periods experienced along the South Africa coastline (both average and maximum) can be accounted for in the design of the wind project structures. This is particularly relevant to the design of turbine and substation foundations and the calculation of forces the foundations must be able to withstand. Long wave periods (combined with greater than average wave heights) may pose significant challenges to the transportation and installation of equipment in the construction of the wind project, as well as operational and maintenance activities. These activities require optimal metocean conditions and suitable weather windows to ensure safety and reliability of activities. While structures can be designed to withstand the local metocean conditions, the performance of available technologies (e.g. vessels or ships) for transportation and installation, and for operations and maintenance, in these metocean conditions requires further investigation.

The second caveat relates to greater current velocities, both average and maximum, along the South African coastline. Similar to wave period, strong current velocities can be accommodated for in the design of structures. Stronger current velocities may be a factor in the planning of construction activities of the wind project and similar to considerations towards wave period, the capabilities of available technologies will need to be assessed and may require adaptation.

RECOMMENDATIONS

South Africa's unique metocean conditions are critical to the successful development of OSW projects, influencing every phase of planning and design. The following is recommended to establish South Africa as a leader in OSW technology suited to its challenging oceanic environment:

- **MET1 / FIN2.** As a quick win, the government should leverage concessional and donor funding for offshore measurement campaigns. Key government departments such as DEE, DFFE or Department of Science and Innovation should collaborate to commission a comprehensive metocean measurement campaign at key offshore locations, critical for informed decision-making in the early phases of OSW development.
- **MET2.** South African research institutions should work with DSI to coordinate research and development on the impact of South Africa's unique metocean conditions on wind projects, positioning the country as a leader in developing and testing advanced OSW technologies. These institutions should partner with international researchers with an established track record in OSW technologies (e.g. floating OSW systems) to develop expertise.
- **MET3.** Research institutions in collaboration with the DSI, SABS and other relevant government departments, should assess the performance of specialised maritime equipment required for OSW projects, ensuring it can meet the operational challenges posed by South Africa's sea states and align technology development efforts with countries that have similar oceanographic conditions

APPENDIX 5: SUMMARY OF STAKEHOLDER ENGAGEMENT CARRIED OUT FOR THIS STUDY

SUMMARY

Effective stakeholder engagement is crucial for this report's findings to be well-received and aligned with the national political context. The following paragraphs present a summary of the consultations with key stakeholders at both national and local levels regarding the offshore wind sector's development. The primary goal was to share the draft findings and discuss the potential benefits and growth scenarios for offshore wind in South Africa. Three virtual workshops were held in 2024 on 20 September, 19 November, and 4 December, which featured active participation and discussions among delegates.

A database of relevant stakeholder organisations was created and continuously updated to ensure effective engagement. Contact details were retained during the project in compliance with the South African Protection of Personal Information Act (Act No. 4 of 2013).

The first workshop on 20 September 2024 was open to all interested parties, with invitations sent to 202 stakeholders. Due to low interest in in-person attendance, the session was held online. The agenda included presentations from various organisations and a Q&A session. The session was scheduled for three hours. Time was allocated after each main section of the presentation to address both chat and verbal questions and after completing the presentation in a dedicated Q&A session. The initial session was successful, demonstrated by good attendance and active engagement with the material from attendees. This led to the decision to partner with the South African Wind Energy Association (SAWEA) for broader outreach.

To ensure broader outreach, a second workshop, organised with SAWEA on 19 November 2024, followed a similar format and actively engaged participants. A final stakeholder engagement session, organised by DMRE, was held on 4 December 2024 exclusively for government stakeholders. The primary goal of this workshop was to provide a platform for government representatives to discuss any issues they might prefer not to raise in a public forum. Additionally, it aimed to involve stakeholders responsible for Integrated Resource Plan (IRP) planning.

All three workshops facilitated meaningful engagement and contributed to this report. The discussions and feedback gathered during these sessions have been instrumental in ensuring inclusivity across different stakeholder groups.

Key discussions across the three workshops related to the following areas of the study:

- The identification of suitable regions for OSW development, focussing on the environmental impact and infrastructure requirements.
- The benefits and cost implications of fixed and floating OSW technologies.
- The need to ensure that OSW is considered part of future integrated response planning, and balance this against the need to provide a least-cost energy mix.
- Reflections on the need for a deeper understanding of the energy potential and technical aspects involved in offshore wind development in South Africa.
- Reflections on the regulatory and policy changes required to ensure an enabling framework for OSW development, particularly regarding licensing processes and land use permits. Delegates advocated for coordinated collaboration among relevant Departments and agencies.
- Considerations of the broader economic implications of OSW development, including the potential opportunities for growth and development and the implications for other activities, such as tourism and fisheries. Delegates also raised concerns about supply chain costs and opportunities.
- Delegates advocated for planned and targeted training and skills transfer initiatives for localised OSW development.
- Concerns about the lack of data to enable site-specific considerations for OSW development were raised.
- The questions were effectively addressed, and valuable stakeholder comments were noted for further consideration. Notably, there was no strong opposition to the concept of offshore wind in South Africa. Instead, the focus was on discussions surrounding its implementation.
- This positive response was also noted in other stakeholder interactions, such as during the execution of individual work packages and the two panel discussions at the 2023 and 2024 Windaba Conferences.

INTRODUCTION

Effective stakeholder engagement is essential to ensuring that the findings of the study *A Strategic Framework for Offshore Wind Development in South Africa* are well-received, aligned with the country's political context, and positioned for endorsement. This report presents the outcomes of consultations with key stakeholders and organizations typically involved at both national and local levels during different phases of offshore wind sector development.

The primary objective of these engagements was to share the draft findings of the study *A Strategic Framework for Offshore Wind Development in South Africa*, enabling stakeholders to understand the potential benefits offshore wind could offer South Africa. Additionally, the sessions aimed to share the expected outcomes of three possible growth scenarios for offshore wind in South Africa.

Three stakeholder engagement workshops were conducted in 2024 to achieve these objectives. While the initial plan envisioned a mix of physical and virtual (or hybrid) meetings, the majority of delegates expressed a preference for online sessions. Consequently, three virtual workshops were held on 20 September, 19 November, and 4 December. These well-attended sessions featured active participation and robust discussions based on the presented findings.

This report summarizes the feedback gathered during the workshops and serve to inform the final recommendations of the study.

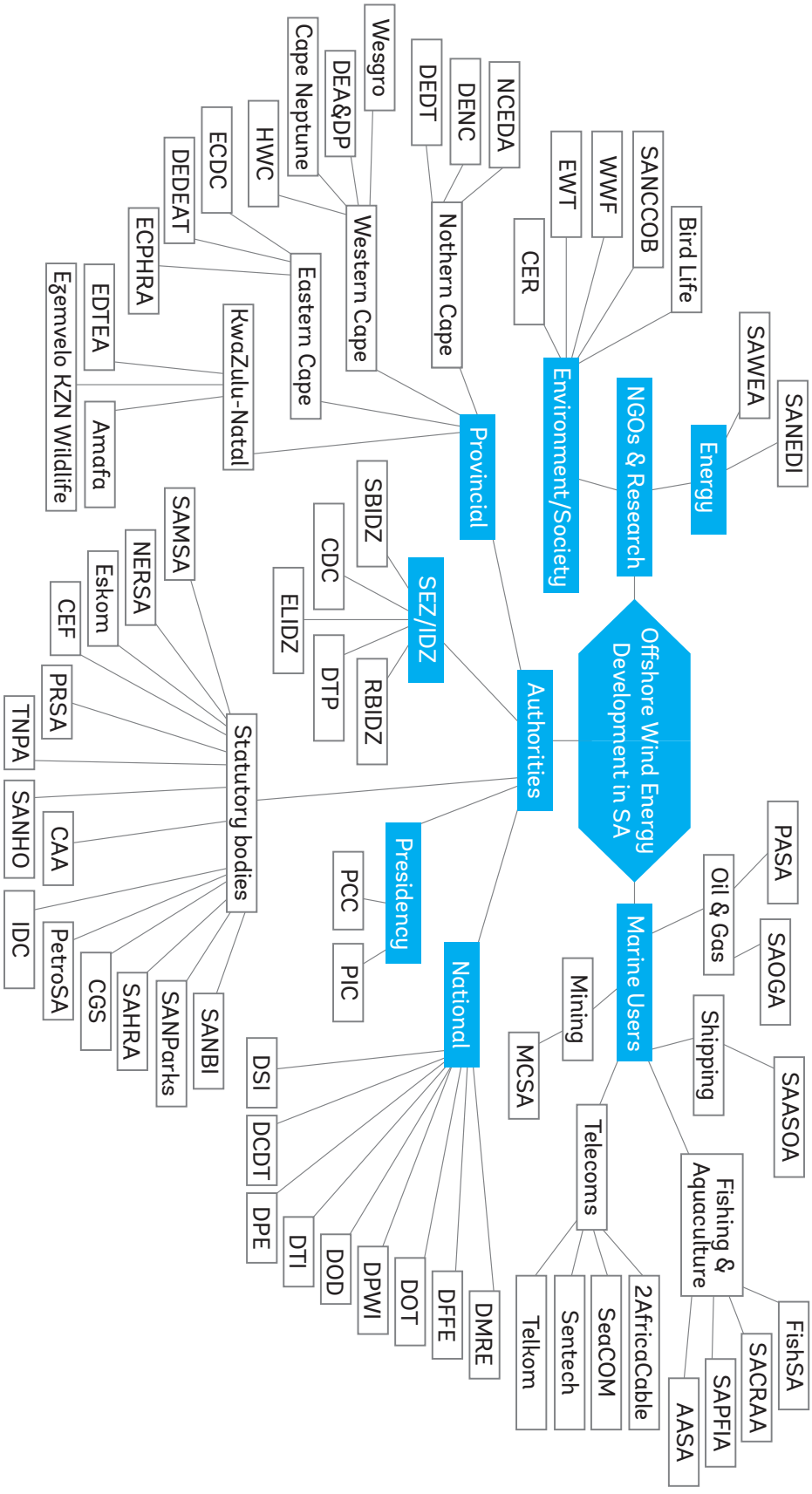
METHODOLOGY

Stakeholder map and database

A database was developed containing a list of relevant stakeholder organisations, categorised according to their interest and influence. An initial stakeholder map was drawn up at the start of the study and the database of stakeholders was continually updated. The initial stakeholder map is shown in Figure 101 and final stakeholder database in Appendix 1.

Individuals within these organisations were identified and their contact information stored. Such contact details were retained for the duration of the project but will not be published without permission, in adherence with the South African Protection of Personal Information Act (Act No. 4 of 2013).

FIGURE 102: STAKEHOLDER MAP.



WORKSHOP FORMAT

Initial workshop overview

The first stakeholder engagement workshop was scheduled for 20 September 2024. The invitation was open to all individuals and organizations interested in offshore wind energy in South Africa. Invitations were sent based on information from the stakeholder database, and invitees were encouraged to forward the invitation to colleagues or others who might be interested, both within and outside their respective organisations.

Delegates were given the option to attend the workshop in person at the Council for Scientific and Industrial Research (CSIR) premises or to join online via Microsoft Teams. Of the initial 202 invitees, fewer than five indicated a preference for in-person attendance. Consequently, the decision was made to conduct the workshop entirely online.

Prior to the event, a detailed agenda was circulated, which included the following items:

1. Opening and Welcome – CSIR
2. Introduction – Department of Mineral Resources and Energy (DMRE)
3. Project Overview – World Bank Group
4. Presentation of draft *A Strategic Framework for Offshore Wind Development in South Africa* contents – Carbon Trust
5. Question and Answer Session – CSIR
6. Closing – CSIR

The session was scheduled for three hours. Delegates were invited to post questions or comments via the Teams chat feature or to ask questions verbally. Time was allocated after each main section of the presentation to address both chat and verbal questions, and also after completion of the presentation in a dedicated Q&A session. The session was recorded for reference purposes; however, the recording was not shared with participants. Instead, a copy of the presentation slides was made available. Additionally, Microsoft Teams generated a transcript of the session, which was used to create a "comments matrix" — a separate deliverable not included in this report.

The initial session was well-attended, and participants actively engaged through both verbal and written questions. Questions were addressed by representatives from the World Bank Group, Carbon Trust, and CSIR, based on their areas of expertise. All questions were resolved before moving on to the next section of the presentation. Based on the strong attendance and active participation, the workshop was deemed a success.

However, it became apparent that a broader audience within the current onshore wind industry needed to be reached. The South African Wind Energy Association (SAWEA) was identified as an ideal partner to facilitate such an outreach.

Subsequent workshops

A second stakeholder workshop took place on 19 November 2024, organized in collaboration with SAWEA. This session followed the same format as the initial workshop and was also well-attended. The audience once again engaged actively, providing both verbal and written feedback. The collaborative effort with SAWEA ensured that a wider industry audience was reached.

A final stakeholder engagement session was held on 4 December 2024, exclusively for government stakeholders. This workshop was organized by the DMRE, with slight adjustments to the format. The World Bank Group presented the contents of *A Strategic Framework for Offshore Wind Development in South Africa*, while the roles of the DMRE and the CSIR were reversed compared to previous sessions. The primary goal of this workshop was to provide a platform for government representatives to discuss any issues they might prefer not to raise in a public forum. Additionally, it aimed to involve stakeholders responsible for Integrated Resource Plan (IRP) planning.

All three workshops successfully facilitated meaningful engagement and contributed to the development of this report. The discussions and feedback gathered during these sessions have been instrumental in ensuring inclusivity across different stakeholder groups.

RESULTS

During the stakeholder workshops, participants posed several questions to the project team and made various statements, which have been summarized below. The questions are categorized according to specific themes, with the statements by delegates provided in a separate section.

Workshop held on 20 September 2024

This workshop was organised by the project team. A total of 202 invitations were sent to stakeholders listed in the database, with 71 accepted, 15 declined, and 7 marked as 'tentative'. On the event day, 145 attendees were recorded, suggesting that some non-respondents from the initial invitations ultimately attended, and that recipients of the original invitations likely shared them with others.

The questions raised by delegates were categorized into the following themes: identification of suitable regions, technology, growth scenarios, and economic aspects, with the most questions focused on the first theme. Additionally, 17 statements were recorded.

Questions relating to the identification of suitable regions

Webinar attendees raised several key points regarding the identification and planning of suitable regions for offshore wind development in South Africa. Questions were raised about the methodologies used, such as whether a weighting scheme was applied to various constraints in identifying the seven suitable regions for offshore wind. Attendees also inquired if data from the Wind Atlas of South Africa (WASA), which includes offshore wind speeds, was incorporated into the analysis.

The integration of onshore infrastructure, particularly grid availability, was highlighted as an important factor in siting decisions. Additionally, attendees sought clarification on how mining licenses and concessions within South Africa's Exclusive Economic Zone (EEZ) would be managed alongside other activities, including offshore wind development.

Biodiversity considerations were a major theme, with questions about how future planning might incorporate protection for sea birds, particularly those with breeding populations on offshore islands. The potential impacts of offshore wind on migratory species like whales and turtles were also discussed, focusing on risks such as physical interactions, underwater noise, and electromagnetic interference.

The role of existing Marine Protected Areas (MPAs), especially the one between Durban and Richards Bay, was brought up, with attendees asking how these areas would be factored into offshore wind planning. They also inquired whether buffers around MPAs were considered in the siting process.

Other concerns included how wind capacity was quantified given the lack of significant coastal meteorological stations and what global best practices for shipping routes could be applied to South Africa's infrastructure planning to ensure coordination and minimize disruption. These questions underscore the need for a balanced and carefully considered approach to offshore wind development, with thorough attention to environmental, logistical, and regulatory factors.

Questions relating to technology

Webinar attendees raised a range of technology-related questions regarding offshore wind development in South Africa. One point of interest was the potential use of suction piles as an alternative to the traditional impact-driven piles, with attendees seeking clarification on whether this method had been considered. The environmental impact of different installation methods was also discussed, with questions about whether there is a correlation between the type of installation recommended and its environmental effects.

The cost implications of offshore wind technology were another focal point, with attendees inquiring about the price difference between floating turbines and conventional pile-driven construction. They also sought to understand whether offshore wind costs are roughly double those of onshore wind, assuming both have favourable wind regimes.

In terms of broader strategy, attendees were curious about how offshore wind is incorporated into the Integrated Resource Planning (IRP) of other jurisdictions, looking for insights into international best practices. Lastly, there was uncertainty about the timeline for offshore wind development in South Africa, with attendees questioning whether opportunities would emerge within the next decade or take longer. These questions highlight the need for clarity on both the technological and economic aspects of offshore wind as South Africa explores this potential energy source.

Questions relating to growth scenarios

Webinar attendees sought clarification on various aspects of the offshore wind development process in South Africa, particularly regarding the capacity and potential of offshore wind projects. One key question raised was whether the proportion of electricity referenced relates to the energy supplied or the installed capacity. Attendees also inquired if the results of the preliminary energy system optimization analysis were available, signalling an interest in understanding the initial findings of the project.

The potential of South Africa's offshore wind capacity was another point of discussion. Specifically, attendees wanted to know whether the 95-Gigawatt (GW) figure mentioned represents a limit to the potential energy available or if more capacity could be accessed. Further, attendees sought

clarification on the figures presented in different scenarios — low, medium, and high — wondering whether these numbers referred to installed capacity or were adjusted for capacity factors. These questions reflect the need for a deeper understanding of the energy potential and technical aspects involved in offshore wind development in South Africa.

Questions relating to regulatory aspects

Webinar attendees raised important questions about the regulatory framework needed for offshore wind development in South Africa. One key topic was the process of licensing areas and granting land use permits to ensure orderly development. Attendees sought clarity on which authorities would be responsible for overseeing these processes.

Environmental concerns were also highlighted, particularly regarding the fishing sector. There were inquiries about whether follow-up environmental assessments would be conducted on the fishing industry after turbine installation to monitor and mitigate any impacts on this sector.

Lastly, attendees sought recommendations for actions South Africa could take in the present to prepare for offshore wind development. They emphasized the importance of planning and proactive measures to ensure that the country is ready for this emerging industry. These questions reflect a broader concern about establishing a clear, effective regulatory framework that balances environmental, economic, and logistical factors in offshore wind development.

Questions relating to economic aspects

Webinar attendees raised several important economic considerations regarding offshore wind development in South Africa. One topic of interest was the economic models used in other regions, with questions about whether there are examples of offshore wind sectors being developed without established markets or being dominated by the state. This reflects a desire to understand alternative approaches to market-driven offshore wind development.

Another point of concern was the potential impact of offshore wind on tourism, with attendees inquiring about global studies examining how offshore wind projects might affect tourism activities in the regions where they are implemented. This highlights a need to assess the broader economic implications of offshore wind, beyond energy production.

Additionally, attendees sought clarity on the methodology used to calculate potential job creation in the offshore wind sector, emphasizing the importance of understanding the economic benefits and workforce development opportunities associated with this industry. These questions reflect a broader interest in the economic feasibility and broader socio-economic impacts of offshore wind in South Africa.

Statements made by delegates

Webinar attendees discussed a wide range of issues related to offshore wind development in South Africa, highlighting both opportunities and challenges. The debate began with the observation that the levelised cost of electricity (LCOE) is an incomplete metric for comparing various generation technologies, particularly those with different supply profiles. The focus, attendees argued, should be on identifying optimal technology combinations to meet energy demand at the lowest cost, with offshore wind being a key component of future Integrated Resource Plan (IRP) studies.

Onshore development complexities were also discussed, with land claims, environmental impact assessments (EIAs), grid issues, conservation tourism, and expanding mining rights complicating onshore energy development. These concerns emphasize the increasing difficulty of developing land-based projects. Additionally, attendees pointed out the need to consider the International Maritime Organisation (IMO) Traffic Separation Scheme, especially for regions with busy maritime traffic.

Attendees highlighted South Africa's well-established power purchase agreement (PPA) market as a positive factor for offshore wind development. However, there were concerns about limited biodiversity data, with hopes that future data would help guide offshore wind development more effectively. Specific environmental considerations included the challenges faced in fishing-rich regions like Saldanha and Cape Point, where the less structured nature of fishing activities could hinder the implementation of separation schemes.

The Integrated Coastal Management Act (2008), which gives municipalities jurisdiction over coastal property, was noted as a potential obstacle to wind farm development, and it was suggested that residential areas should also be incorporated into the planning data. Furthermore, important migratory corridors for species like southern right and humpback whales were highlighted, with a need to incorporate these into future planning. Other species, including bats migrating along the KZN/Eastern Cape coast, should also be considered, along with underwater archaeological sites that might be impacted by offshore wind installations.

Economic and regulatory perspectives were also touched on, with attendees advocating for further collaboration with agencies like the Department of Forestry, Fisheries, and the Environment (DFFE), BirdLife South Africa, and NGOs to access available environmental data. The Department of Transport expressed its support for the study and a willingness to collaborate on future energy solutions to position South Africa for success in the offshore wind sector.

Finally, while offshore wind has the potential to address South Africa's base load energy challenges, the environmental considerations could shift preferred development locations away from the KZN coast. Nonetheless, well-placed offshore structures could not only mitigate environmental impacts but also enhance localized fisheries by fostering species aggregation. The proactive engagement of KZN Province with companies on offshore wind EIAs and leases further underscores the importance of coordinated planning and collaboration for successful offshore wind development.

Workshop held on 19 November 2024

This workshop was organised by SAWEA. While the exact number of invitations sent is unknown, the organization has over 140 members, and the maximum attendance on the day was 236. The questions raised by delegates were categorized into the following themes: economic aspects, regulatory aspects, identification of suitable regions, and education and training, with the majority of questions focused on economic aspects. Additionally, 3 statements were recorded.

Questions relating to economic aspects

Questions raised about offshore wind development in South Africa reflect a strong interest in understanding the financial, technical, and strategic considerations involved. Attendees sought clarity on the government's position regarding offshore wind, particularly concerning cost implications and the potential for private-public partnership models to drive development.

The discussion included queries about methodologies used to estimate job creation, reflecting a focus on the economic benefits of offshore projects. Attendees also questioned whether investment plans incorporate funding for research and innovation through entities like the National Research Foundation (NRF) and whether lifecycle considerations, such as recycling and reuse of wind equipment, were addressed.

Concerns about supply chains were evident in questions about the original equipment manufacturers (OEMs) considered in cost estimates, comparing Chinese and Western European options. Financing trends and how financial institutions evaluate and mitigate risks associated with offshore wind projects were also highlighted as critical topics.

Finally, the rationale for pursuing offshore wind, despite South Africa's abundant land resources, was questioned. Attendees were particularly interested in a detailed comparison of the costs and benefits of onshore versus offshore projects to better understand the strategic direction of this energy transition.

Questions relating to regulatory aspects

Webinar attendees raised key questions about governance, planning, and regulatory challenges associated with offshore wind development in South Africa. A recurring theme was the clarity of decision-making authority, particularly whether the Department of Forestry, Fisheries, and the Environment (DFFE) would oversee project approvals.

Concerns about land rights and access to state-owned land were also prominent, with questions on how these rights would be allocated and what measures would be taken to mitigate associated risks. Attendees sought insight into how the *Strategic Framework for Offshore Wind Development in South Africa* aligns with the broader Masterplan for Renewables, emphasizing the importance of ensuring these frameworks complement each other.

Permitting challenges emerged as a critical topic, with questions about the barriers to offshore wind projects and the strategies governments and regulators are employing to address them. Finally, the evolving insurance landscape was highlighted, with attendees asking whether South Africa's insurance market might adopt exclusions similar to those seen in Europe's offshore wind sector. These questions reflect a keen interest in understanding the structural and procedural aspects of enabling offshore wind in South Africa.

Questions relating to the identification of suitable regions

Webinar attendees highlighted the need to address spatial and regulatory complexities in offshore wind development in South Africa. Questions were raised about whether offshore oil and gas exploration zones were factored into the geospatial assessments, and attendees sought clarity on the data sources and shapefiles used to delineate potential offshore wind regions.

The potential for conflict between offshore mining rights and wind energy development emerged as a significant concern. Attendees inquired whether legislative or regulatory measures are being developed to facilitate negotiations, avoid blanket exclusion zones, and mitigate tensions between oil field stakeholders and wind farm developers.

Environmental considerations were also discussed, with specific questions about effective methods for monitoring bats in offshore environments where fixed infrastructure like masts is unavailable. These questions underscore the importance of integrating spatial, regulatory, and environmental strategies into offshore wind planning.

Questions relating to education and training

Webinar attendees focused on the importance of developing a skilled workforce for offshore wind development in South Africa. Questions were raised about the role of Global Wind Organisation (GWO)-accredited training providers in educating and certifying staff for the offshore wind sector.

There was also interest in whether any incentives currently exist to promote the training and development of personnel for this emerging industry. Additionally, attendees sought insight into South Africa's readiness in terms of offshore technology, specifically regarding engineering skills, safety standards, and manufacturing capabilities. They inquired about analyses of these areas and how any existing gaps could be addressed both in the short and long term, emphasizing the need for strategic workforce development as the sector grows.

Statements made by delegates

Webinar attendees raised several key considerations regarding the development of offshore wind in South Africa, particularly around workforce readiness, financial risks, and education. One point emphasized the importance of addressing swimming skills and overcoming water-related fears to improve employability in the offshore wind sector.

The financial risks tied to offshore wind projects were also a topic of concern, with attendees noting that the tender structure presents significant challenges. After securing lease areas and financing, developers face substantial non-reimbursable costs for feasibility and Final Investment Decision (FID) studies, which can account for 2-5% of the project. Bureaucratic delays in site characterization and permitting have led to financial setbacks for companies like BP and Orsted. A national framework for data gathering was proposed as a way to reduce costs and attract private investment without over-relying on taxpayer funding.

Lastly, the importance of educating university students about the energy sector was highlighted, stressing that a strong, well-informed workforce is essential for the long-term growth of the offshore wind industry in South Africa.

Workshop held on 4 December 2024

This workshop was organized by DMRE and limited to invited stakeholders from other government departments, with a total of 25 stakeholders invited. While the presentation appeared to be well received, only one question was asked, which focused on how the government can best facilitate offshore wind development and what the first steps are that need to be taken.

DISCUSSION

Based on a comparison of the number of invitations sent out with the number of delegates in attendance, the stakeholder workshops were well-supported. Participants demonstrated active engagement, posing both verbal and written questions, all of which were addressed effectively by representatives from the World Bank Group, Carbon Trust, and CSIR, each responding within their areas of expertise. Additional positive indicators included attendees expressing appreciation for the efforts made, offering thanks, and requesting the presentation slides. Notably, there was no strong opposition to the concept of offshore wind in South Africa. Instead, the focus was on discussions surrounding the implementation of the concept.

This positive response was also noted in other stakeholder interactions, such as during the execution of individual work packages and during the two panel discussions on the topic at the 2023 and 2024 Windaba Conferences.

CONCLUSION

The objectives of the stakeholder workshops were successfully achieved. The results of the draft offshore wind study for South Africa were widely shared with relevant stakeholders across both the private and public sectors. Questions were effectively addressed, and valuable comments from stakeholders were duly noted for further consideration.

APPENDIX 6: LIST OF STAKEHOLDER ORGANISATIONS

TABLE 71: LIST OF STAKEHOLDER ORGANISATIONS.

Stakeholder			Classification
1	DMRE	Department of Mineral Resources and Energy	Authorities (national)
2	DFFE	Department of Forestry, Fisheries and the Environment	Authorities (national)
3	DOT	Department of Transport	Authorities (national)
4	DPWI	Department of Public Works and Infrastructure	Authorities (national)
5	DSI	Department of Science and Innovation	Authorities (national)
6	DCDT	Department of Communication and Digital Technology	Authorities (national)
7	DPE	Department of Public Enterprises	Authorities (national)
8	DTI	Department of Trade and Industry	Authorities (national)
9	DOD	Department of Defence	Authorities (national)
10	PIC	Presidential Infrastructure Committee	Presidency
11	PCC	Presidential Climate Commission	Presidency
12	SAMSA	South African Maritime Safety Authority	Statutory bodies
13	NERSA	National Energy Regulation South Africa	Statutory bodies
14	Eskom	Eskom	Statutory bodies
15	CEF	Central Energy Fund	Statutory bodies
16	PRSA	Ports Regulator of South Africa	Statutory bodies
17	TNPA	Transnet Ports Authority	Statutory bodies
18	SANHO	South African Navy Hydrographic Office	Statutory bodies
19	CAA	Civil Aviation Authority	Statutory bodies
20	IDC	Industrial Development Corporation	Statutory bodies
21	SANBI	South African National Biodiversity Institute	Statutory bodies
22	SANParks	South African National Parks	Statutory bodies
23	SAHRA	South African Heritage Resources Agency	Statutory bodies
24	CGS	Council for Geoscience	Statutory bodies
25	NCEDA	Northern Cape Economic Development Agency	Authorities (provincial)
26	DENC	Northern Cape Department of Environment and Nature Conservation	Authorities (provincial)
27	DEDT	Northern Cape Department of Economic Development and Tourism	Authorities (provincial)
28	Wesgro	Wesgro (Western Cape tourism, trade and investment promotion agency)	Authorities (provincial)
29	DEA&DP	Western Cape Department of Environmental Affairs and Development Planning	Authorities (provincial)
30	CapeNature	CapeNature	Authorities (provincial)
31	HWC	Heritage Western Cape	Authorities (provincial)
32	ECDC	Eastern Cape Development Corporation	Authorities (provincial)

Stakeholder			Classification
33	DEDEAT	Eastern Cape Department of Economic Development, Environmental Affairs and Tourism	Authorities (provincial)
34	ECPHRA	Eastern Cape Provincial Heritage Resources Authority	Authorities (provincial)
35	DEDTEA	KZN Department of Economic Development, Tourism and Environmental Affairs	Authorities (provincial)
36	Ezemvelo KZN Wildlife	Ezemvelo KZN Wildlife	Authorities (provincial)
37	Amafa	KZN Amafa Provincial Heritage Authority	Authorities (provincial)
38	SBIDZ	Saldanha Bay Industrial Development Zone / Freeport Saldanha	SEZ/IDZ
39	CDC	Coega Development Corporation	SEZ/IDZ
40	ELIDZ	East London Industrial Development Zone	SEZ/IDZ
41	DTP	Dube Tradeport	SEZ/IDZ
42	RBIDZ	Richards Bay Industrial Development Zone	SEZ/IDZ
43	BirdLife SA	BirdLife SA	NGOs / Research
44	SANCCOB	Southern African Foundation for the Conservation of Coastal Birds	NGOs / Research
45	WWF SA	World Wildlife Foundation	NGOs / Research
46	EWT	Endangered Wildlife Trust	NGOs / Research
47	CER	Centre for Environmental Rights	NGOs / Research
48	SANEDI	South African National Energy Development Institute	NGOs / Research
49	SAWEA	South African Wind Energy Association	NGOs / Research
50	PASA	Petroleum Agency of South Africa	Marine users
51	SAOGA	South African Oil and Gas Association	Marine users
52	MCSA	Minerals Council South Africa	Marine users
53	SAASOA	South African Association of Ship Operators and Agents	Marine users
54	FishSA	FishSA	Marine users
55	SACRAA	South African Consolidated Recreational Angling Association	Marine users
56	SAPFIA	South African Pelagic Fishing Industry Association	Marine users
57	AASA	Aquaculture Association of Southern Africa	Marine users
58	Telkom SA	Telkom SA	
59	Sentech	Sentech	Marine users
60	SeaCOM	SeaCOM	Marine users
61	2AfricaCable	2AfricaCable	Marine users

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