Energy Technologies Area Lawrence Berkeley National Laboratory

National Survey of Attitudes of Wind Power Project Neighbors

March 13th, 2018: Webinar 4 of 4

Comparing Strongly Annoyed Individuals with Symptoms Near U.S. Turbines To Those In Surveyed European Communities

Preliminary Results

Please Note:

- All participants will be muted during the webinar
- Please submit questions via the chat window
- This webinar will be recorded

Gundula Hübner and Johannes Pohl

University Halle-Wittenberg and
Medical School of Hamburg Germany

Ben Hoen

Lawrence Berkeley National Laboratory
Electricity Markets and Policy Group

This analysis was funded by the Wind Energy Technologies Office of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

About the authors

Gundula Hübner

- Professor of Social Psychology at the MSH Medical School Hamburg
- Professor of Environmental Psychology at the Martin-Luther-University Halle-Wittenberg
- Focus on the social acceptance of renewable energies, on- and offshore wind energy
- Expert on stress impact of wind turbines on residents as well as persuasive communication to promote sustainable behavior

Johannes Pohl

- Senior researcher at the MSH Medical School Hamburg and the Martin-Luther-University Halle-Wittenberg, Germany.
- Focus on the social acceptance of renewable energies, on- and offshore wind energy, the stress impact of wind turbines on residents
- Expertise in stress- and bio psychology

Outline Of The Presentation

Part I. National Survey Project Background

Part II. Survey Frame Overview

Part III. Comparing Strongly Annoyed Individuals with Symptoms Near U.S. Turbines To Those In Surveyed European Communities

Part IV. Next Steps & Outreach

National Survey of Attitudes of Wind Power Project Neighbors: Project Overview

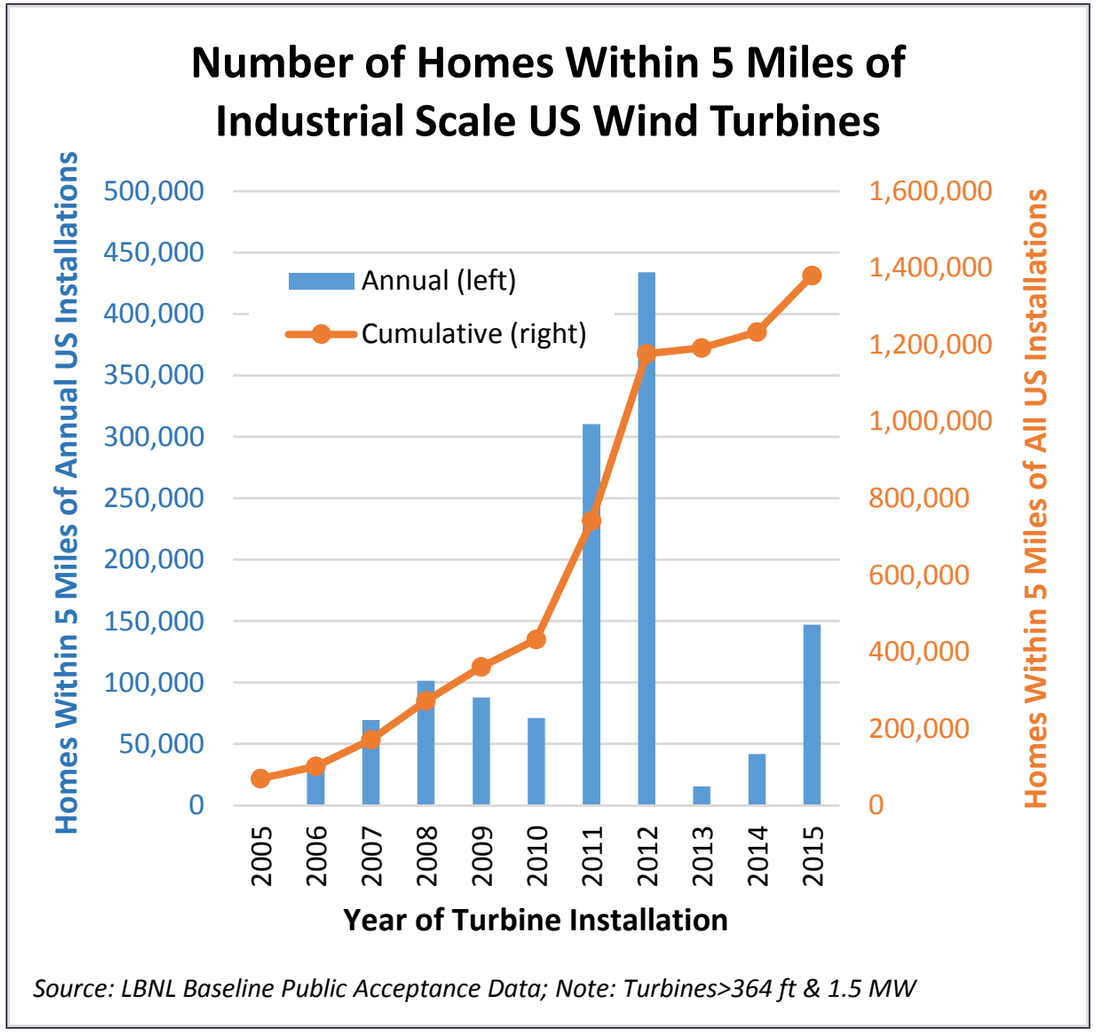
Project PI: Ben Hoen, Research Scientist, LBNL

Collaborating Researchers:

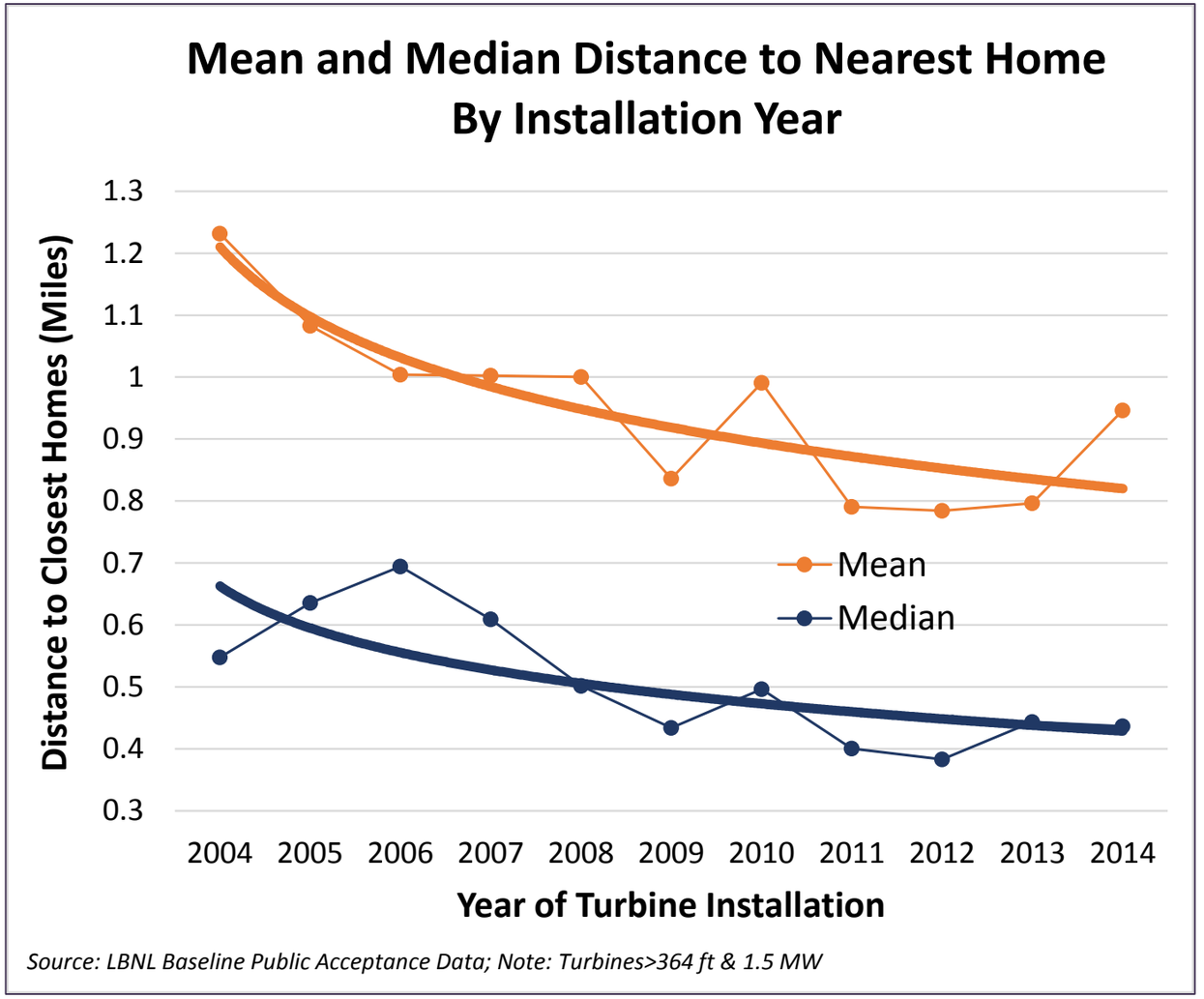
- **LBNL:** Joe Rand, Ryan Wiser
- **University of Delaware:** Jeremy Firestone
- **Portland State University:** Debi Elliott
- **University Halle-Wittenberg, Medical School of Hamburg:** Gundula Hübner, Johannes Pohl
- **NREL:** Eric Lantz
- **Resource Systems Group, Inc:** Ryan Haac, Ken Kaliski, Matt Landis

Project Years: FY2015-FY2018; **DOE Program:** Wind Energy Technologies Office

The Cumulative Number of Homes Near Turbines Is Increasing, While the Distance to the Nearest Homes Is Decreasing



Source: LBNL Baseline Public Acceptance Data; Note: Turbines>364 ft & 1.5 MW

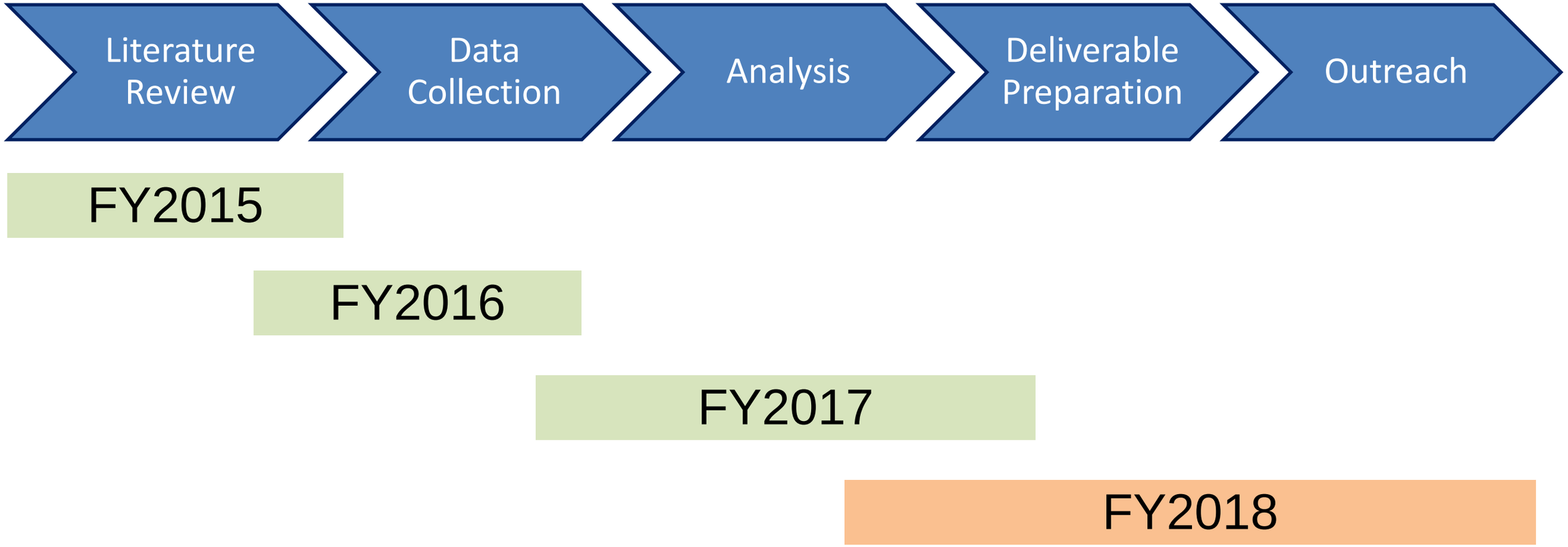


Source: LBNL Baseline Public Acceptance Data; Note: Turbines>364 ft & 1.5 MW

National Survey of Attitudes of Wind Power Project Neighbors: Project Objectives

- Provide first-of-its kind **broad-based, representative** information on public acceptance issues surrounding wind facilities in the **United States**.
- Allow a **wide array of stakeholders to better understand** the attitudes & annoyances towards wind energy in local communities in the US and the main correlates to those perceptions.
- Allow **greater confidence in the likely effects** of proposed wind energy projects by increasing knowledge about existing projects.
- Potentially help **inform wind stakeholder & DOE R&D** priorities to increase benefits and reduce costs of the next-generation wind technologies and deployments.

Baseline Public Acceptance Analysis
Timeline



Literature Review: *"Thirty years of North American wind energy acceptance research: What have we learned?"*

Project Lead(s): Rand

Collaborating Researchers: Hoen

Purpose: (1) to summarize North American wind energy public acceptance literature with a focus on some of the key correlates; and (2) to identify research gaps that the current research might help address

Published in Energy Research and Social Science, July, 2017

Energy Research & Social Science 29 (2017) 135–148

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Review

Thirty years of North American wind energy acceptance research: What have we learned?

Joseph Rand*, Ben Hoen

Lawrence Berkeley National Laboratory, 1 Cyclotron Rd., Berkeley, CA 94720, USA

ARTICLE INFO

Keywords:
Wind energy
Social acceptance
Support and opposition
Attitudes

ABSTRACT

Thirty years of North American research on public acceptance of wind energy has produced important insights, yet knowledge gaps remain. This review synthesizes the literature, revealing the following lessons learned. (1) North American support for wind has been consistently high. (2) The NIMBY explanation for resistance to wind development is invalid. (3) Socioeconomic impacts of wind development are strongly tied to acceptance. (4) Sound and visual impacts of wind facilities are strongly tied to annoyance and opposition, and ignoring these concerns can exacerbate conflict. (5) Environmental concerns matter, though less than other factors, and these concerns can both help and hinder wind development. (6) Issues of fairness, participation, and trust during the development process influence acceptance. (7) Distance from turbines affects other explanatory variables, but alone its influence is unclear. (8) Viewing opposition as something to be overcome prevents meaningful understandings and implementation of best practices. (9) Implementation of research findings into practice has been limited. The paper also identifies areas for future research on wind acceptance. With continued research efforts and a commitment toward implementing research findings into developer and policymaker practice, conflict and perceived injustices around proposed and existing wind energy facilities might be significantly lessened.

1. Introduction

1.1. Background and motivation

Over the last 30 years, wind energy in North America has evolved from a fringe, isolated, experimental concept into a mainstream and viable source of electricity, meeting about 5% of U.S. electricity demand (6% in Canada) and representing the largest source of new electric capacity additions in many recent years [1,2]. Wind energy is widely seen as an abundant electricity source with the potential to provide a wide range of environmental and social benefits [3]. State/provincial-level mandates, federal incentives, declining wind energy costs, and relatively favorable economics have spurred the aggressive North American wind deployment of the past 10–15 years [2].

This rapid growth in wind energy deployment will likely continue. In the United States, for example, recent market analysis suggests that annual wind power capacity additions are expected to continue rapidly in the coming five years ([2], p. 1) driven by expected lower prices [4]. Meanwhile, the U.S. Department of Energy's recent *Wind Vision Report*, which outlines pathways for wind energy to provide up to 35% of the nation's electrical demand by 2050, suggests that the "low hanging fruit" wind sites (those that have good wind resources and are close to loads and transmission, yet far from communities) have largely been developed, implying that future wind development likely will happen increasingly near communities. As such, the report underlines the need for a better understanding of the drivers of wind facility acceptance among affected communities [5]. This recommendation echoes the calls of numerous social scientists, who have suggested that successful implementation of U.S. wind projects relies on a deeper understanding of local stakeholders (e.g., [6]).

Multiple facets of acceptance can impact the deployment of renewable energy projects. Wüstenhagen et al. [7] point to three dimensions: *Sociopolitical acceptance* (acceptance of policymakers and key stakeholders), *market acceptance* (acceptance of investors and consumers), and *community acceptance* (pertaining to procedural justice, distributional justice, and trust). However, as Sovacool ([8], p. 4511) points out, these social, technical, economic, and political dimensions of acceptance all influence each other in an integrated, "pernicious tangle." For example, community acceptance of wind energy can affect market acceptance and vice versa. Indeed, this has been the case when local opposition has delayed or derailed proposed wind projects [9–11]. For years, debates around wind energy acceptance in North America

* Corresponding author.
E-mail addresses: jrand@lbl.gov (J. Rand), bhoen@lbl.gov (B. Hoen).

http://dx.doi.org/10.1016/j.erss.2017.05.019
Received 22 February 2017; Received in revised form 8 May 2017; Accepted 15 May 2017
Available online 25 May 2017
2214-6296/

Outline Of The Presentation

Part I. National Survey Project Background

Part II. Survey Frame Overview

Part III. Comparing Strongly Annoyed Individuals with Symptoms Near U.S. Turbines To Those In Surveyed European Communities

Part IV. Next Steps & Outreach

Multi-Model Survey Conducted in 2016

Sampling Steps

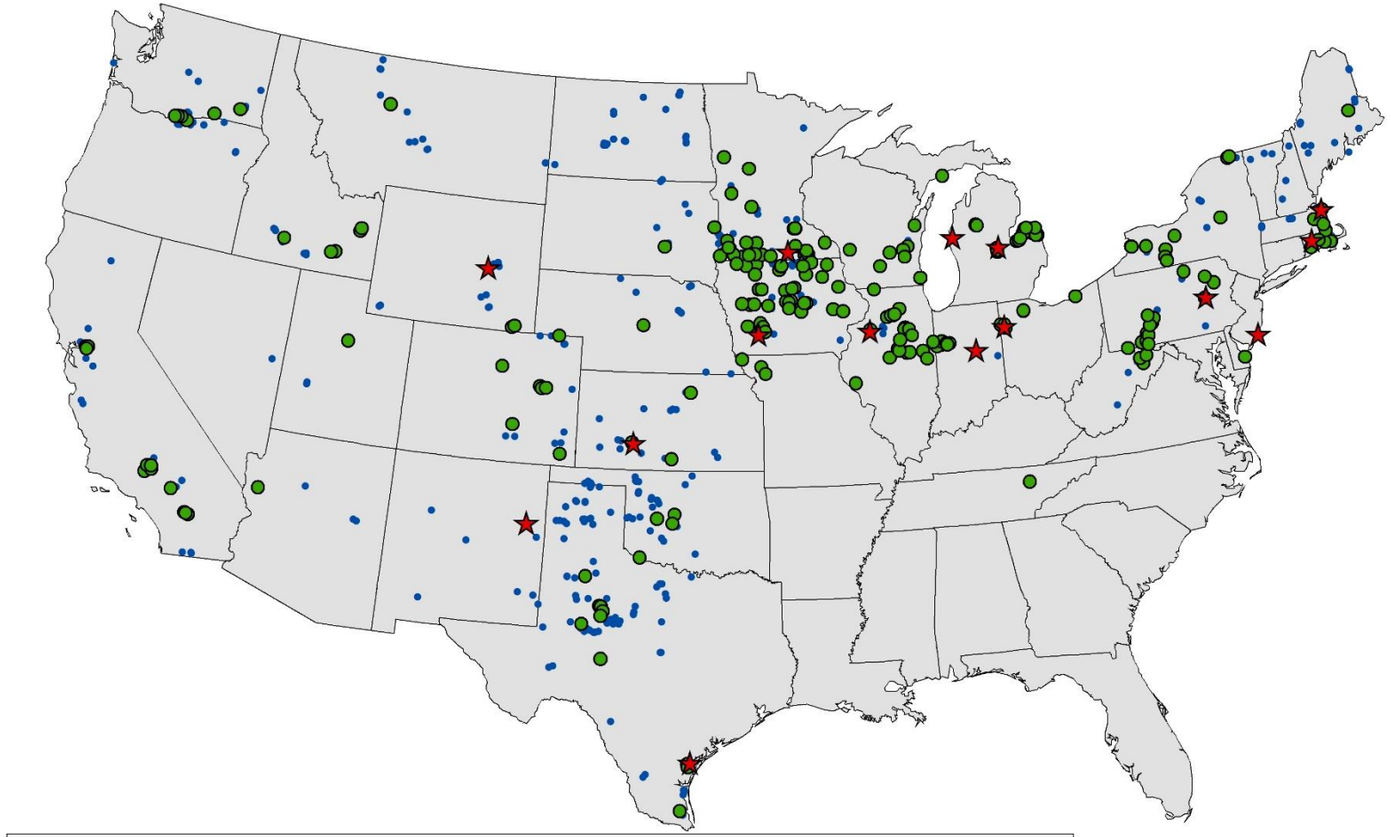
- Pilot phone survey (December 2015)
- Phone survey (March 2016)
- Internet & mail survey (June-July 2016)
- 1705 valid responses (22% overall response rate)

22-minute survey
~ 50 questions

Images: www.mmrstrategy.com

www.brookmark.com

Responses Collected Near 250 Wind Power Projects Across 24 States, From The Full Sample Of 604 Projects



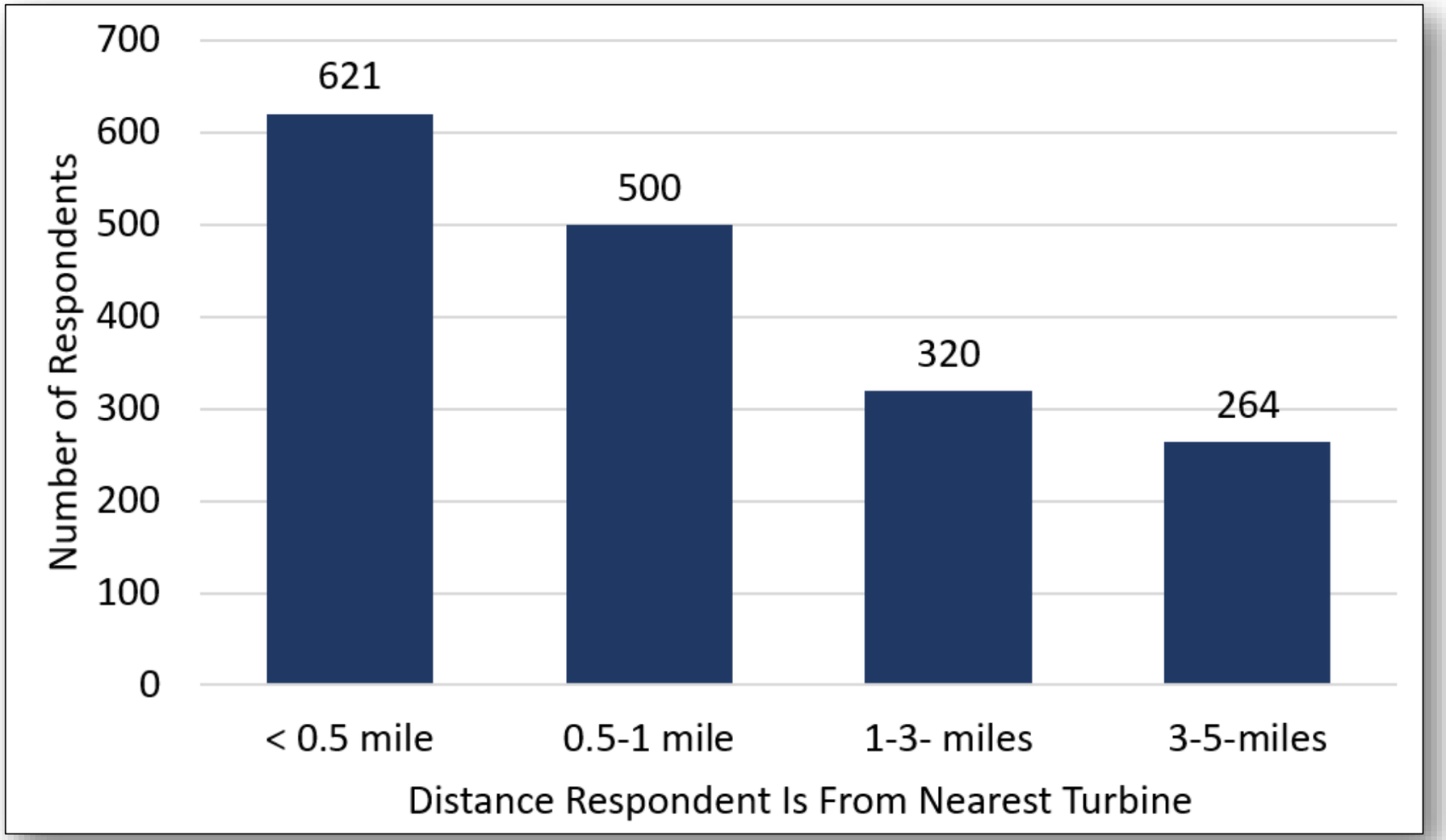
Random sample of residences within 5 miles of a modern wind turbine

- >= 364 feet tall
- >= 1.5 MW

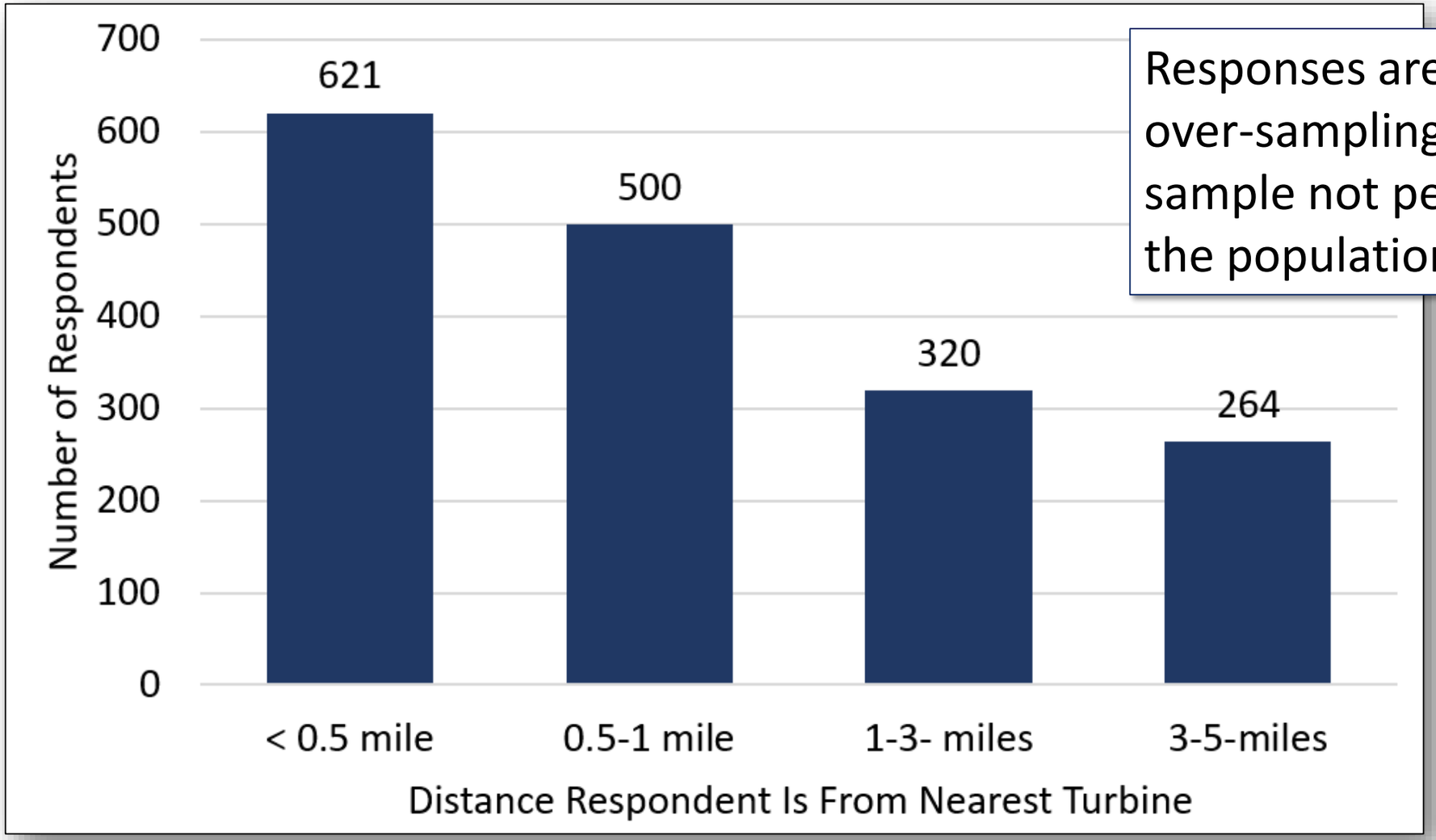
Oversampled

- close to (<1 mile) turbines
- large projects (>10 turbines)
- where sound was modeled

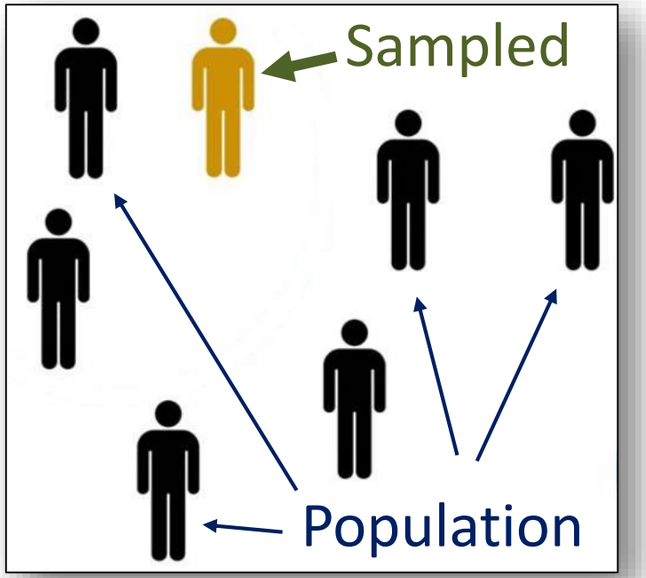
Final Responses By Sampling Cohort (*n* = 1705)



Final Responses By Sampling Cohort (*n* = 1705)



Responses are weighted to account for over-sampling and to adjust for a sample not perfectly representative of the population



National Survey of Attitudes of Wind Power Project Neighbors: Analysis Areas

Overall Analysis Areas

- Review of North American Wind Acceptance Literature
- Overall Analysis of Attitudes of 1,705 Wind Project Neighbors

Topic Specific Analysis Areas

- Planning Process Fairness and Attitudes
- Predicting Audibility of and Annoyance to Wind Project Sounds Using Modeled Sound
- Comparing Strongly Annoyed Individuals with Symptoms Near U.S. Turbines To Those In Surveyed European Communities

*** Preliminary Results ***

- Results have not been submitted to nor reviewed for a peer-reviewed journal.
- The results could change as work progresses.
- Changes to the results could change some of the conclusions.
- If you wish to cite these results, use the following:

  Hübner, G., J. Pohl, B. Hoen, J. Firestone, J. Rand, D. Elliott (2018) Comparing Strongly Annoyed Individuals with Symptoms Near U.S. Turbines To Those In Surveyed European Communities. Lawrence Berkeley National Laboratory. Preliminary Results Webinar. March 13, 2018.

Outline Of The Presentation

Part I. National Survey Project Background

Part II. Survey Frame Overview

Part III. Comparing Strongly Annoyed Individuals with Symptoms Near U.S. Turbines To Those In Surveyed European Communities

Part IV. Next Steps & Outreach

Comparing Strongly Annoyed Individuals With Symptoms Near U.S. Turbines To Those In Surveyed European Communities

Project Lead(s): Hübner, Pohl, Hoen

Collaborating Researchers: Firestone, Rand, Elliott

Purpose: To investigate individuals who are “strongly” annoyed (i.e., annoyed with symptoms), and compare results between this U.S. study and other studies in Europe, to examine differences and correlates

Numbers of Respondents: 1441 (respondents within 3 miles)

Primary Analysis Methodology: t- & Chi^2-tests; Pearson correlation; regression analysis

Methods

- Comparison between US and European residents
- Distance < 3 miles to the nearest wind turbine
- Weighted US data, unweighted European data
- N, M, SEM, %; figures: M ± SEM
- t-test, chi^2-test, Pearson correlation
- Multiple regression with unweighted US data
- Effect sizes used for this analysis:
  - Cohen's d (for t-test):
    "not relevant/negligible" <0.2; "small" 0.2—0.49; "medium" 0.5—0.79; "large" ≥ 0.8
  - w (for Chi^2 test):
    "not relevant/negligible" <0.1; "small" 0.1-0.29; "medium" 0.3-0.49; "large" ≥ 0.5

Three European Samples Using The Same Survey Questions Are Compared To The U.S. Results

Note: Respondents for the papers listed were limited to those within 3 miles. Statistics refer to those subsamples.	**Pohl et al. (2012)**	**Pohl et al. (2018)**	**Hübner & Löffler (2013)**	**Combined European Dataset**
Country	Germany	Germany	Switzerland	**Multiple**
n: <3 miles (total shown in paper)	372 (420)	212 (212)	445 (467)	**1029**
Average age	51	55	52	**52**
Gender (male; female)	59%; 41%	52%; 48%	48%; 52%	**53%; 47%**
Number of wind projects	13	1	7	**21**
Wind turbines per project (WT)	5–18	9	1–16	**1-18**
WT total height: feet (meters)	387–492 (118–150)	492 (150)	236–485 (72–148)	**236–492 (72–150)**
WT capacity (MW)	0.8–2.3	2.0	0.6–2.0	**0.6-2.3**
Distance range to home (miles)	0.37–1.24	0.78–1.80	0.14–2.98	**0.14–2.98**
Average distance to home (miles)	0.83	1.18	1.23	**1.08**

The Samples Are Largely Comparable In Terms Of Key Demographic Variables

Mean *(Standard Error of the Mean - SEM)*	**USA**	**Europe**	**Effect size** ***p*-value**
Age *n*	56.92 (0.43) 1407	52.22 (0.47) 1015	small (0.30) < .0001
Gender *n*	45% (m); 55% (f) 1428	53% (m); 47% (f) 1018	not relevant (0.08) < .0001

Overall Attitudes In Both Samples Are Positive, With Europeans Being Slightly More Positive

Mean (SEM)	**USA**	**Europe**	**Effect size** ***p*-value**
Present attitude towards wind farm *n*	0.72 (0.03) 1416	1.00 (0.05) 987	small (0.22) < .0001

Scale: –2 (very negative) to +2 (very positive)

U.S. Residents Perceive The Planning Process As More Fair, But Are More Annoyed By It

But in both samples, the mean annoyance levels are quite low.

Mean (SEM) *n*	**USA**	**Europe**	**Effect size** ***p*-value**
Perceived planning process fairness	2.31 (0.06) 692	1.62 (0.05) 906	small (0.48) < .0001
Annoyed by planning and construction process	0.90 (0.05) 769	0.56 (0.04) 1000	small (0.26) < .0001

Scale: 0 (not at all) to 4 (very)

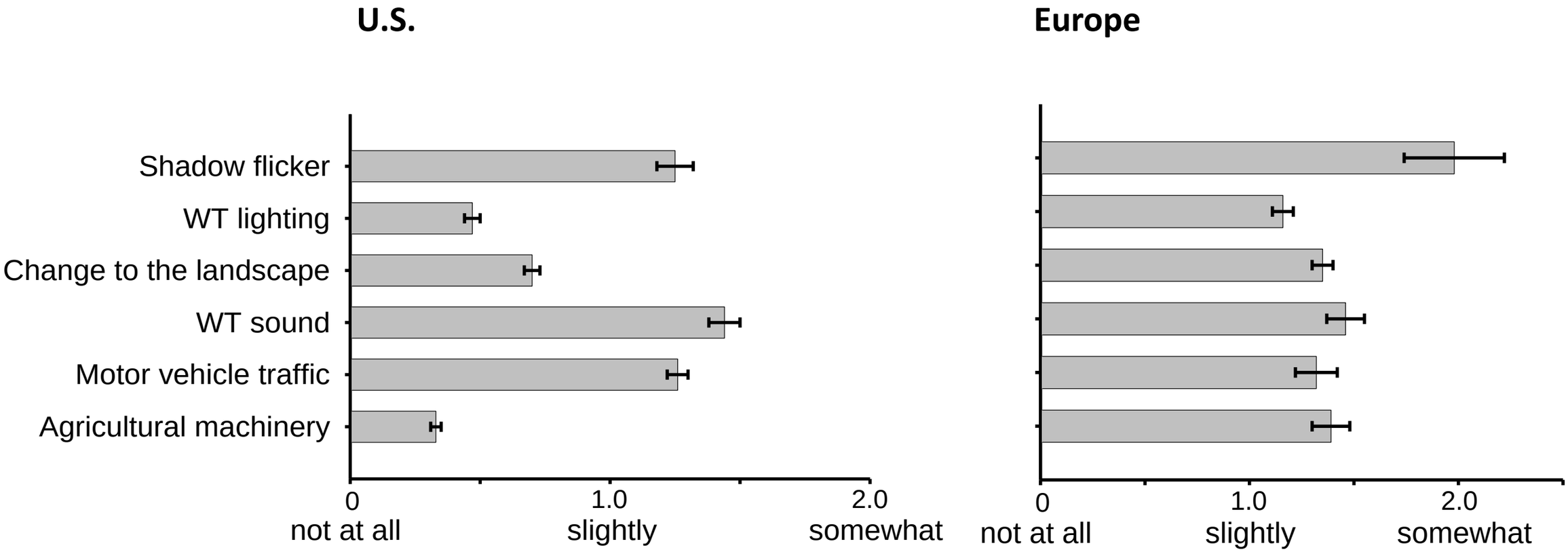
Consistently Lower U.S. Incidences Of Both Hearing the Wind Project And Experiencing Shadow Flicker

% *n*	U.S.	Europe	Effect size *p*-value
Blades cast shadow, outside home	3.3% 1423	8.8% 467	small (0.11) < .0001
Blades cast shadow, inside home	2.3% 1434	8.8% 467	small (0.15) < .0001
Can hear wind farm, outside home	10.9% 1434	41.0% 671	medium (0.35) < .0001

Note: The European sample responents are, on average, closer to the turbines than the U.S. respondents, which might explain the higher %s. (USA: M = 1.68 miles, SEM = 0.02; Europe: M = 0.99 miles, SEM = 0.01; Effect size: large (d=1.24), p<.0001).

BERKELEY LAB

Overall, Relatively Low Annoyances Within 3 Miles: Wind Turbine Sound Is Greatest in U.S., Followed By Shadow Flicker



Roughly 8% Have Claimed To Have Experienced Negative Effects From U.S. Wind Projects; Most Cope By Talking To Others

Have you ever experienced any negative effects from the wind project?

Overall %
7.8%

U.S. Only (*n*=1441)

How have you coped…?	Overall %	% of Those Affected
Talked with others	5.7%	74%
Tried to relax	4.1%	52%
Accepted it	3.8%	49%
Ignored it	3.6%	46%
Reduced its effects (e.g., sound dampening, shutting windows, closing blinds)	3.1%	40%
Avoided it	3.0%	39%

BERKELEY LAB

U.S. Symptoms Related To Annoyances Are Rare, Appear Most Often For Sound – Comparable To Europe (See Supplemental Slides)

U.S. Only

Turbine Annoyances

Reported Symptoms Occurring At Least Monthly	Sound	Landscape Change	Lighting	Shadow Flicker
n	*1441*	*1441*	*1441*	*1441*
Being in a bad mood	3.3%	2.6%	1.8%	2.3%
Anger	1.1%	1.9%	1.7%	0.6%
Lack of concentration	2.4%	0.6%	0.7%	1.3%
Difficulty falling asleep	3.2%	0.6%	1.0%	0.6%
Otherwise not sleeping well	2.7%	0.5%	1.1%	0.6%

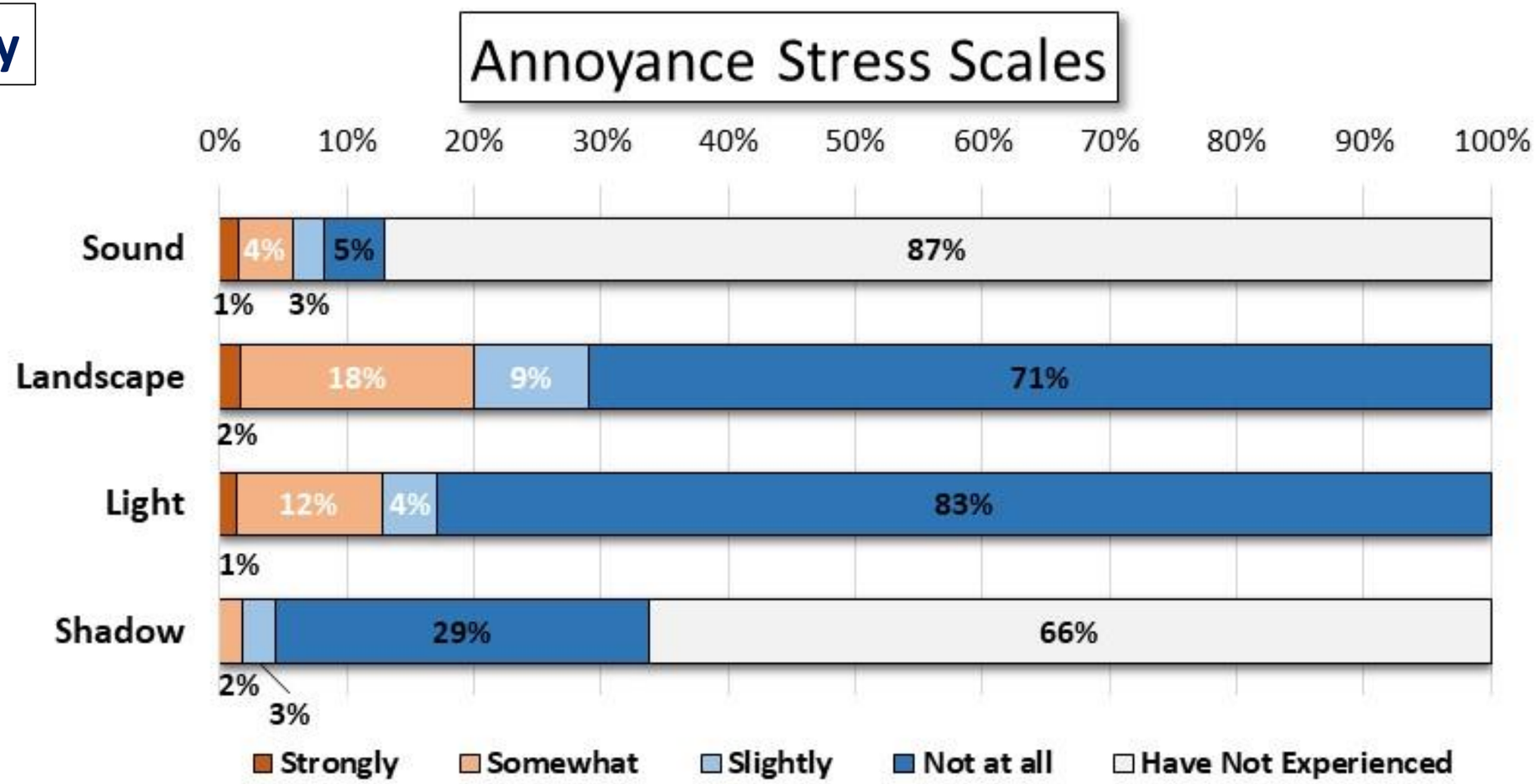
Definition Of Annoyance Stress Scale

A Combination Of Annoyance Level And Symptom Frequency

Annoyance Level	Have Not Experienced Sound or Flicker	Not At All	Slightly	Somewhat, Moderately, or Very	Somewhat, Moderately, or Very
Symptom Frequency	Not Applicable	Not Applicable	No Symptoms	No Symptoms	Monthly, Weekly, or Daily
Annoyance Stress Scale	**Not Experienced Sound or Flicker**	**Not at all**	**Slightly**	**Somewhat**	**Strongly**

18% Are Somewhat Annoyed By Landscape But Overall, Stress Related Annoyance Is Very Rare

U.S. Only



Data are weighted and only include respondents within 3 miles of a turbine

“Strongly” Annoyed Stress Scale Residents Represent A Small Portion Of The Population. Few Differences Between US and European Annoyance Stress Levels

% (*n*)[a] total *n*	U.S.	Europe	Effect size *p*-value
Sound	1.1% (16) *1441*	4.3% (28) *657*	small (0.102) < .0001
Landscape Change	1.5% (22) *1441*	0.0% (0) *445*	not relevant (0.060) .009
Lighting	1.2% (18) *1441*	1.2% (10) *817*	not relevant (0.001) .959
Shadow Flicker	0.2% (3) *1441*	0.2% (1) *445*	test not possible
Total	2.3% (33) *1441*	3.7% (38) *1029*	not relevant (0.049) .041

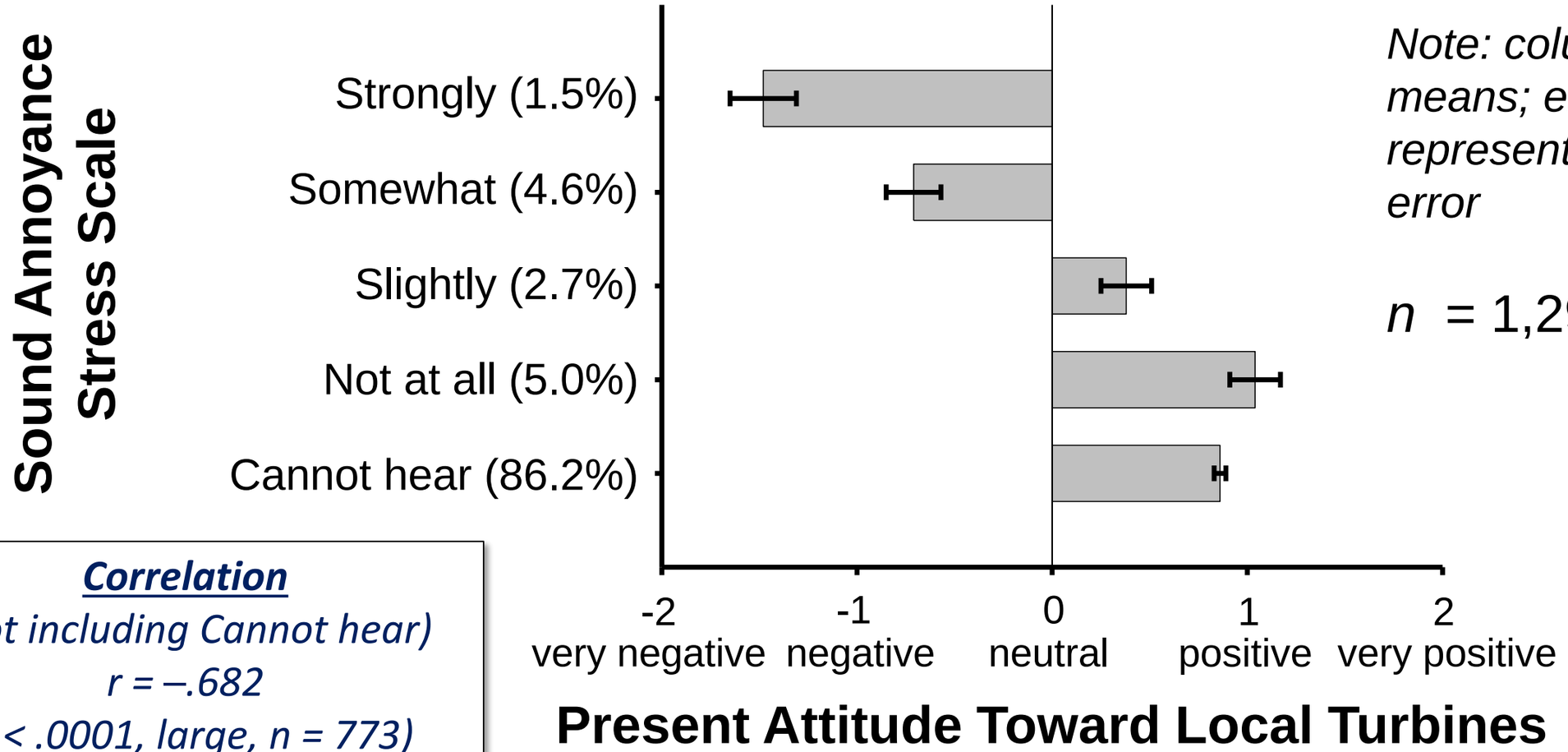
a. *In the U.S. the strongly annoyed n are estimated based on weighted percentage. In Europe they are the actual counts*

BERKELEY LAB

Unless Noted, The Next Slides Focus Only On U.S. Respondents And Sound Annoyance Stress Scales (SASS)

Although the percentages of those that are "strongly" annoyed (i.e., with symptoms) are quite low for sound, landscape, shadow and lighting scales, the Sound Annoyance Stress Scales will be the focus for the remaining slides in the deck.

Focusing on Sound Annoyance Stress Scale (SASS) It Is Strongly Correlated With Present Attitude



Note: columns represent means; error bars represent the standard error

n = 1,294

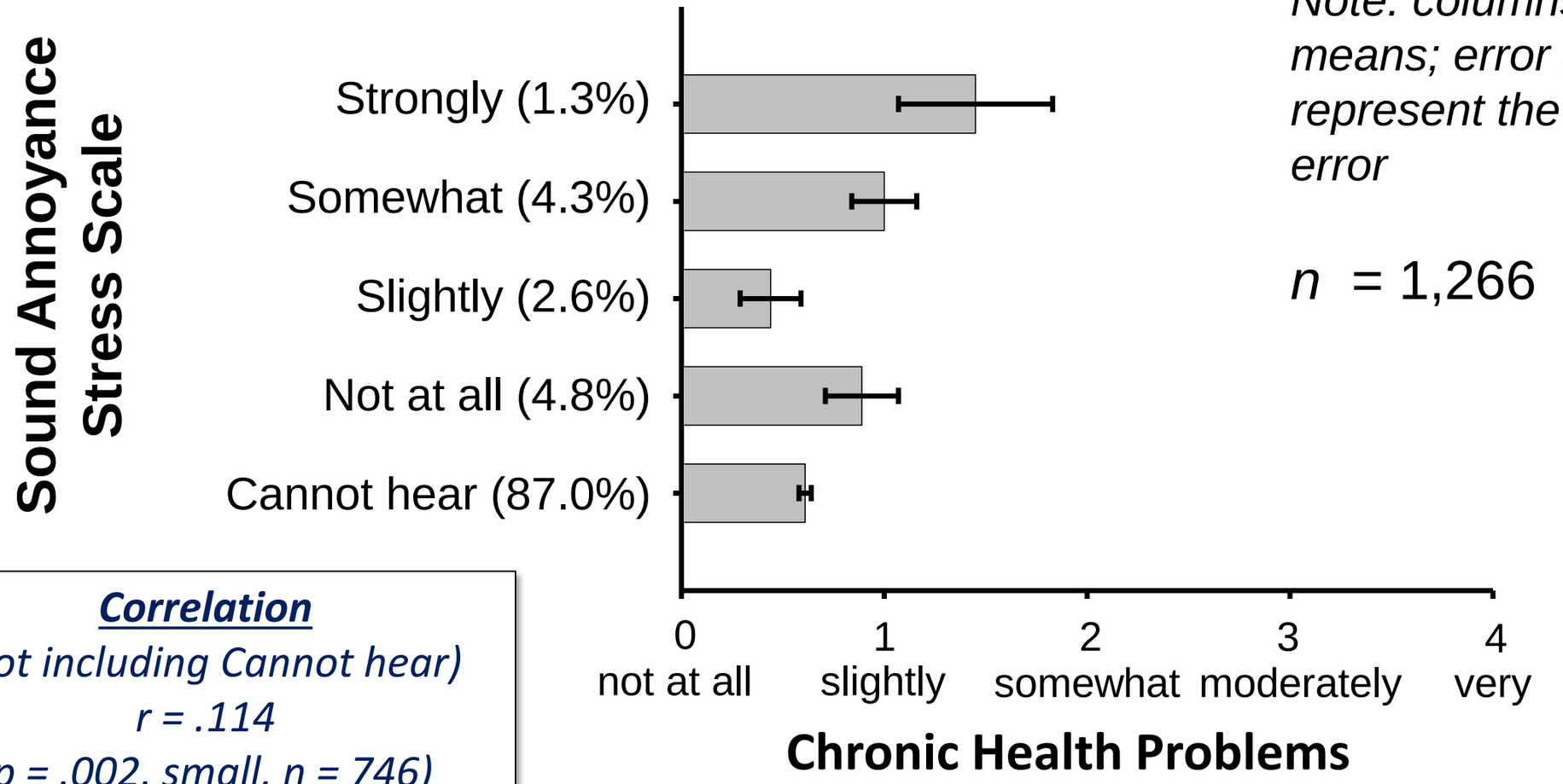
Correlation

(Not including Cannot hear)

r = –.682

(p < .0001, large, n = 773)

Chronic Health Problems (Not Related To Wind Turbines) Are Negligibly Correlated To SASS



Note: columns represent means; error bars represent the standard error

n = 1,266

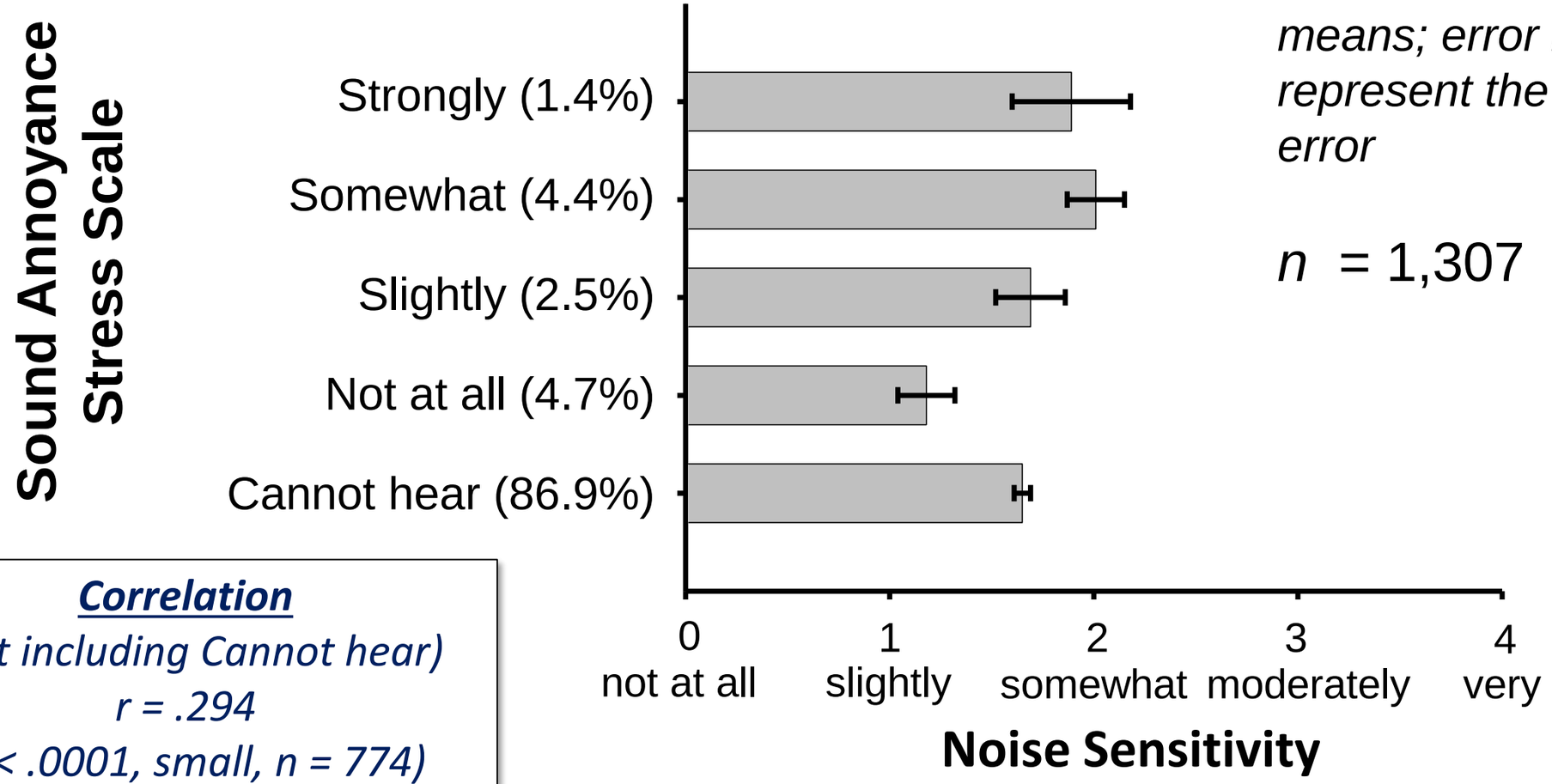
Correlation

(Not including Cannot hear)

r = .114

(p = .002, small, n = 746)

Noise Sensitivity Is Negligibly Correlated With SASS



Note: columns represent means; error bars represent the standard error

n = 1,307

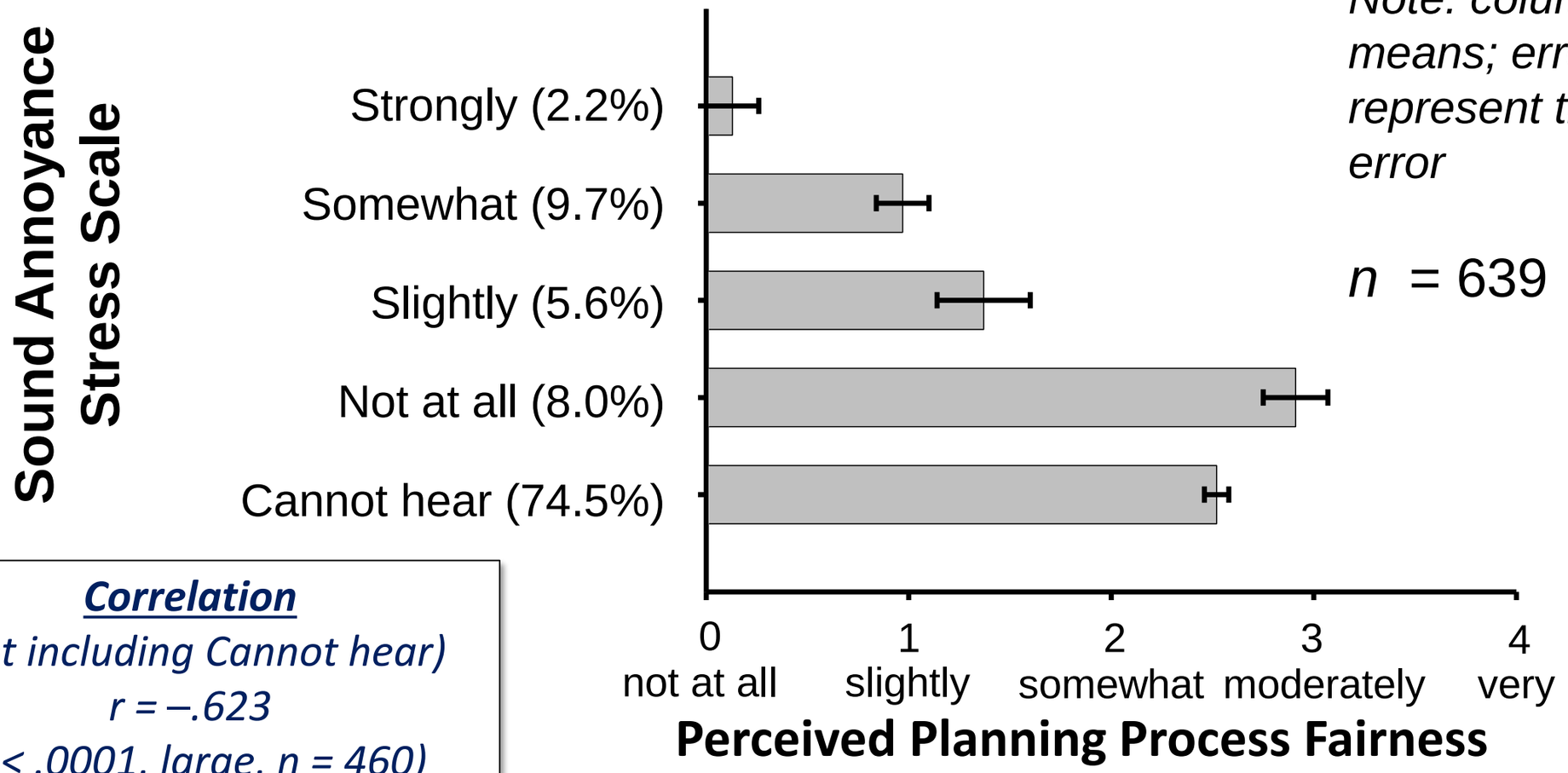
Correlation

(Not including Cannot hear)

r = .294

(p < .0001, small, n = 774)

SASS Is Strongly Correlated With Perceived Planning Process Fairness



Note: columns represent means; error bars represent the standard error

n = 639

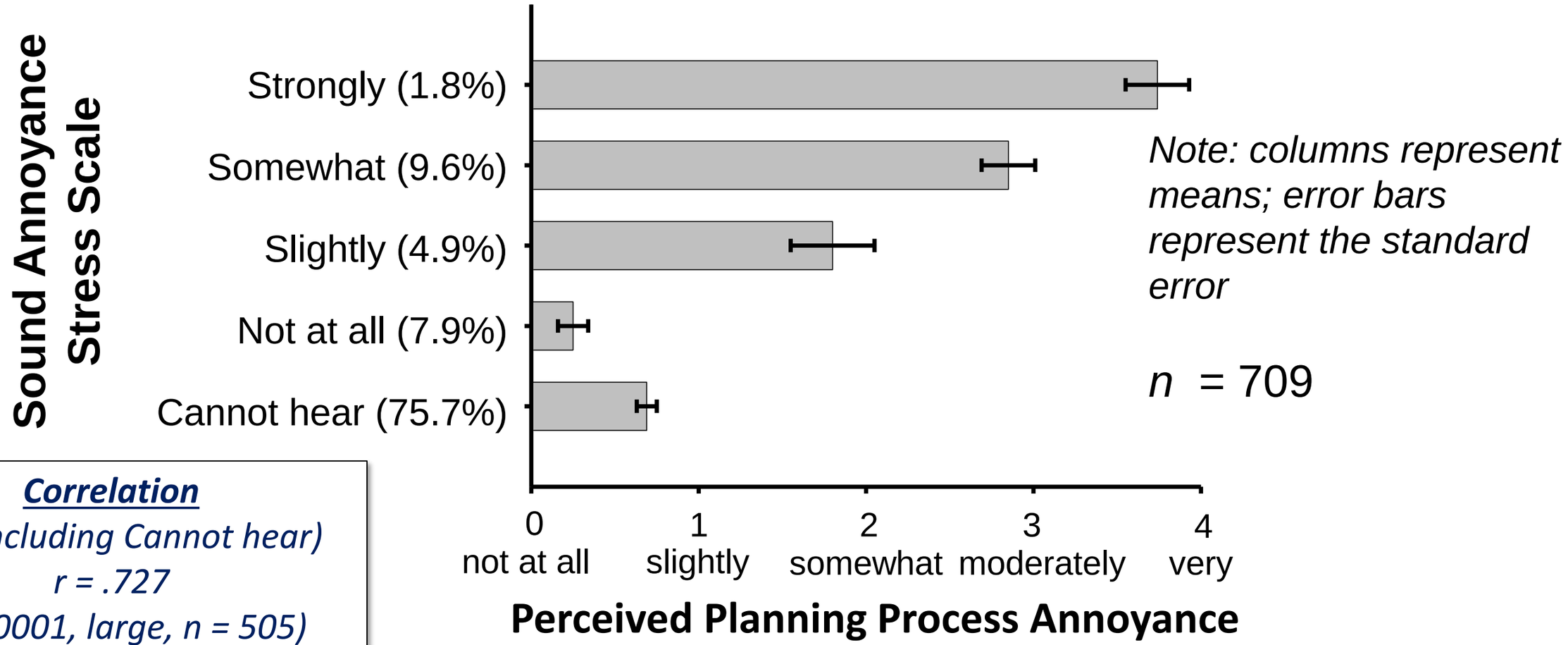
Correlation

(Not including Cannot hear)

r = –.623

(p < .0001, large, n = 460)

Similarly, SASS Is Strongly Correlated With Planning Process Annoyance



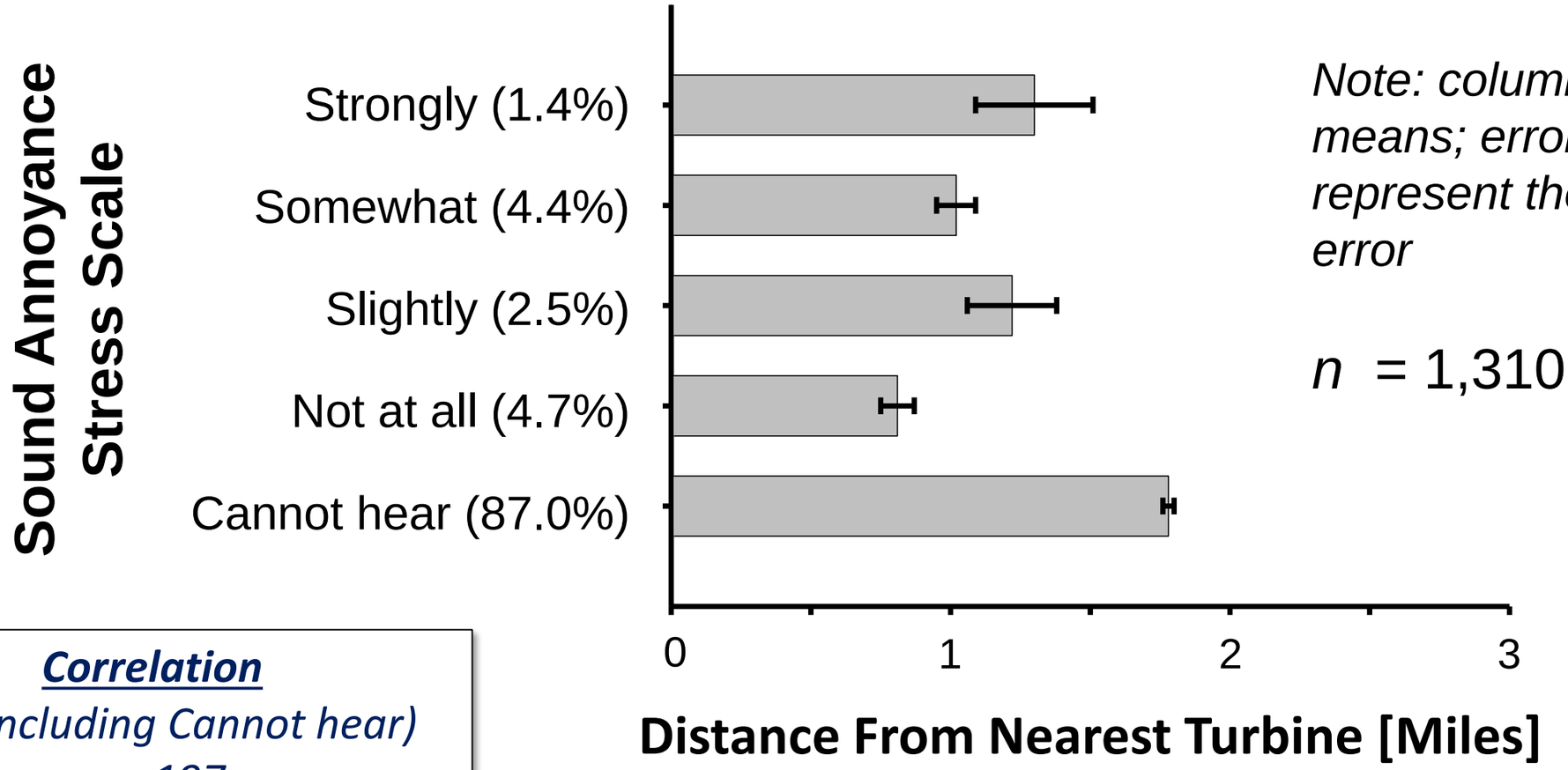
Correlation

(Not including Cannot hear)

r = .727

(p < .0001, large, n = 505)

SASS Is Negligibly Correlated With Distance From The Turbines



Note: columns represent means; error bars represent the standard error

n = 1,310

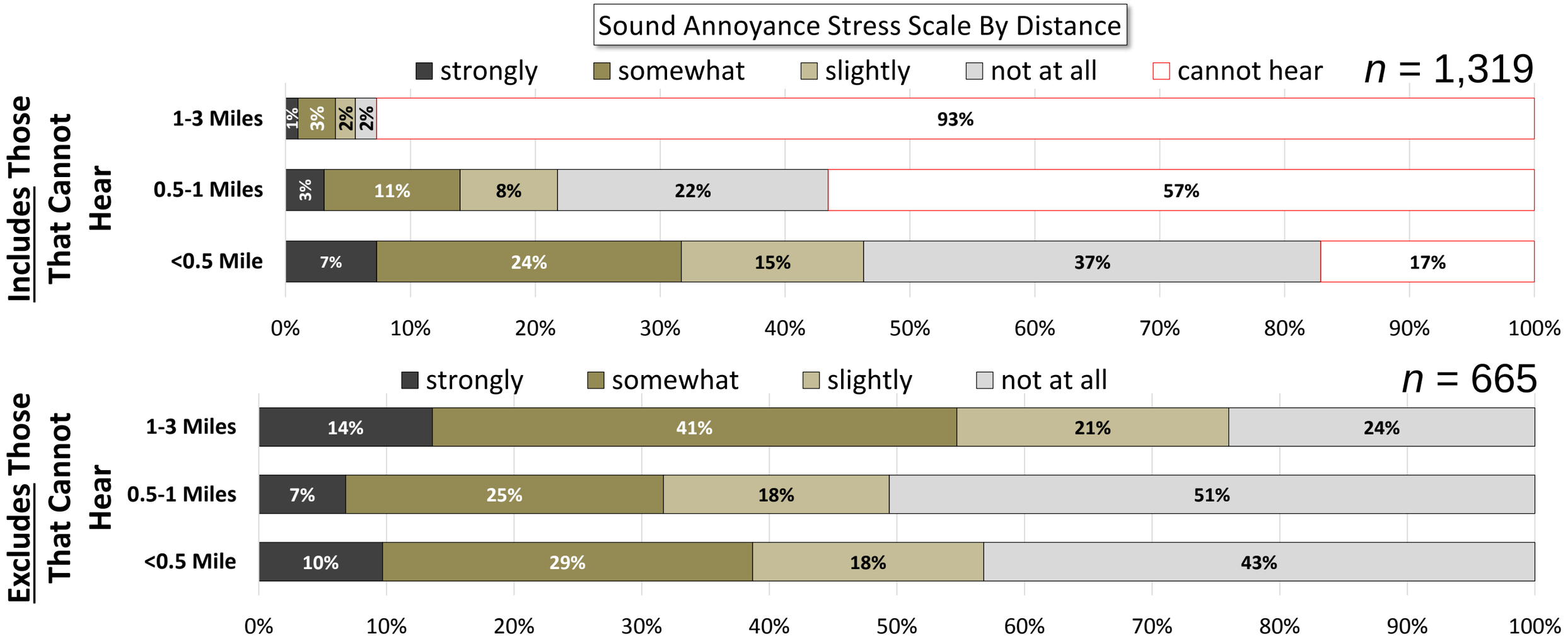
Correlation

(Not including Cannot hear)

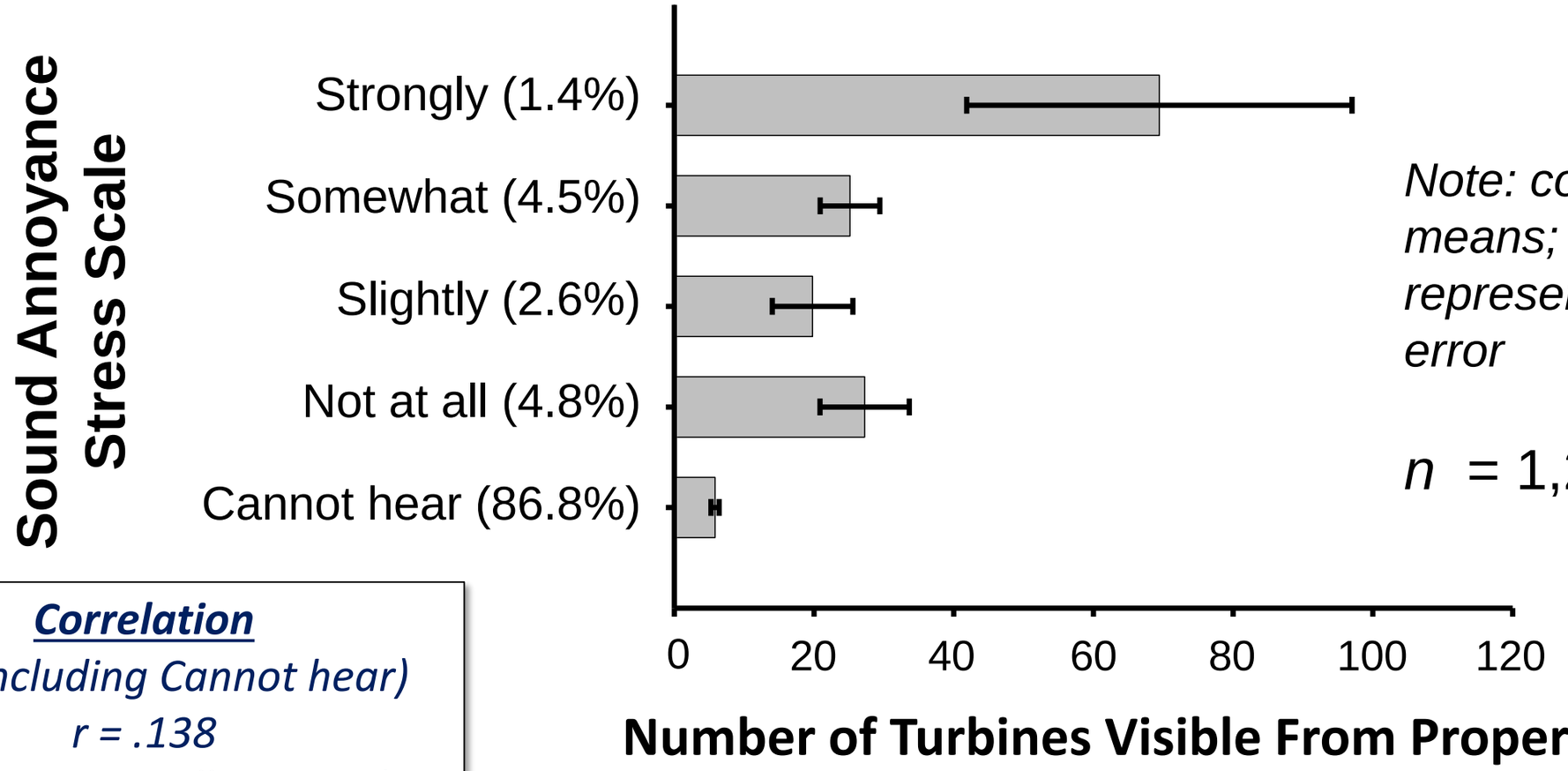
r = .197

(p < .0001, small, n = 779)

SASS Is Negligibly Correlated With Distance From The Turbines



Number Of Turbines Visible From The Property Is Negligibly Correlated With SASS, Though Strongly Annoyed See More

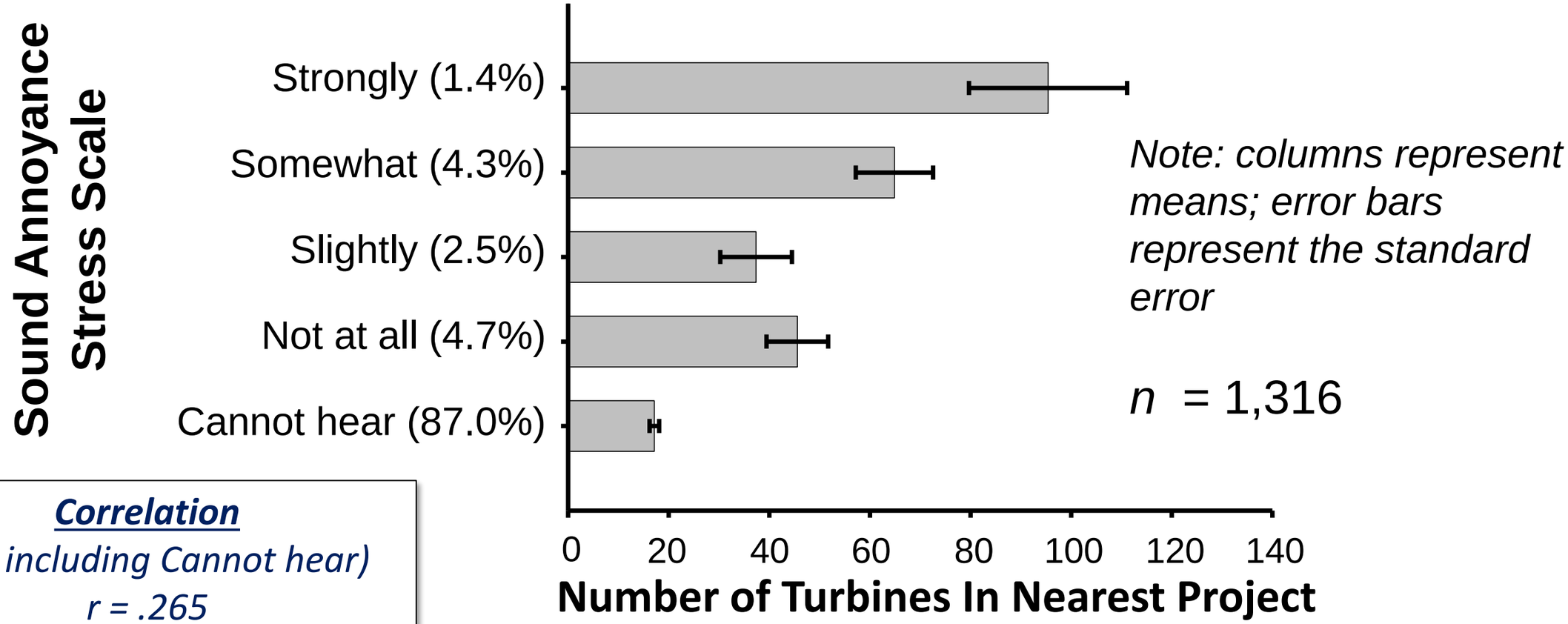


Note: columns represent means; error bars represent the standard error

n = 1,253

Correlation
(Not including Cannot hear)
r = .138
(p < .0001, small, n = 743)

Number Of Turbines In The Nearby Project Is Negligibly Correlated With SASS With Stronger Annoyance Near Larger Projects



Note: columns represent means; error bars represent the standard error

n = 1,316

Correlation

(Not including Cannot hear)

r = .265

(p < .0001, small, n = 779)

U.S. Present Attitude Toward Wind Project And Annoyance Toward Planning Process Are Strongly Correlated With SASS

Predictor (see notes)	Coefficient	Beta	p-value
Present attitude towards wind farm	**–.334**	**–.431**	**< .0001**
Annoyed by planning process	**.188**	**.289**	**< .0001**
Process was fair	–.053	–.077	.100
Sensitive to noise	.093	.102	**.004**
Acute health problems, not wind	.010	.011	.781
Chronic health problems, not wind	–.009	–.011	.781
Distance (miles)	–.069	–.021	.501
Total number of turbines in nearest project	.001	.071	**.036**

N = 396, R^2 adjusted = .614, VIF < 2.9, unweighted sample

Notes: Demographic variables were also included, such as: age, gender, education, income and race. None were strongly correlated.

BERKELEY LAB

Conclusions

- Overall U.S. annoyance is rather low and the number of strongly annoyed residents is few.
- Strongly annoyed residents report stronger negative attitude, stronger planning process annoyance, and less fair planning process.
- The WT sound annoyance and shadow flicker annoyance are between “slightly” and “moderately” in U.S. and Europe while the maximum average annoyance of other emissions is “slightly”.
- Attitudes towards U.S. wind projects are somewhat positive but less positive than in Europe.
- Attitudes and annoyance by the planning process explain 61% of the variation in U.S. WT sound annoyance stress, though direction of the causation is unclear.
- Physical parameters such as distance and demographic characteristics do not explain U.S. WT sound annoyance stress.
- The comparable overall result patterns in the U.S. and Europe support the reliability of both sets of findings.

Researcher Takeaways

- Because of the strong link between symptoms, annoyance and perceived planning process fairness, though accepting unclear causation, any efforts to improve the process might greatly help to reduce annoyance and related symptoms. Examples include early and informal participation of residents and consideration of their concerns (e.g., see Firestone, et al., 2017 using this same sample for more discussion)
- It appears that sound and shadow flicker regulations are being applied correctly, and that should continue and be strengthened where possible, potentially addressing sound qualities not presently addressed (such as frequency modulation).
- To better understand annoyance, long term monitoring of residents might be useful to collect information on sound parameters, amplitude modulation, stress indicators, and situational conditions. This might lead to possible mitigation procedures.

Outline Of The Presentation

Part I. National Survey Project Background

Part II. Survey Frame Overview

Part III. Comparing Strongly Annoyed Individuals with Symptoms Near U.S. Turbines To Those In Surveyed European Communities

Part IV. Next Steps & Outreach

Upcoming Outreach & Next Steps

Upcoming Outreach

- Austrian Wind Energy Association (Vienna, March 2018)
- AWEA Siting and Compliance Conference (Memphis, March 2018)
- IEA Wind Task 28 meeting (Copenhagen, March 2018)
- European Wind Summit, WindEnergy Hamburg (September 2018)

source: hingemarketing.com

Next Steps

- Submit additional journal papers (spring/summer 2018)
- Release the analysis data & survey instrument (fall 2018)

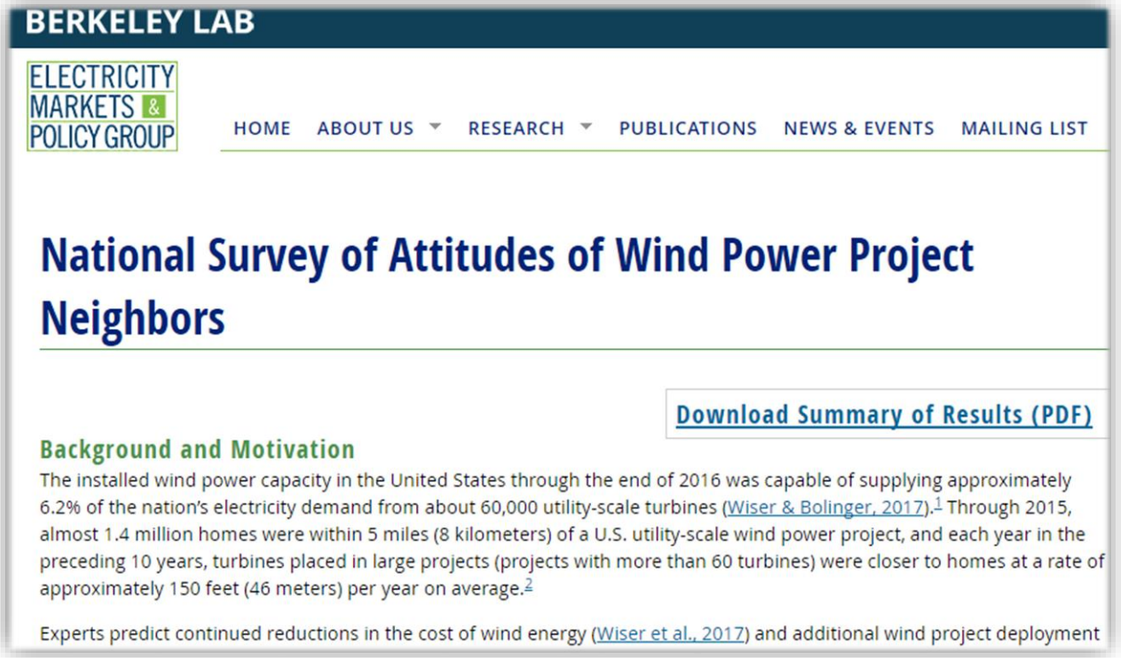
Questions?

Gundula Hübner: gundula.huebner@psych.uni-halle.de

Johannes Pohl: johannes.pohl@psych.uni-halle.de

Ben Hoen: bhoen@lbl.gov

Visit the project webpage for more info and updates
https://emp.lbl.gov/projects/wind-neighbor-survey



If you wish to cite these results use the following:

Hübner, G., J. Pohl, B. Hoen, J. Firestone, J. Rand, D. Elliott (2018) Comparing Strongly Annoyed Individuals with Symptoms Near U.S. Turbines To Those In Surveyed European Communities. Lawrence Berkeley National Laboratory. Preliminary Results Webinar. March 13, 2018.

This work is supported by the US DOE Wind Energy Technologies Office

Supplemental Slides

Overall, Relatively Low Annoyances: In The U.S., Sounds Rate As The Most Annoying On Average (*Slide 24 Statistics*)

Mean (SEM) *n*	**U.S.**	**Europe**	**Effect size** ***p*-value**
Shadow flicker (limited to those experiencing flicker on property)	1.25 (0.07) 454	1.98 (0.24) 46	small (0.46) .002
Lighting	0.47 (0.03) 1397	1.16 (0.05) 752	medium (0.52) < .0001
Landscape change	0.70 (0.03) 1414	1.35 (0.05) 1024	small (0.46) < .0001
Sound (limited to those that can hear sounds on property)	1.44 (0.06) 779	1.46 (0.09) 264	not relevant (0.01) .851
Traffic (not specific to wind)	1.26 (0.04) 1422	1.32 (0.10) 211	not relevant (0.04) .515
Agricultural machinery	0.33 (0.02) 1382	1.39 (0.09) 212	large (1.02) < .0001

U.S. Respondents Have Lower Acute And Chronic Health Problems And Less Noise Sensitivity

Mean (SEM) *n*	**U.S.**	**Europe**	**Effect size** ***p*-value**
Acute health problems in 4 weeks, not wind	0.64 (0.03) 1388	1.20 (0.03) 1010	medium (0.50) < .0001
Chronic health problems, not wind	0.70 (0.03) 1384	1.08 (0.04) 1007	small (0.33) < .0001
Noise sensitivity	1.66 (0.03) 1431	2.01 (0.05) 710	small (0.28) < .0001

Scale: 0 (not at all) to 4 (very)

Overall Few Take Action; U.S. Residents Took Slightly More Supportive and Slightly Less Opposing Actions

	U.S.	Europe
Supportive action	12.5%	6.9%
Opposed action	4.4%	9.6%
n	1441	679

Note: Some differences in percentages might be due to differences in the survey questions regarding actions. The US survey question was answered by only the respondents that were in the community before the project's construction and who were aware of the planning process, while the European questions were answered by all respondents that might have taken action before or after construction.

Sound Annoyance (not SASS) Is Uncorrelated to Wind Project Characteristics, But Is To Planning Process And Attitude

Pearson Correlation (*p*-value) *n*	U.S.	Europe
Distance to nearest turbine	.154 (< .0001) 779	—.105 (.007) 650
Sound pressure level, day	.140 (.023) 264	.271 (.001) 147
Number of turbines in the nearest project	.202 (< .0001) 779	.113 (.004) 650
Planning process fairness	—.622 (< .0001) 461	—.430 (< .0001) 585
Planning process annoyance/stress	.734 (< .0001) 506	.373 (< .0001) 639
Present attitude towards wind project	—.706 (< .0001) 773	—.674 (< .0001) 647

European Symptoms Related To Annoyances Are Also Rare; Higher Than U.S. For Sound, But Lower For Others

Europe Only

Turbine Annoyances

Reported Symptoms Occurring At Least Monthly	Sound	Landscape Change	Lighting	Shadow Flicker
n	*679*	*467*	*887*	*467*
Being in a bad mood	4.1%	0.4%	0.3%	0.0%
Anger	4.0%	0.4%	0.0%	0.0%
Lack of concentration	3.7%	0.0%	0.3%	0.2%
Difficulty falling asleep	4.6%	0.0%	1.0%	0.0%
Otherwise not sleeping well	4.7%	0.0%	0.8%	0.0%

SASS Appears Less Related to Wind Project Characteristics, But More To Planning Process And Attitude; U.S. and E.U. Very Similar

Pearson Correlation (*p*-value) *n*	U.S.	Europe
Distance to nearest turbine (excluding those that cannot hear)	.197 (< .0001) 779	.057 (.357) 261
Sound pressure level, day (excluding those that cannot hear)	.116 (.060) 264	.204 (.016) 139
Number of turbines in the nearest project	.365 (< .0001) 1316	.398 (< .0001) 648
Planning process fairness	—.395 (< .0001) 639	—.397 (< .0001) 565
Planning process annoyance/stress	**.490** (< .0001) 709	**.467** (< .0001) 620
Present attitude towards wind project	—.362 (< .0001) 1294	**—.620** (< .0001) 644

References

Hübner & Löffler (2013) *Wirkungen von Windkraftanlagen auf Anwohner in der Schweiz:* Einflussfaktoren und Empfehlungen *(which translates to: Impact of Wind Turbines of Residents in Switzerland: Impact Factors and Recommendations*). Institut für Psychologie der Martin-Luther-Universität Halle-Wittenberg, Germany. Research Report

Pohl, J., G. Hübner, A. Mohs (2012) *Acceptance and Stress Effects of Aircraft Obstruction Markings of Wind Turbines*. Energy Policy, 50 (November): 592–600.

Pohl, J., J. Gabriel, G. Hübner (2018) *Understanding Stress Effects of Wind Turbine Noise – The Integrated Approach*. Energy Policy, 112 (January): 119-128.