

Annex IV Environmental webinar
Effects of Energy Removal on Physical Systems
3rd February 2015

The implications of tidal resource interactions

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With thanks to Matthew Easton
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<http://mhk.pnl.gov/environmental-webinars>

Introduction

- Motivation; Interaction of Tidal Developments
 - Resources are not additive
 - Environmental effects at a distance
- Modelling Approaches
 - 2D and 3D hydrodynamic models
 - Circuit diagrams
- Interactions
 - Systemic
 - Inter-Channel, [Draper et al. x 2)
 - Intra-Channel, [Easton and Woolf]
- Conclusions



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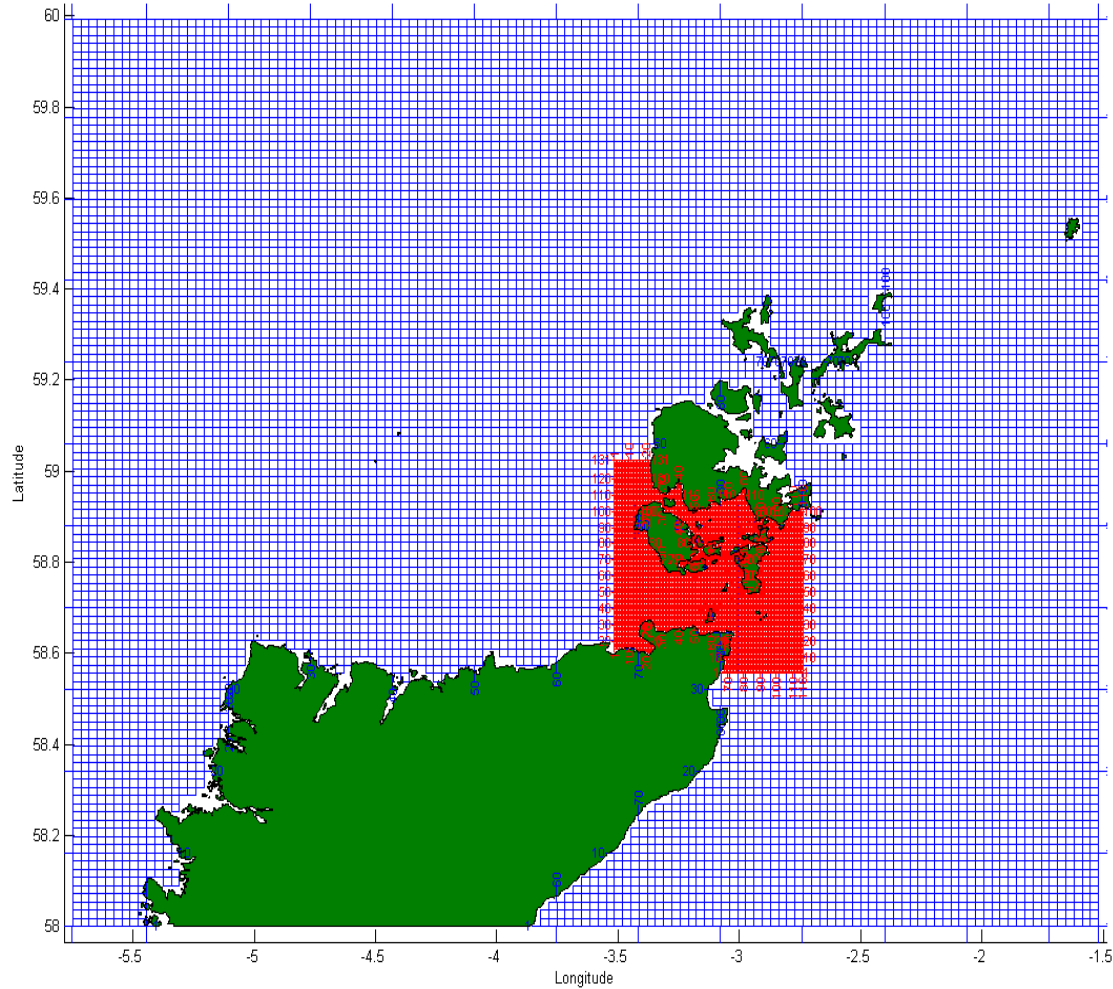
Interaction of Tidal Developments

- Resources are not additive
 - **We cannot calculate extractable energy by separate models of each site**
 - **The optimum is not obvious and requires experimentation**
 - **“Parallel is good, Serial is bad”**
- Environmental Effects
 - Local
 - E.g. displacement and collision
 - Spatial planning with GIS tools, “piled on top of each other”
 - At a distance
 - E.g. migration, **fluid dynamics**
 - **Spatial planning complicated**

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3D or 2D model with nested grid

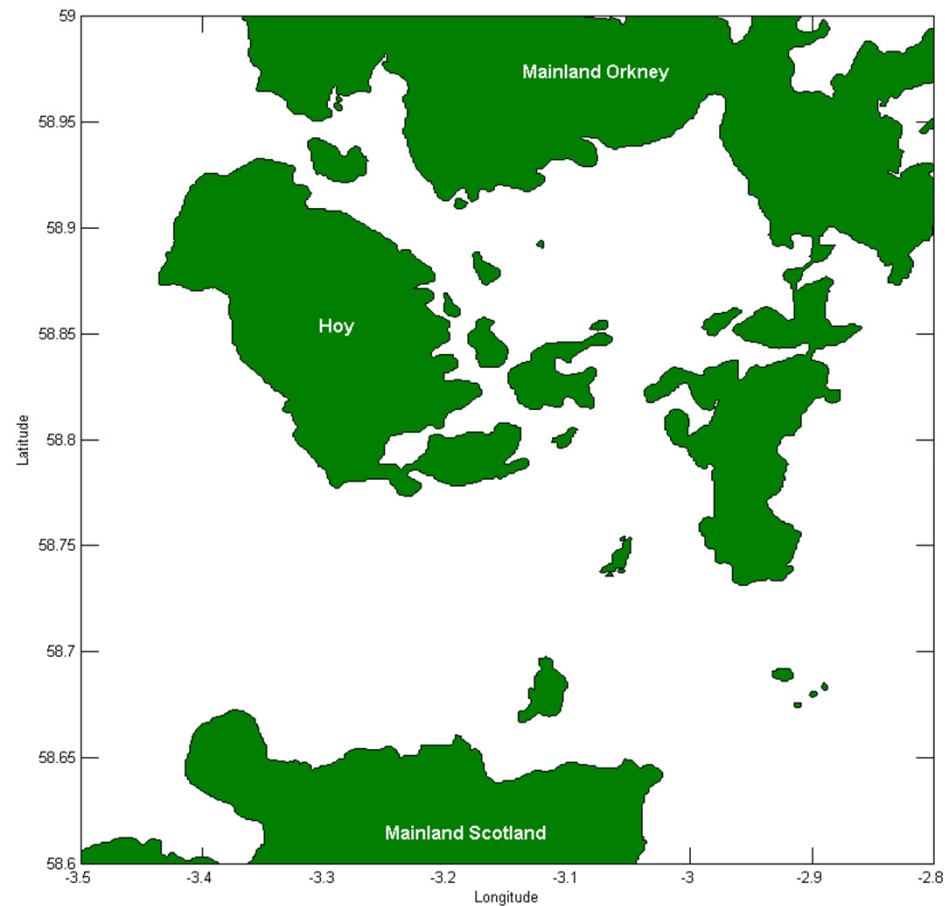


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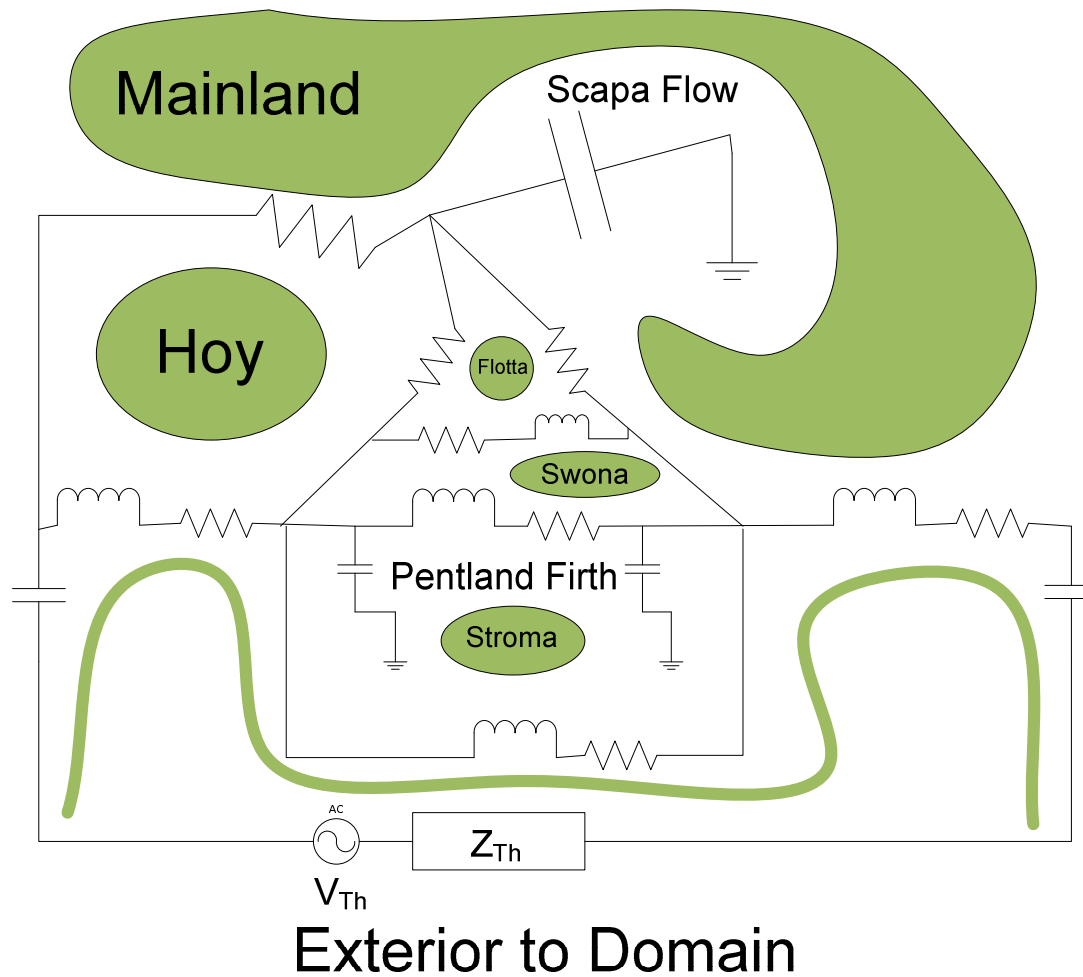
Pentland Firth and Scapa Flow I

- A normal view



Pentland Firth and Scapa Flow II

- An electrical analogue



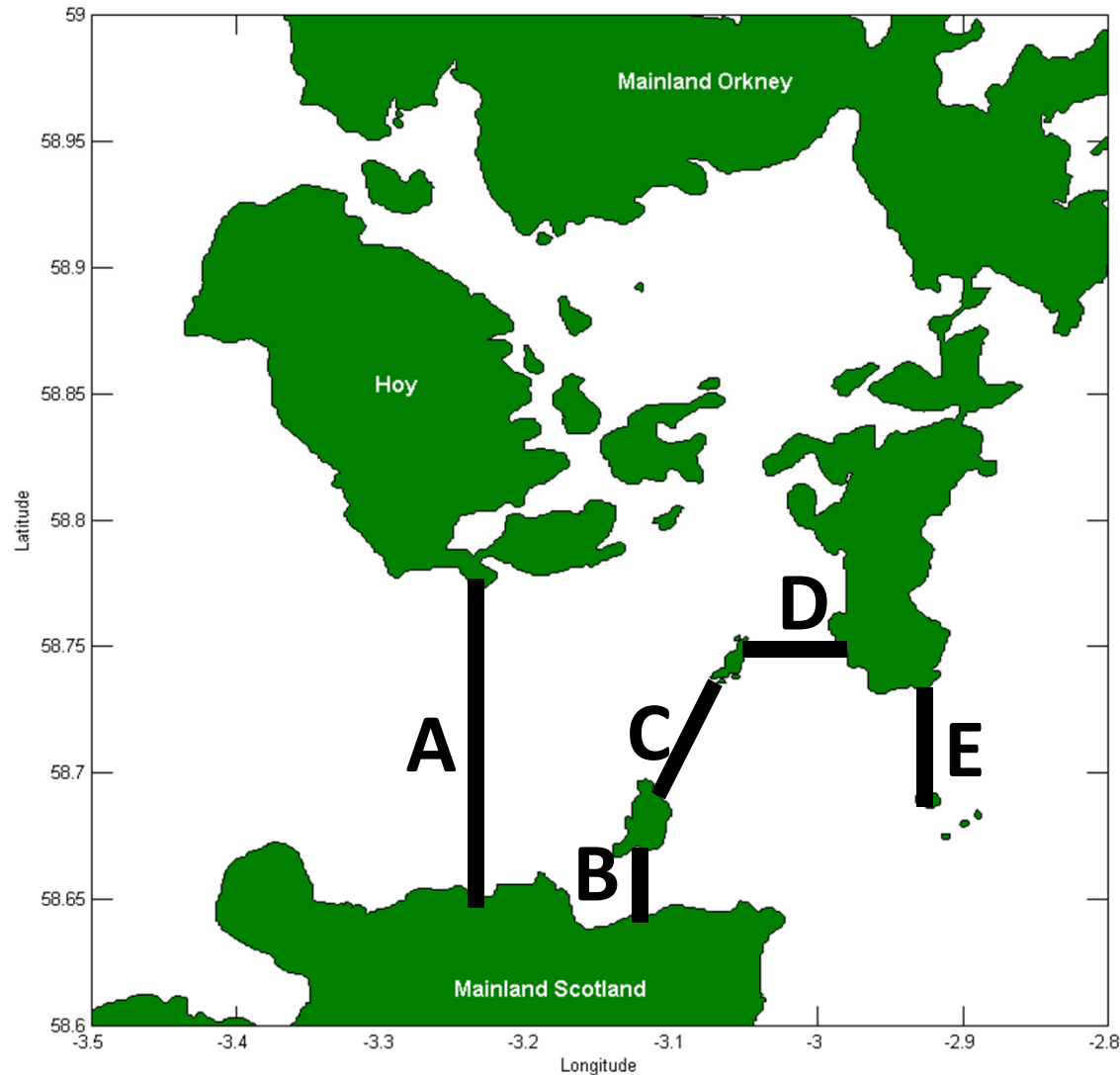
For more details see:

Woolf, D. K. (2013) “The strength and phase of the tidal stream”, *International Journal of Marine Energy*, 3, 3-13.

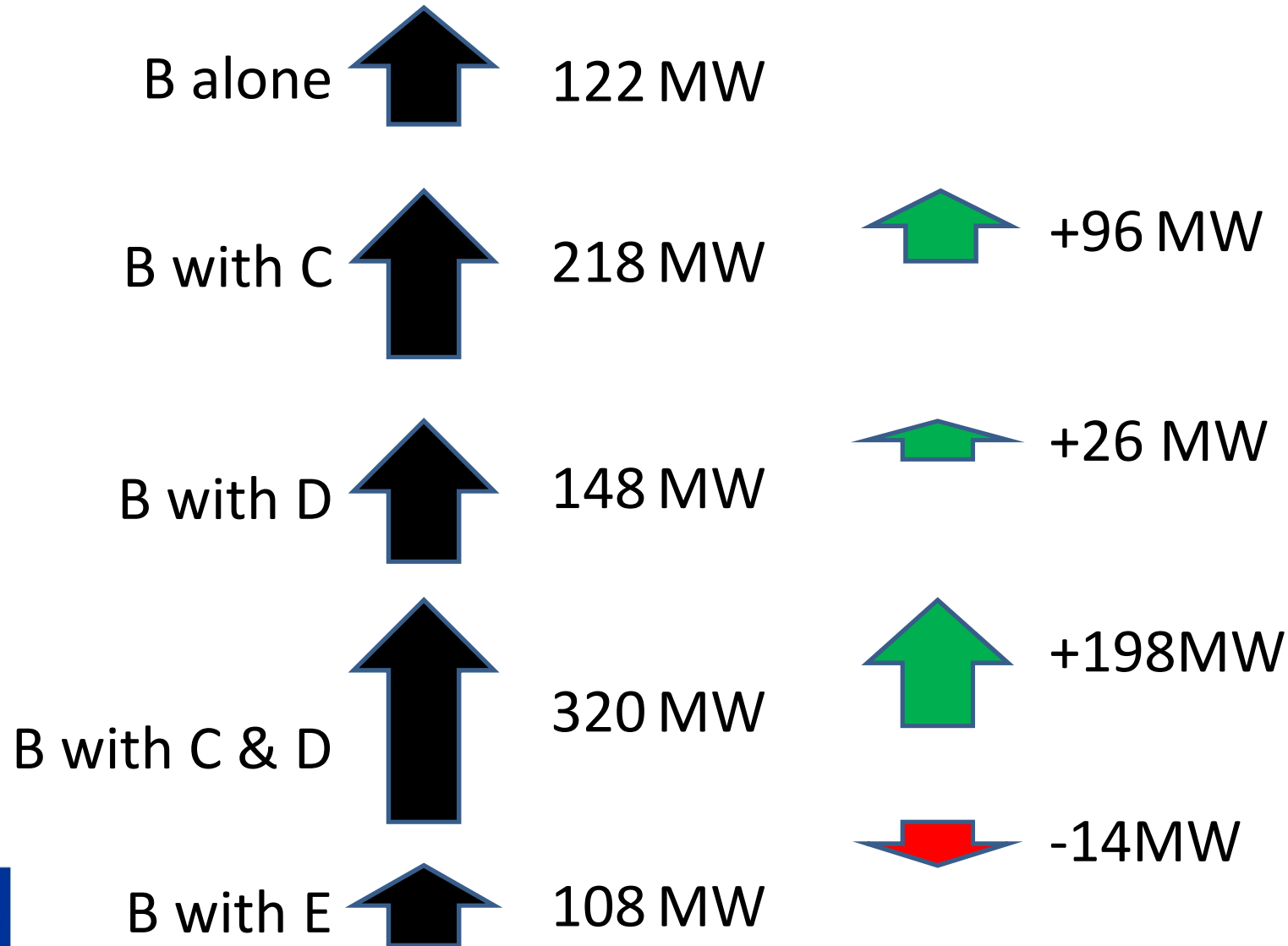
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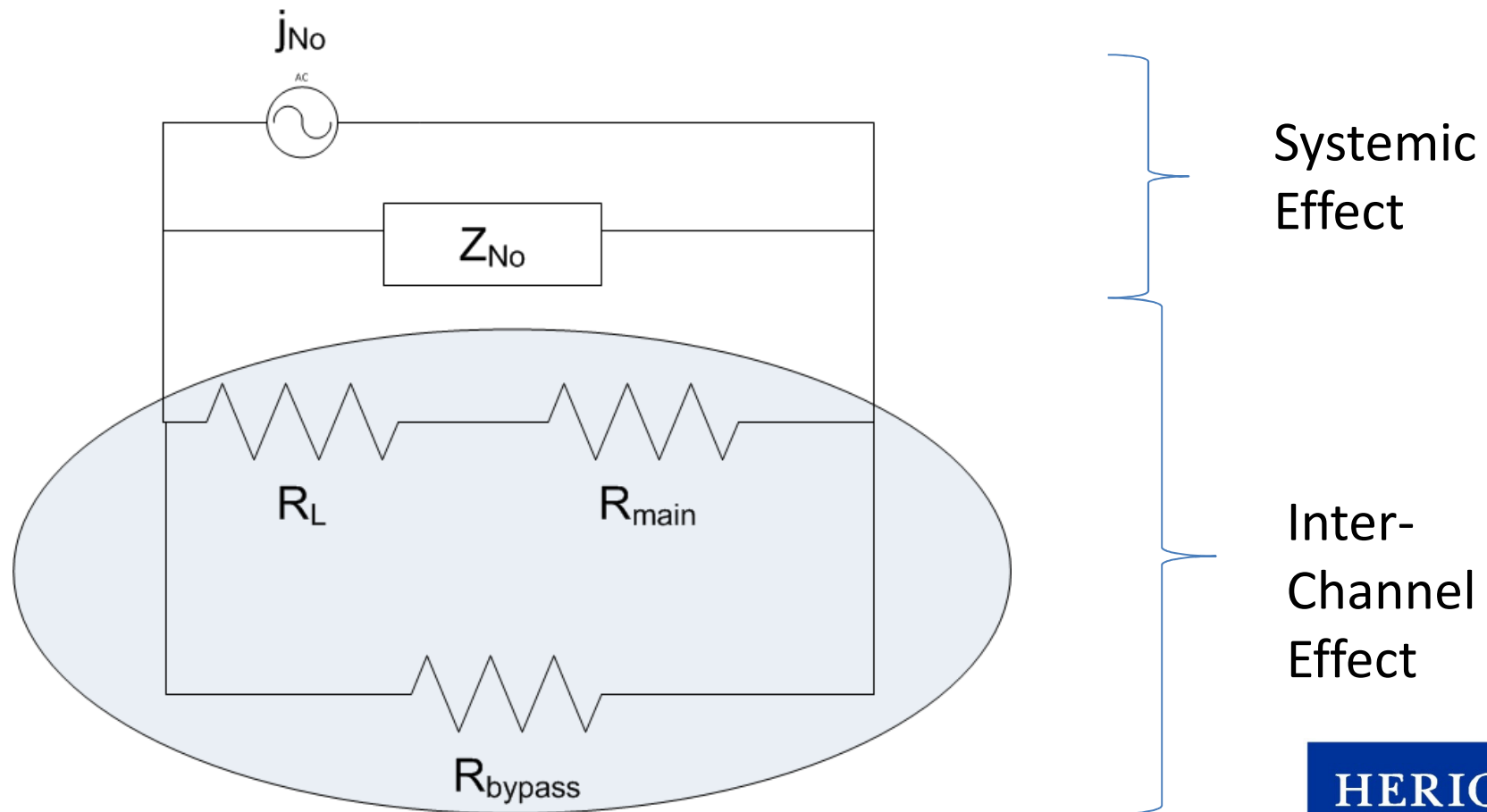
Inter-Channel effects in the Pentland Firth {after Draper et al. 2014a, b}



Inter-Channel effects in the Pentland Firth {after Draper et al. 2014a, b}



Simple Representation of Systemic and Inter-Channel Effect



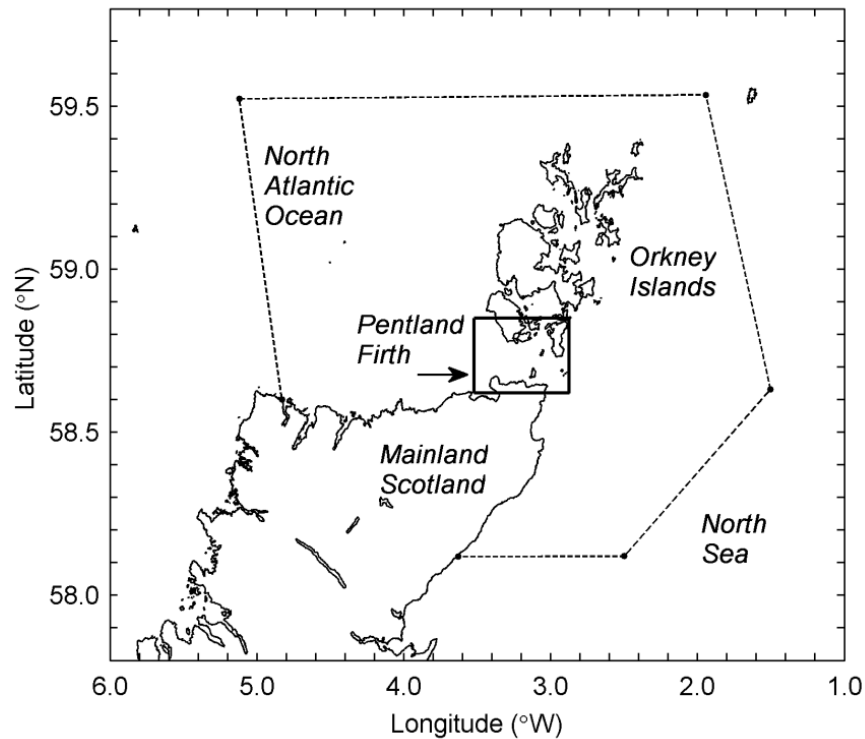
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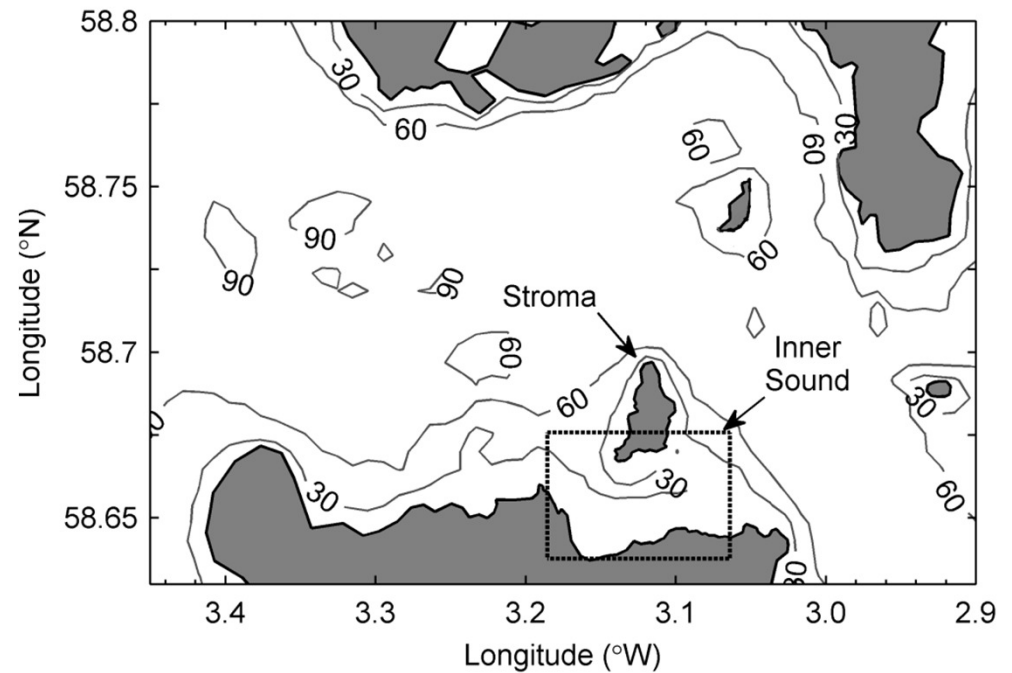


Geographic setting

North Scotland and Orkney



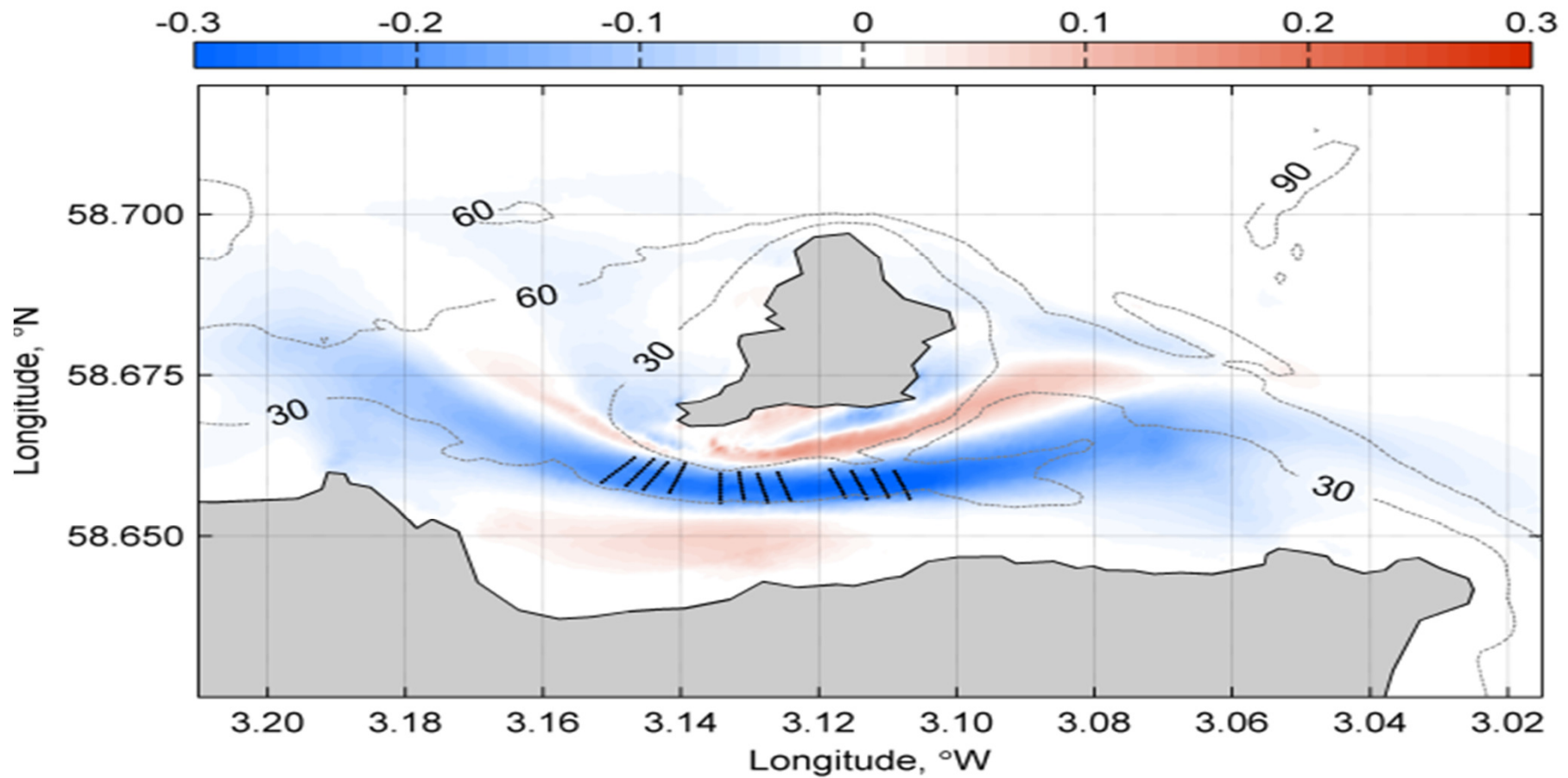
The Pentland Firth



Courtesy of Matthew Easton

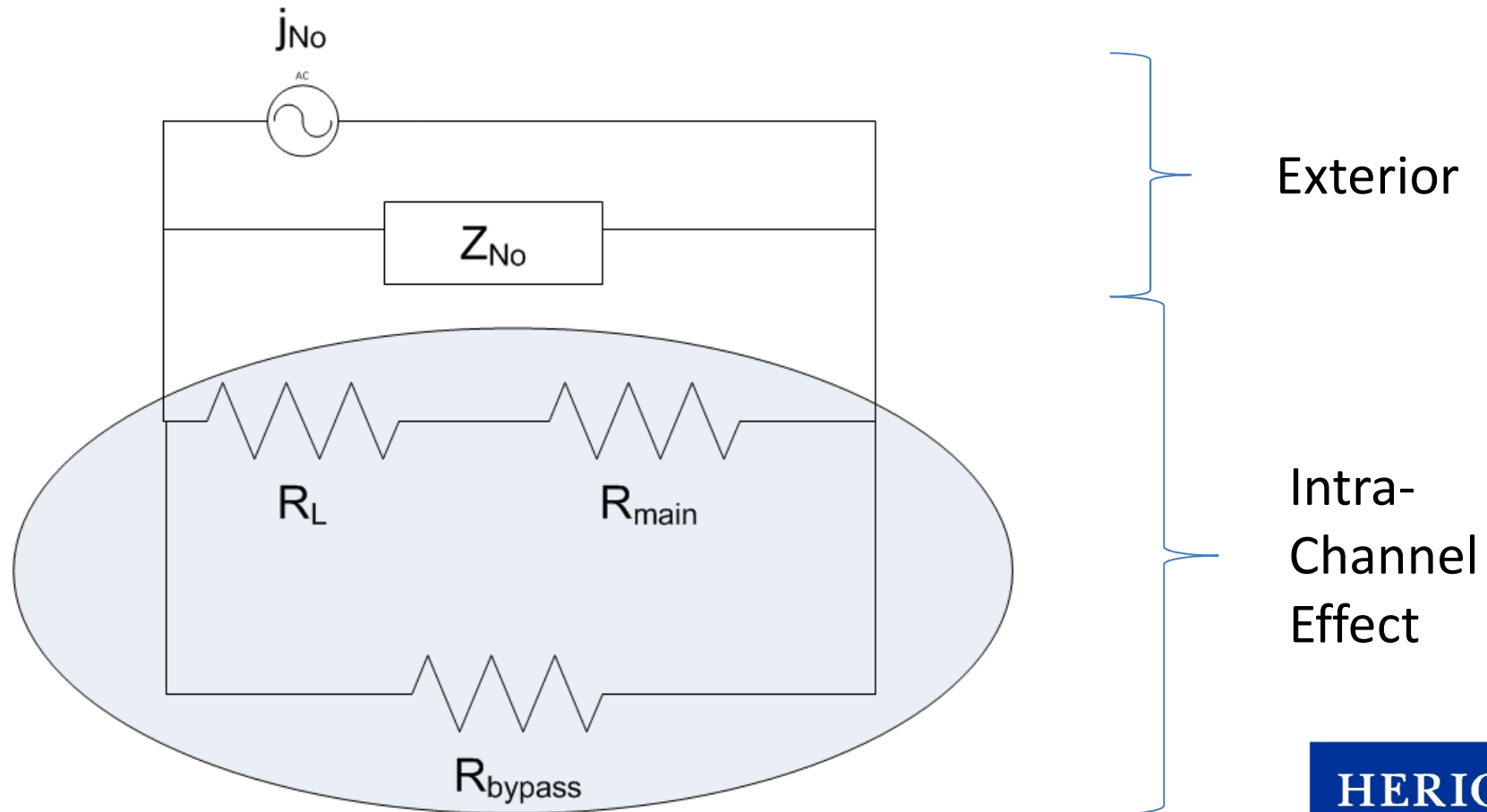
Intra-Channel Effect

Change in mean current speed resulting from an array of tidal turbines








Courtesy of Matthew Easton

Simple Representation of Intra-Channel Effect



Effect on Current Speeds

	FULL WIDTH	PARTIAL
ON WHOLE		
ON MAIN		
ON BYPASS	N/A	

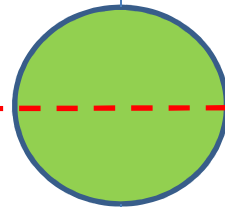
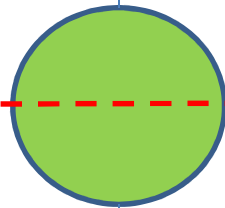
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- Conclusions (**Governance and Policy**)

Jurisdiction A

Proposal A1

Proposal A2

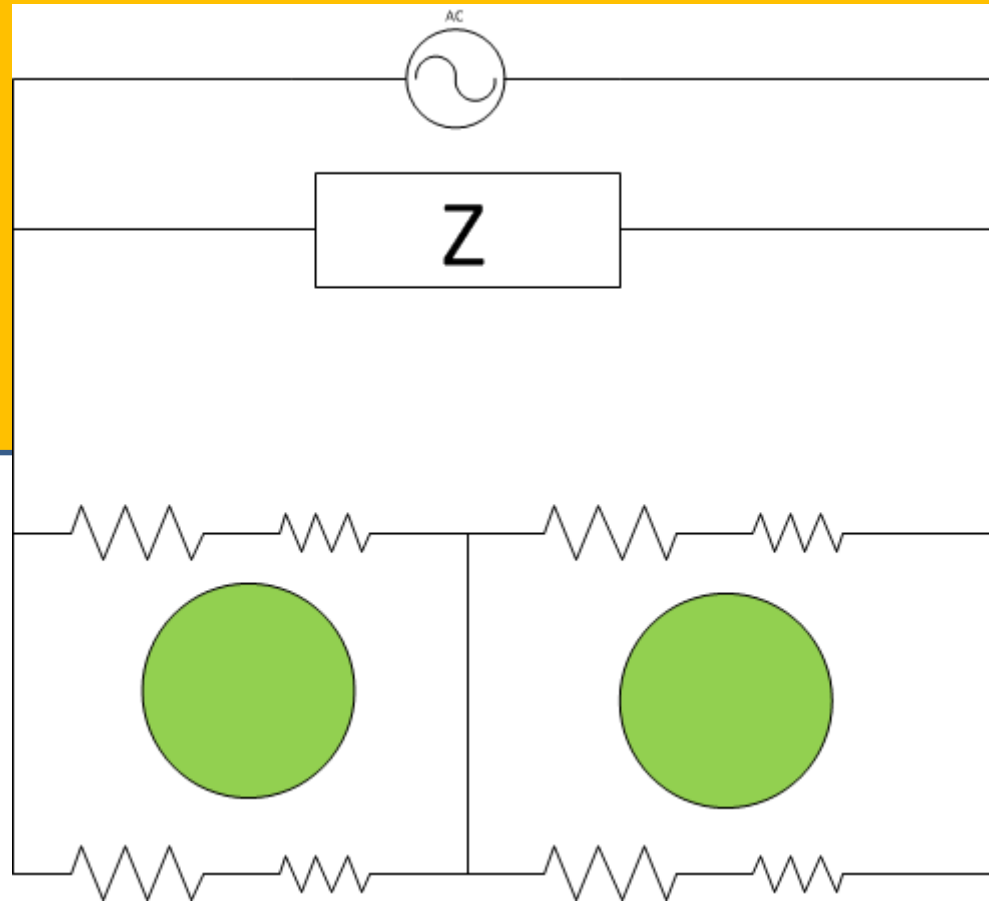


Political Boundary

Proposal B1

Proposal B2

Jurisdiction B





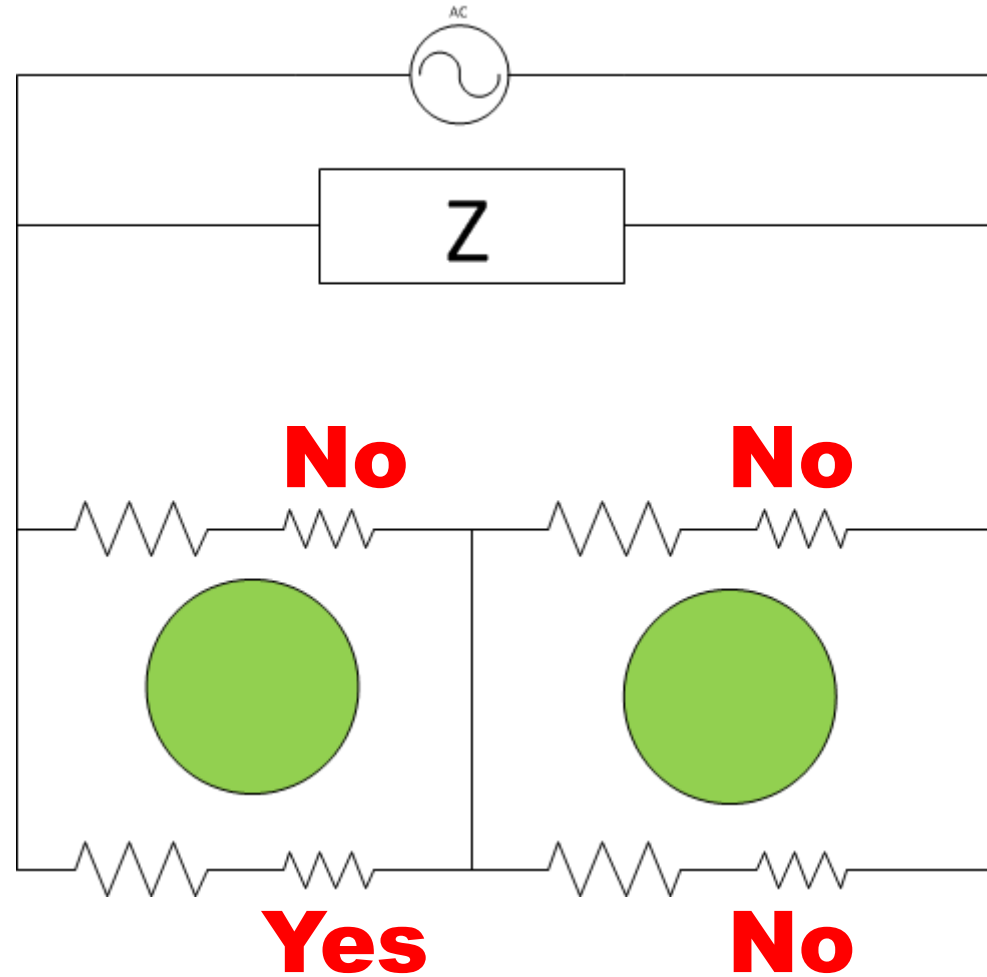
Bad Strategy



Questionable Strategy



Good Strategy





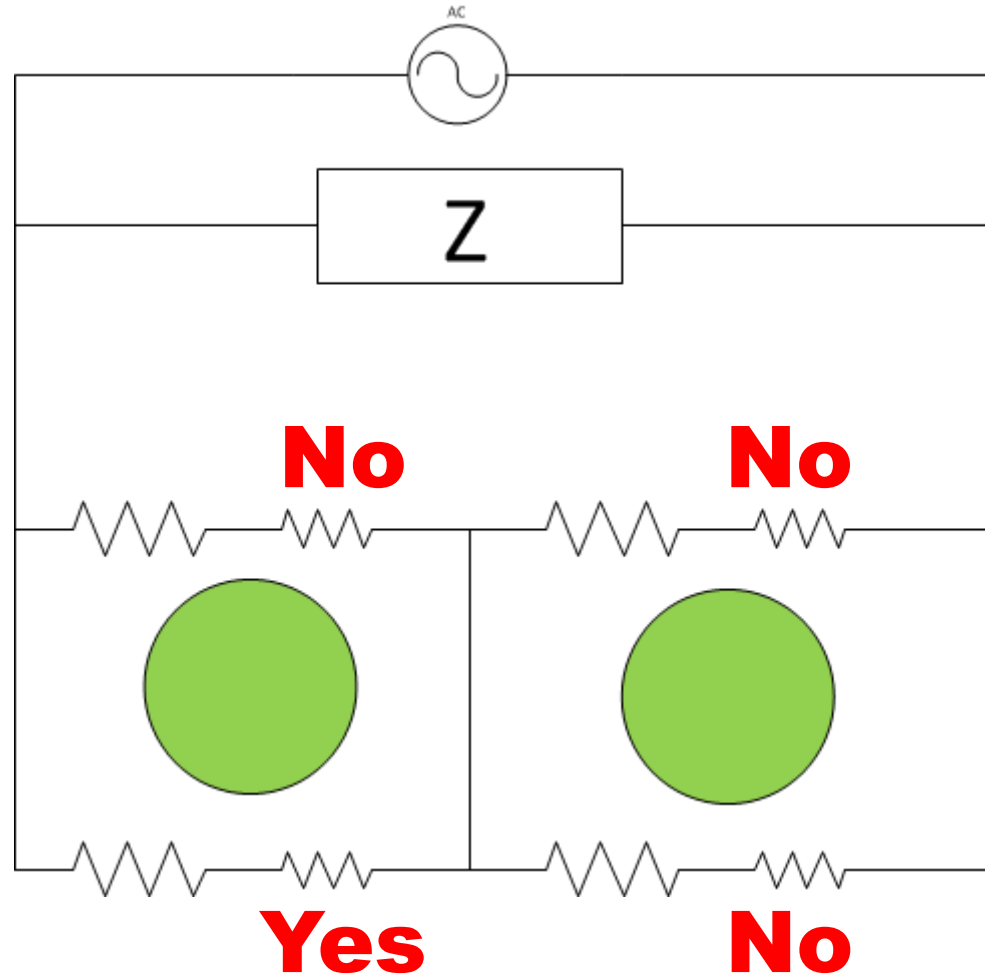
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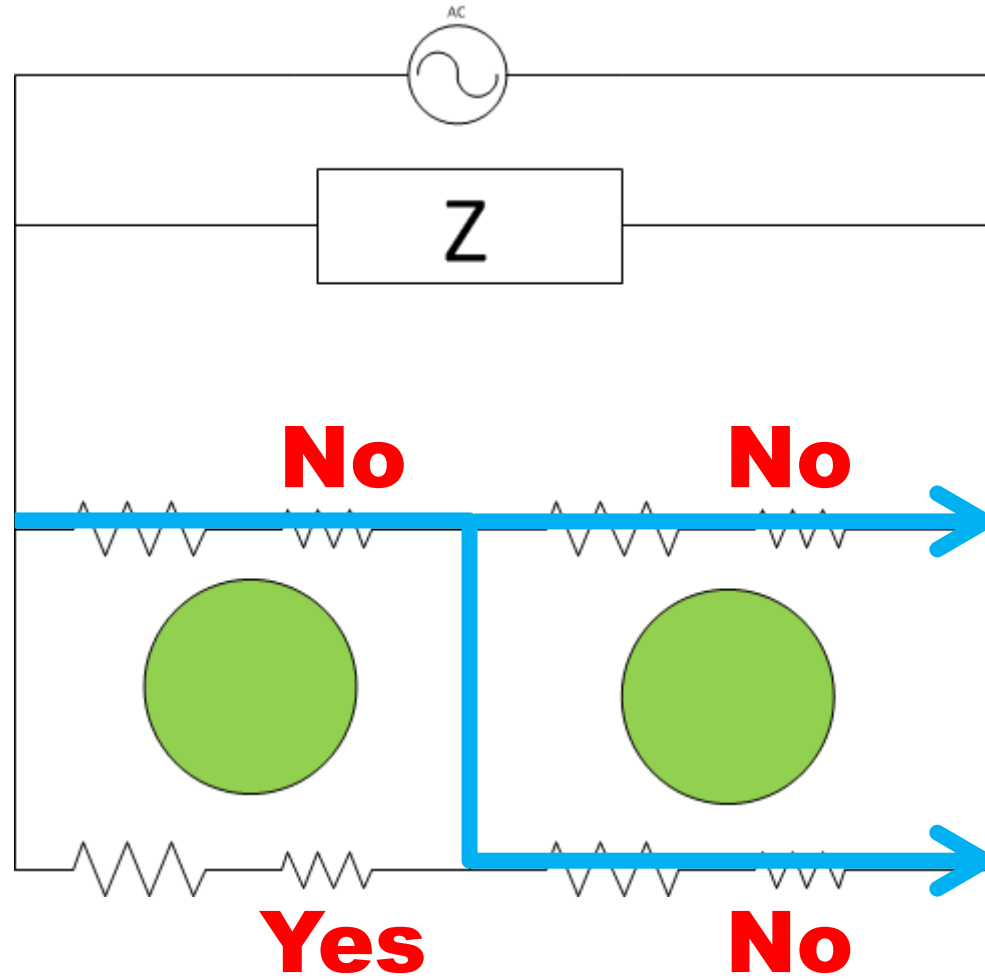
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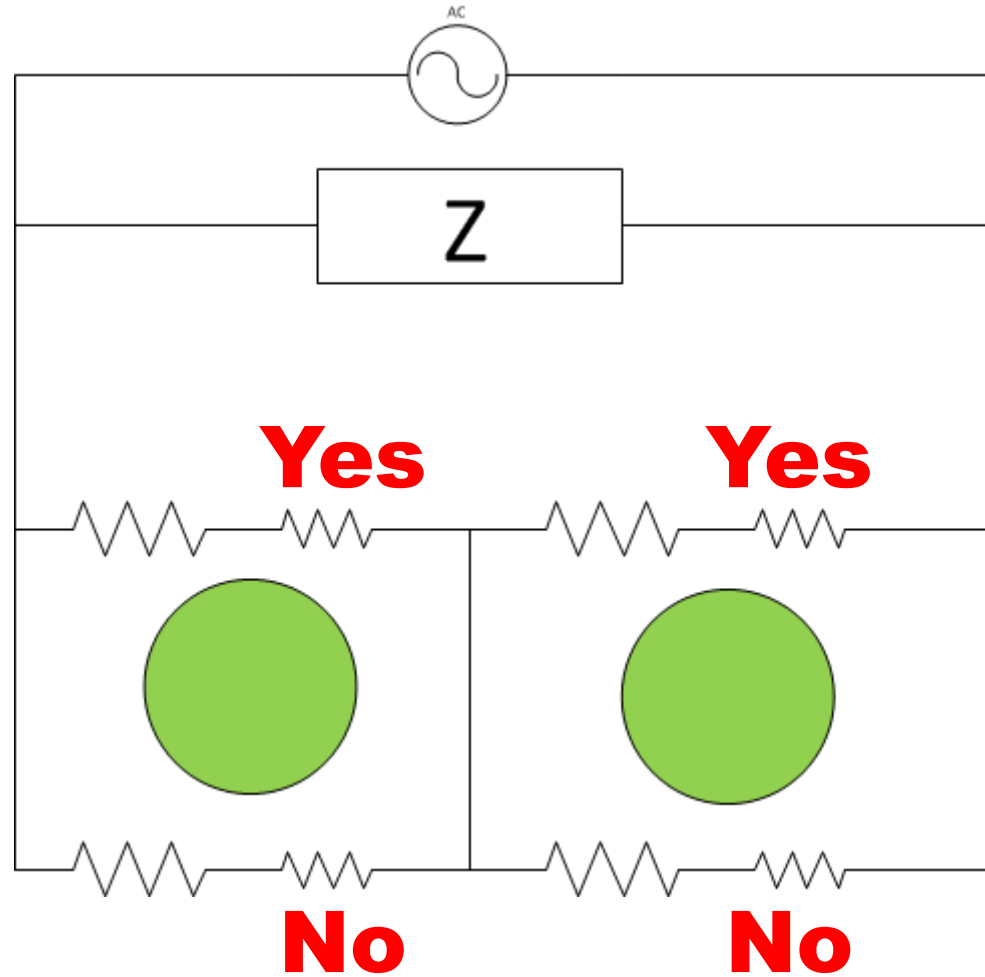
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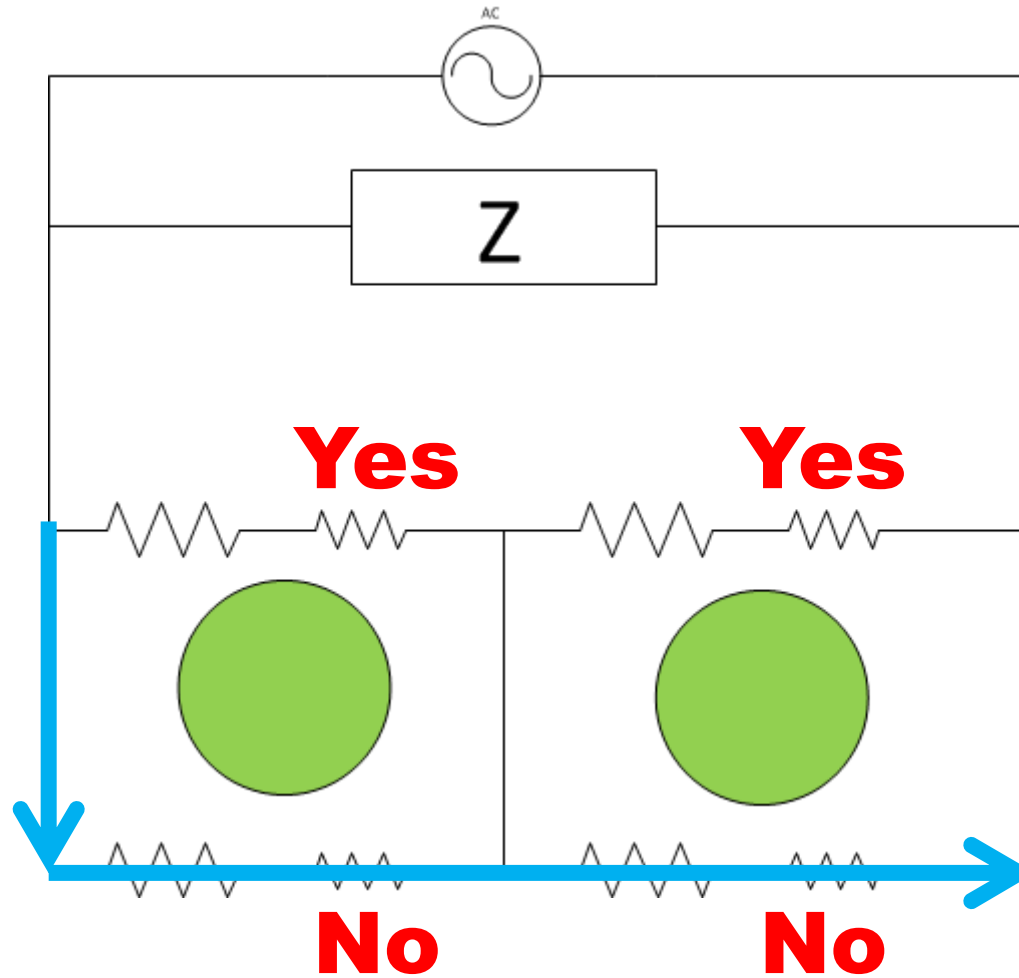
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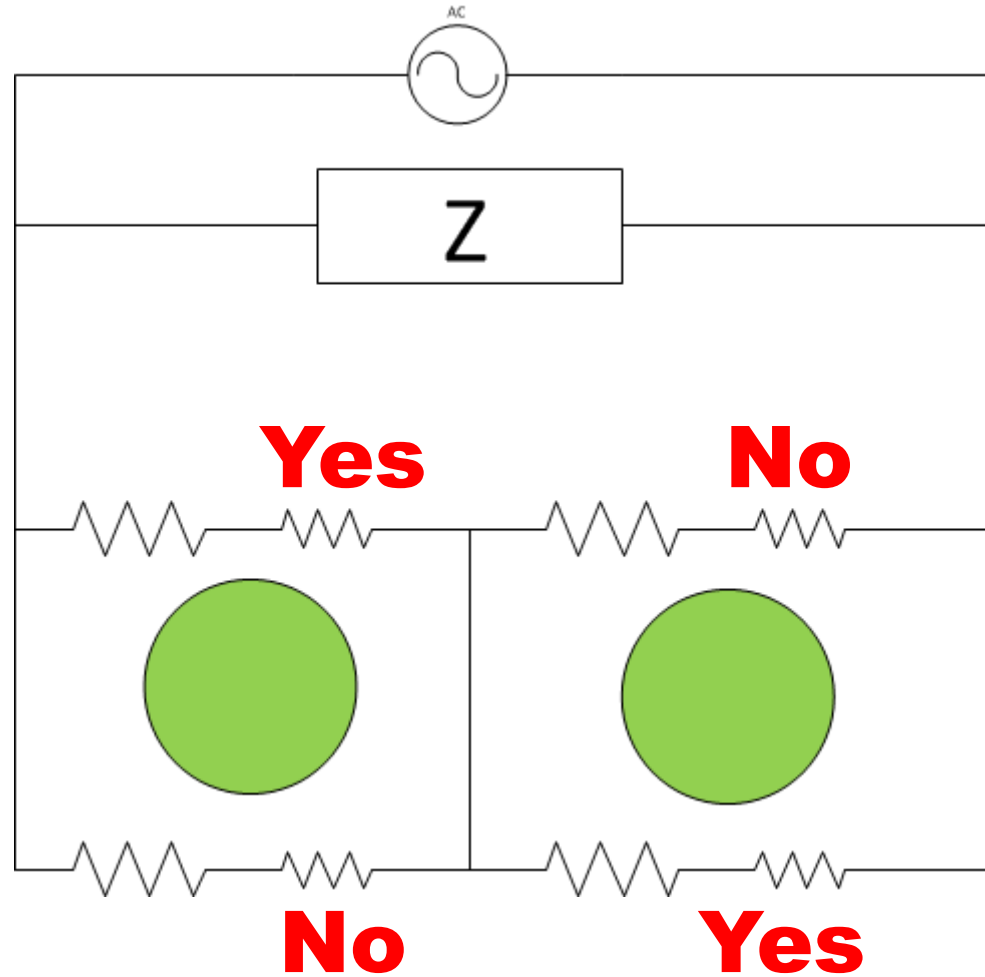
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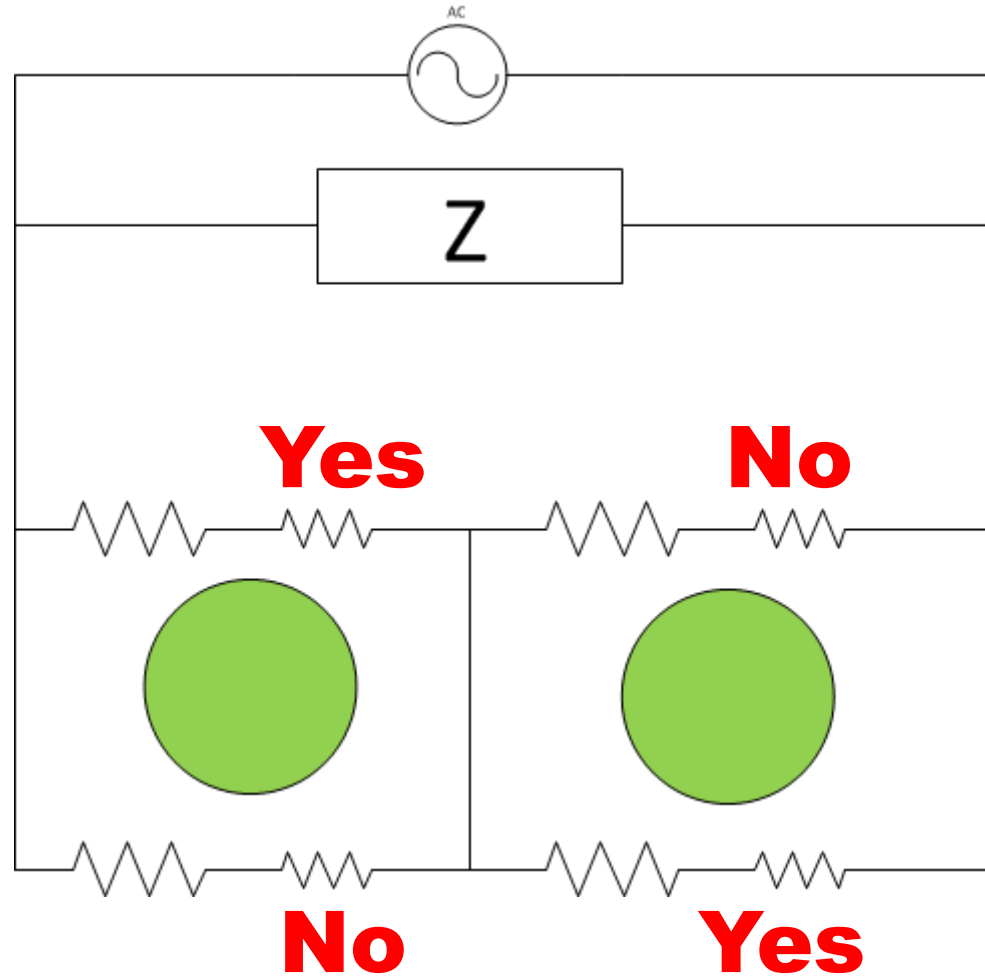
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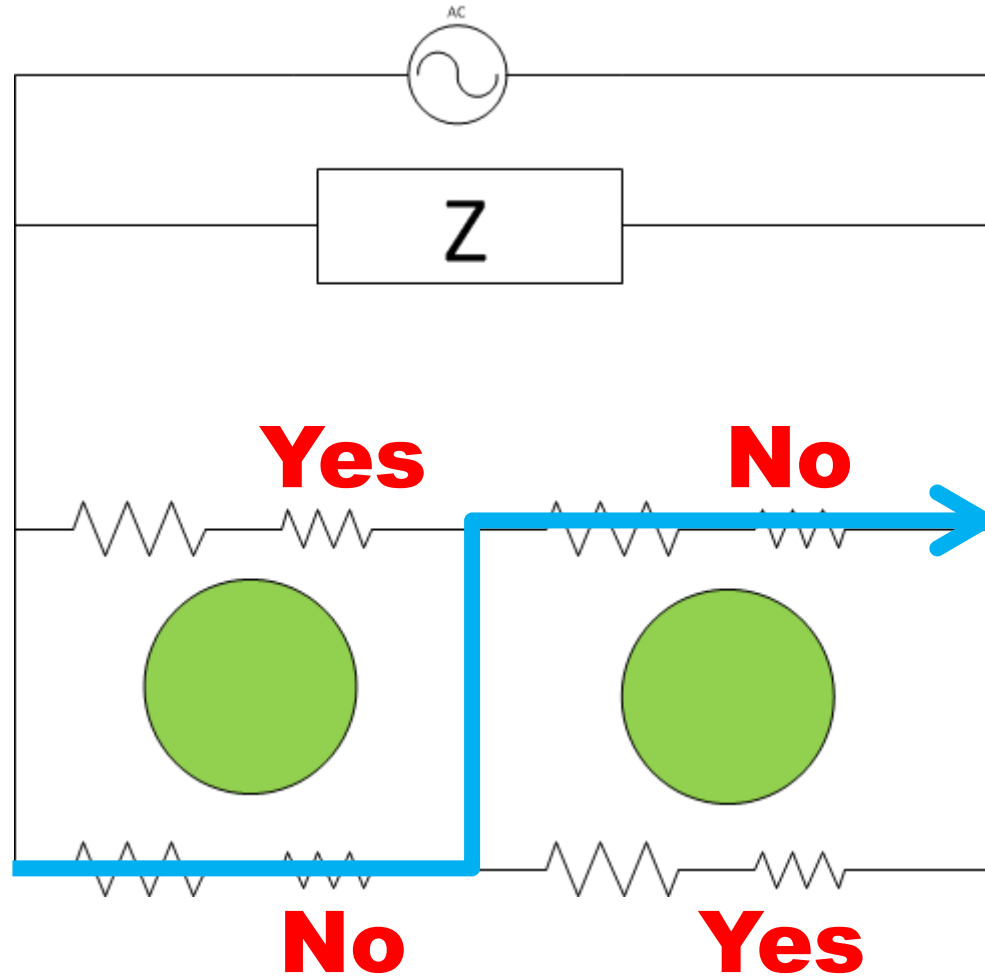
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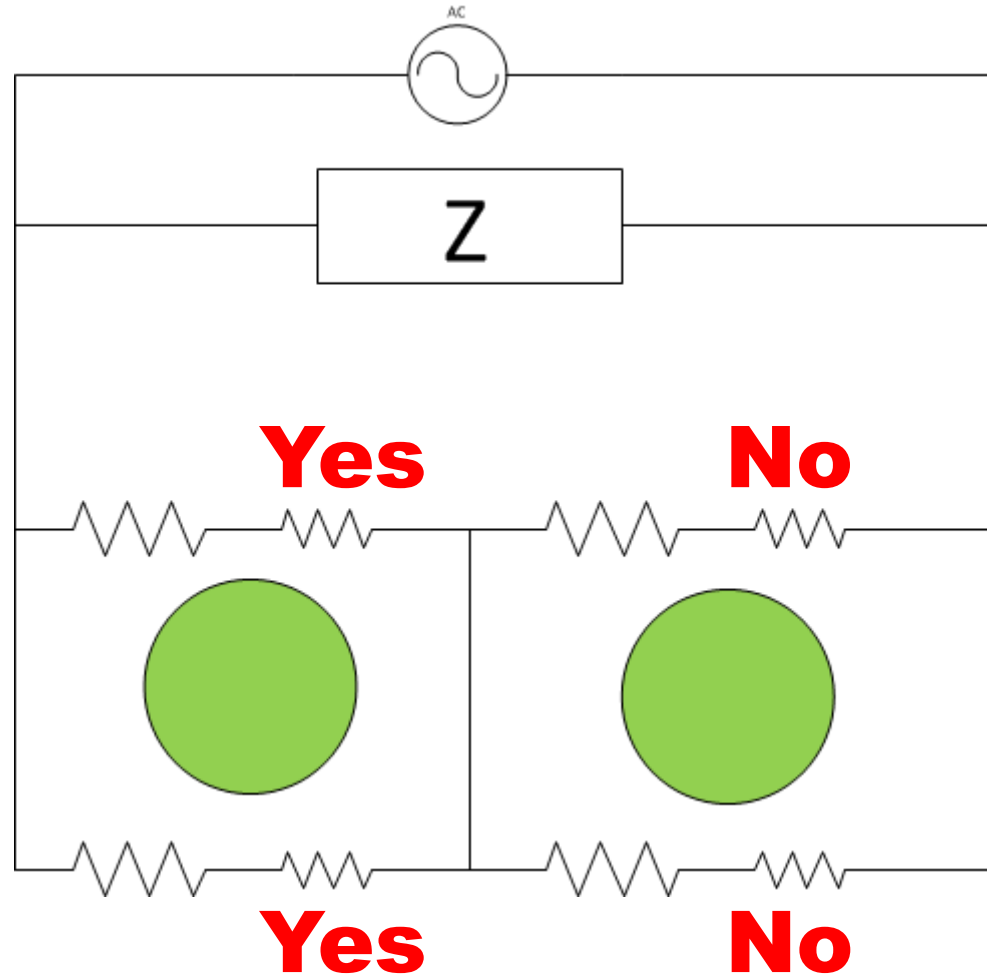
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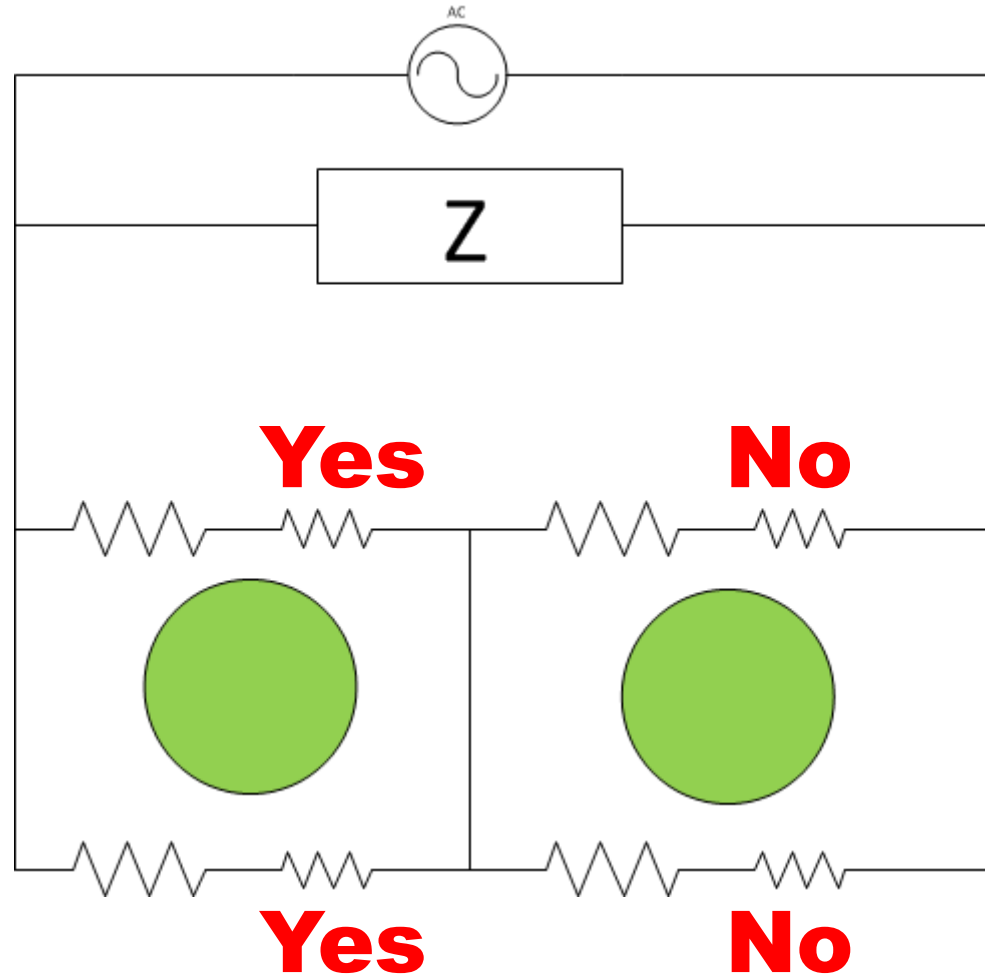
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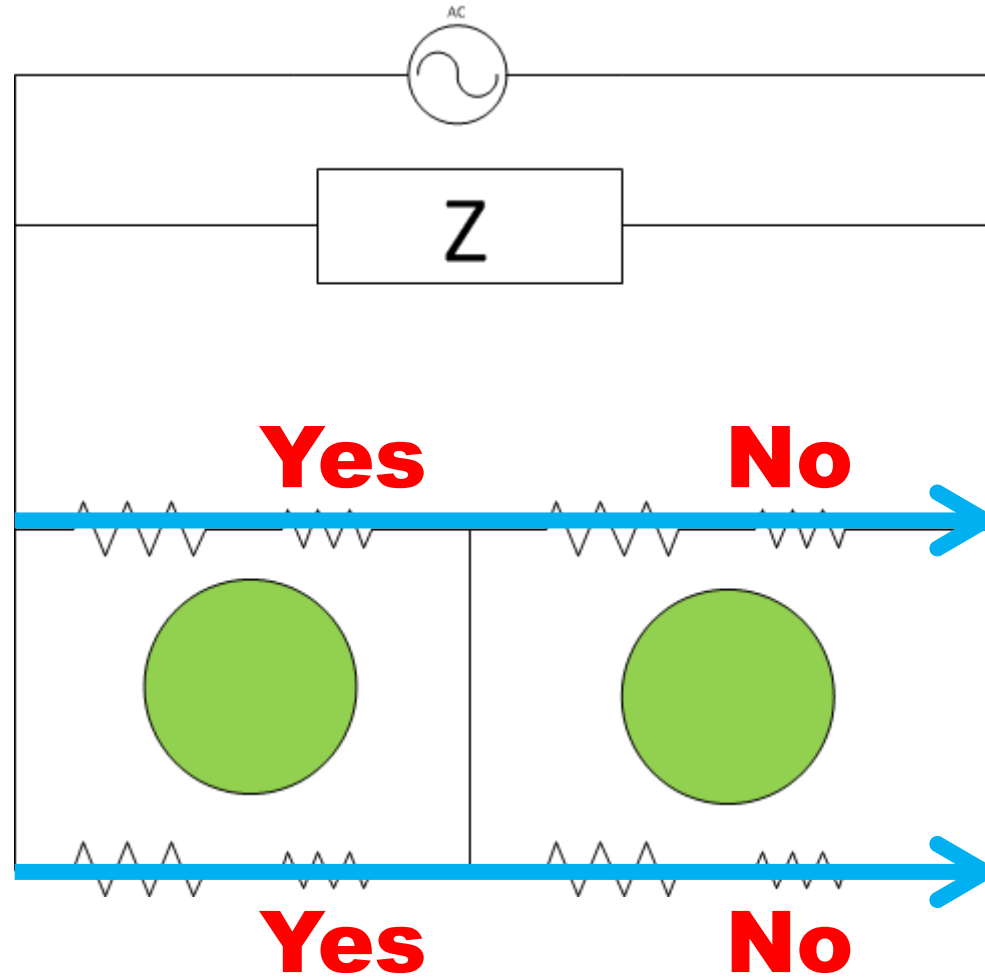
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Implications of Tidal Interactions

- Modelling
 - “Essentially, all models are wrong, but some are useful” George Box [b. 1919, d. 2013]
 - Electrical circuit analogies are useful
 - Diversity but not duplication
- Do not confuse
 - Undeveloped with Unaltered
 - Inactivity with Conservation
- Think strategically
 - Design systems and policies that enable strategic decisions