Energy Technologies Area  Lawrence Berkeley National Laboratory

## National Survey of Attitudes of Wind Power Project Neighbors

## January 30th, 2017: Webinar 1 of 4

# Overall Analysis of Attitudes of 1,705 Wind Power Project Neighbors

## *Preliminary Results*

**Please Note:**

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


**Ben Hoen & Joe Rand**

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.

# Outline Of The Presentation

**Part I. National Survey Project Background**

**Part II. Survey Frame Overview**

**Part III. Overall Analysis of Attitudes Results**

**Part IV. Next Steps & Outreach**

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

**Project PI:** Ben Hoen, Research Scientist, LBNL

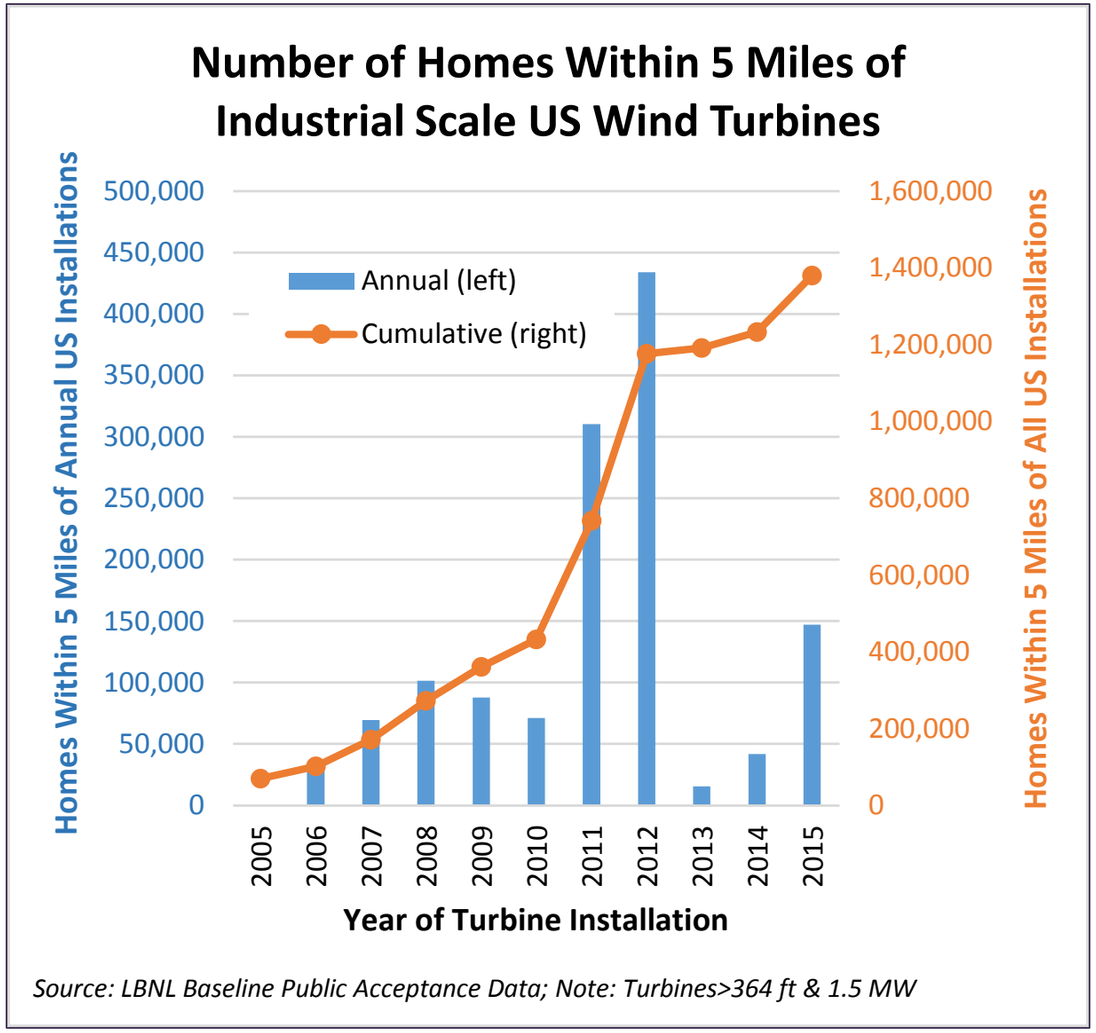
**Collaborating Researchers:**

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

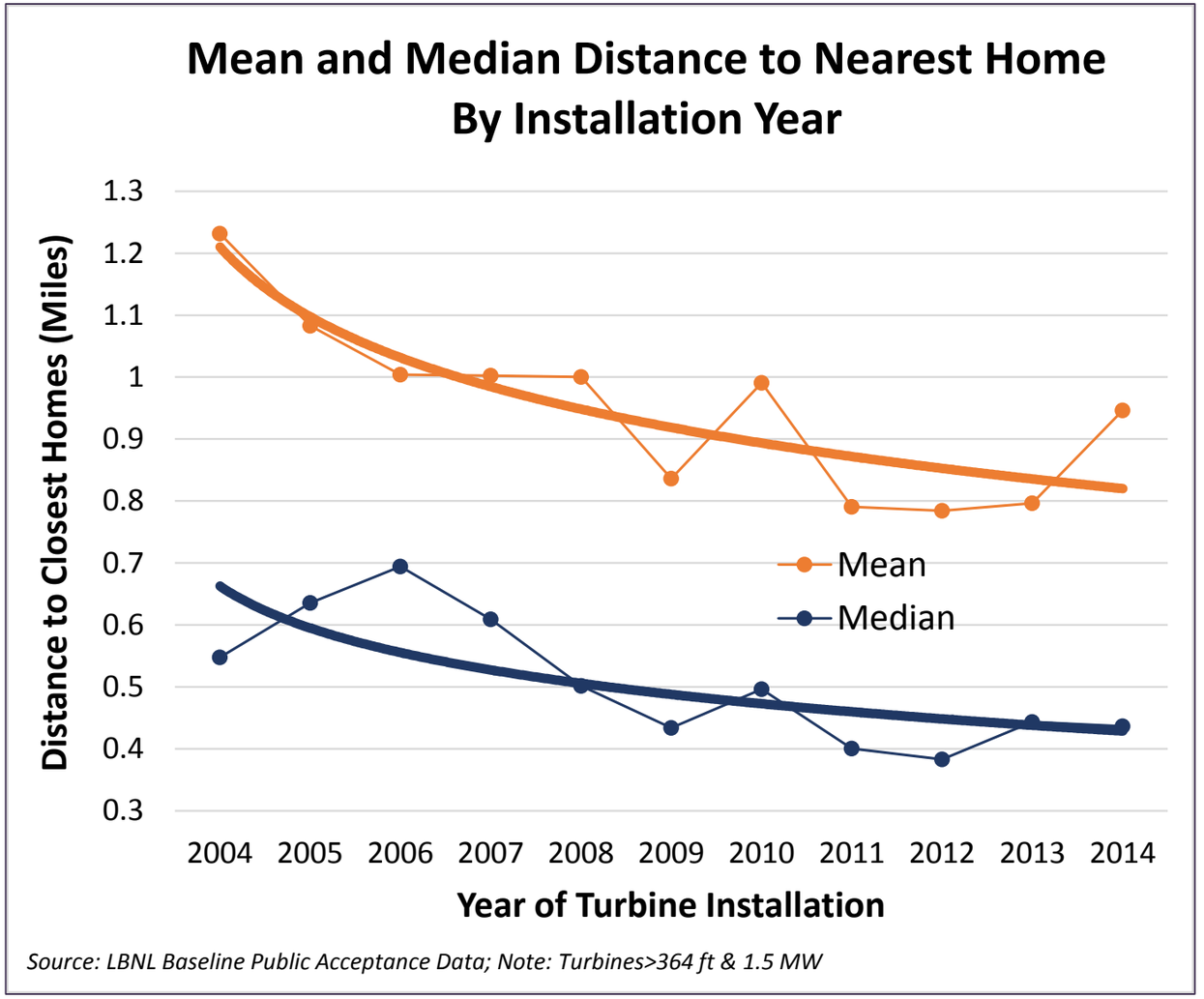
**Project Years:** FY2015-FY2018

**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*

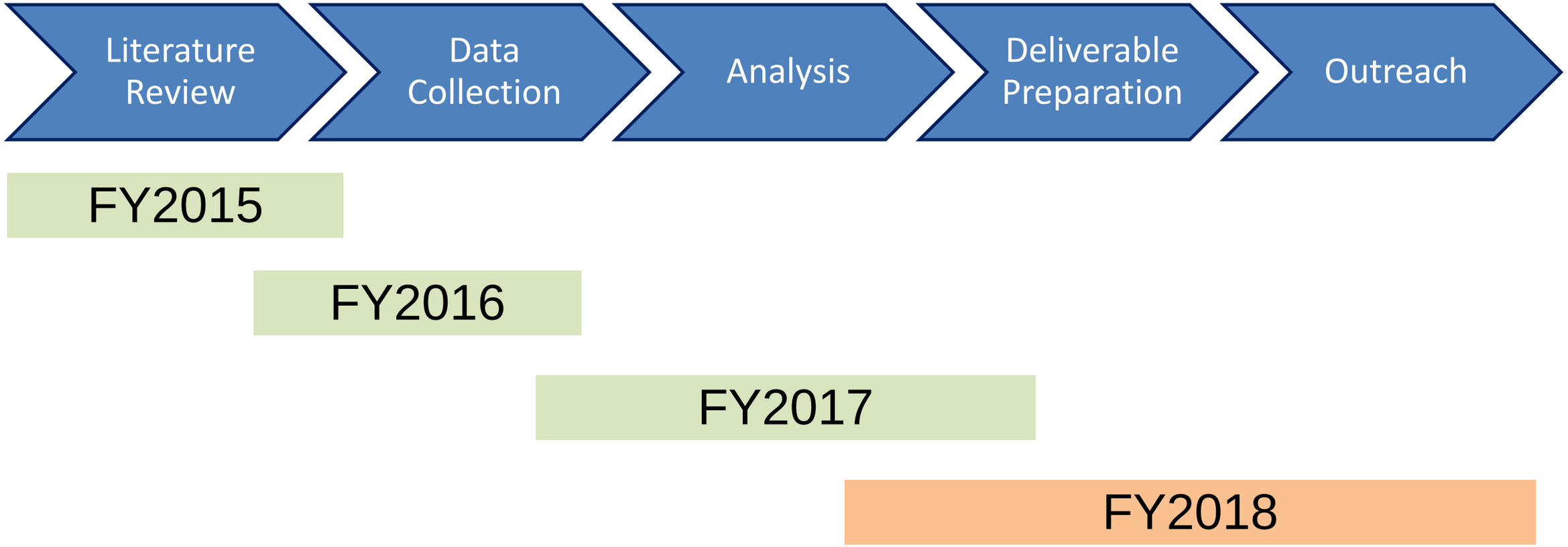



*Source: LBNL Baseline Public Acceptance Data; Note: Turbines>364 ft & 1.5 MW*

# **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

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Review

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

Joseph Rand*, Ben Hoen

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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

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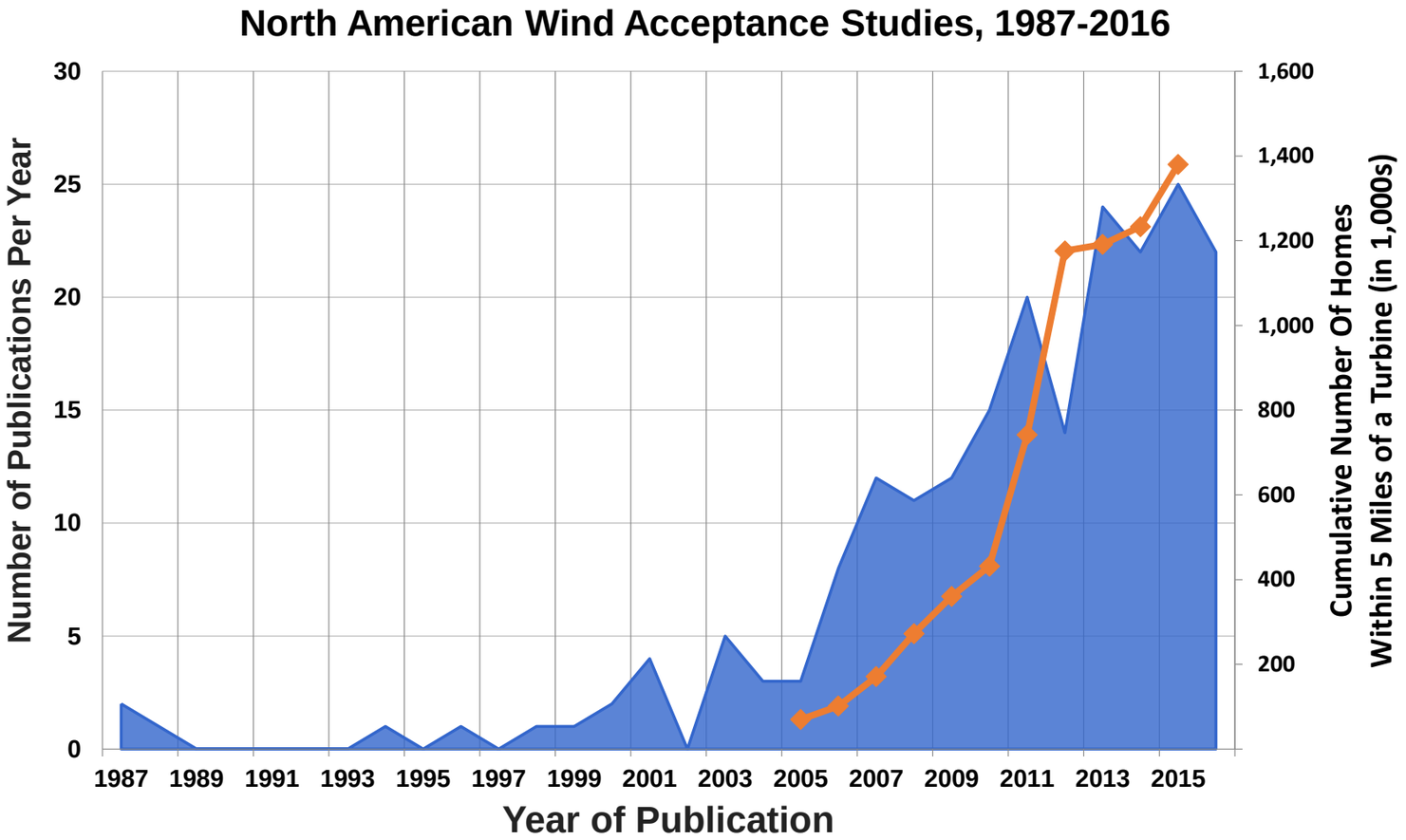
Available online 25 May 2017
2214-6296/

# Literature Review: Overview

- Reviewed over 130 published reports and articles
- Focused primarily on North American literature
- Papers published from 1987 to 2016



# Literature Review: Research Gaps

- A nationally representative sample of U.S. wind “neighbors”
- Larger sample of “very close” (< 1 mi) respondents
- Compare wind acceptance to other energy sources
- Distinguish those who moved-in *after* wind project construction from those living there *prior*
- Correlate attitudes / annoyance and modeled or measured sound
- Community preferences for the project development process
- Preferred compensation mechanisms (i.e., investment opportunity, reduced taxes, etc.)
- Public perceptions of property value impacts near wind projects
- Attitude changes over time around existing U.S. wind projects
- Implementation of strategies from previous wind acceptance research

# Outline Of The Presentation

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# 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)

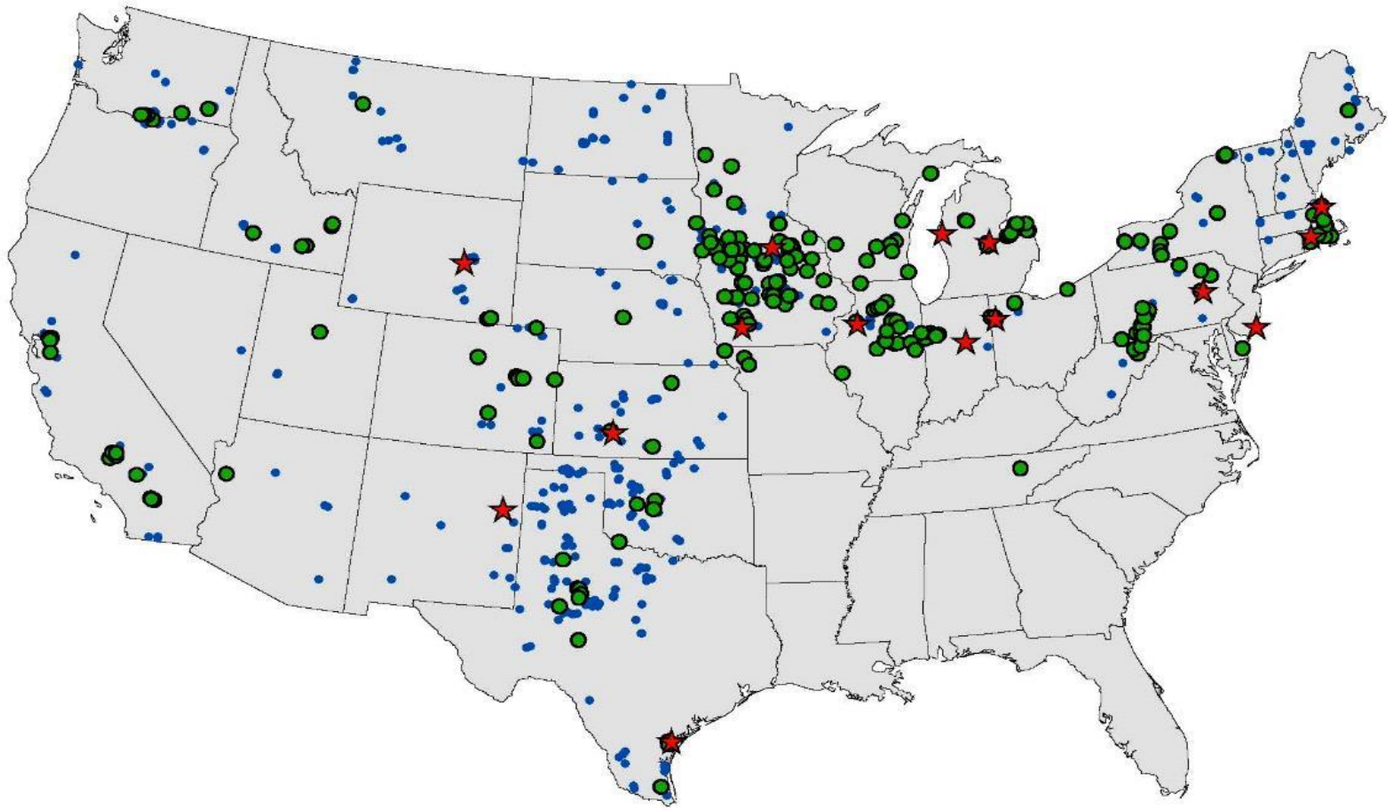
**22-minute survey**
**~ 50 questions**



Images: www.mmrstrategy.com

www.brookmark.com

# Responses Collected Near 250 Wind Power Projects Across 24 States, From The Full Sample Of 743 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

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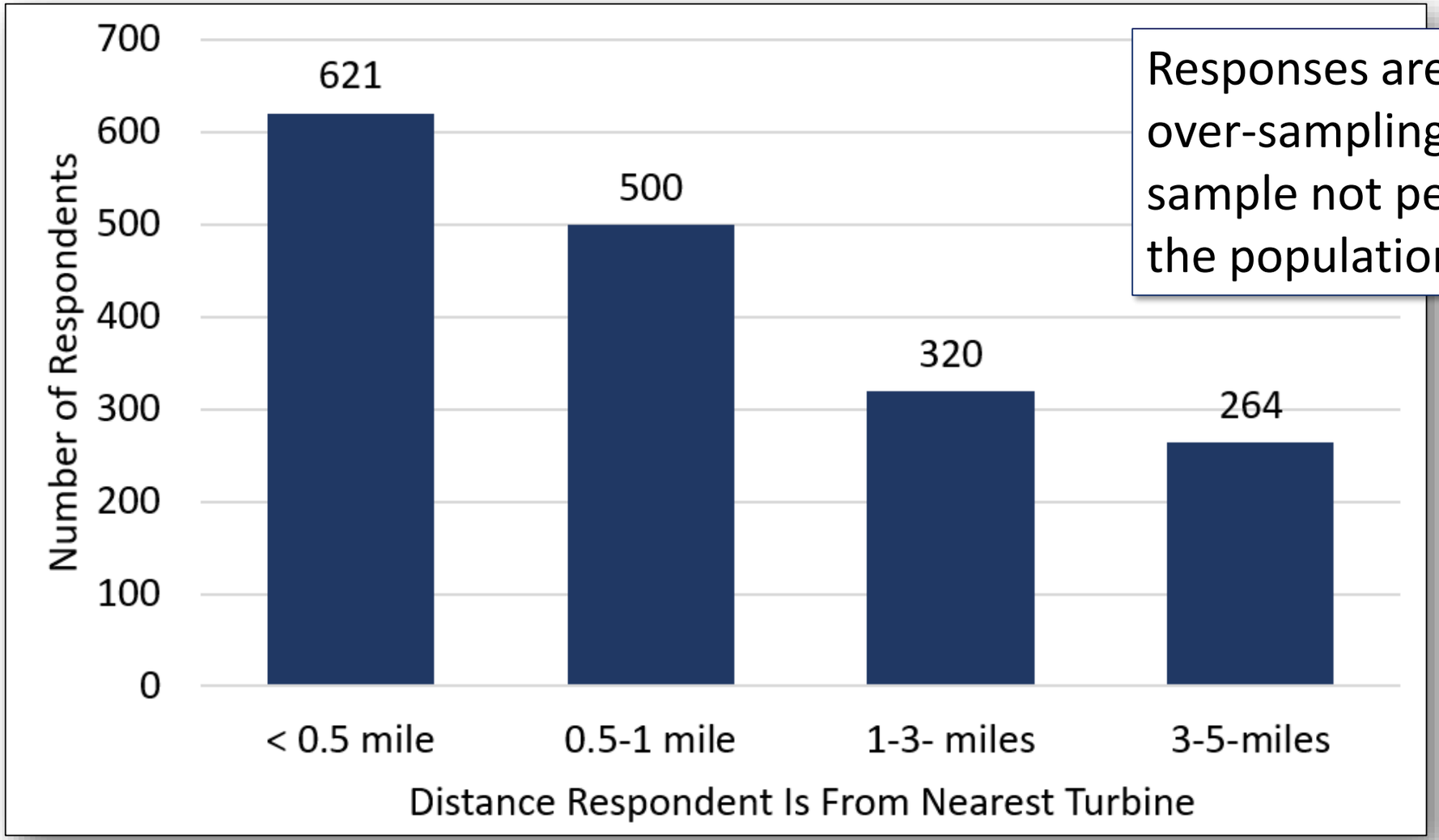
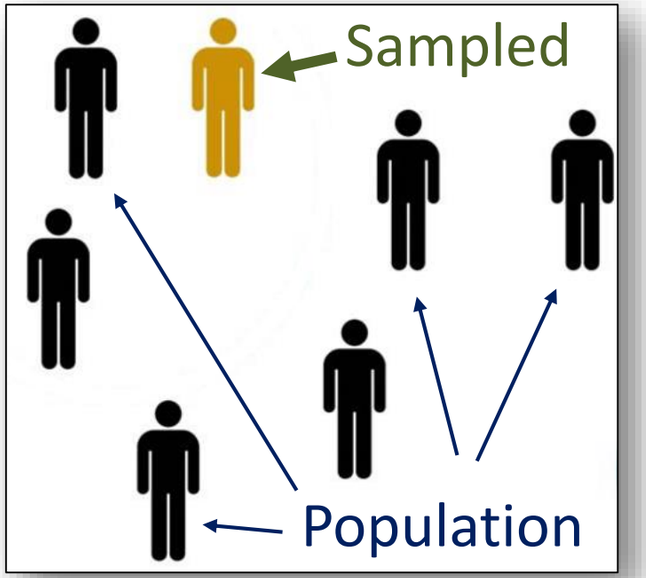
# Final Responses By Sampling Cohort (*n* = 1705)




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
- Strongly Annoyed Individuals and U.S./Europe Comparison

# Outline Of The Presentation

**Part I. National Survey Project Background**

**Part II. Survey Frame Overview**

**Part III. Overall Analysis of Attitudes Results**

**Part IV. Next Steps & Outreach**

# Overall Analysis Of Attitudes Of 1,705 Wind Power Project Neighbors

**Project Lead(s):** Hoen

**Collaborating Researchers:** Firestone, Rand, Elliott, Hübner, Pohl, Wiser, Lantz

**Purpose:** To investigate attitudes (and underlying influences) across all respondents, including those that moved in either pre- or post-construction

**Numbers of Respondents:** 1,705 (Full Dataset)

**Primary Analysis Methodology:** Chi$^2$, T-Tests, Regression

# *** Preliminary Results ***

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

  *Hoen, B., J. Firestone, J. Rand, D. Elliott, G. Hübner, J. Pohl, R. Wiser, E. Lantz (2018) Overall Analysis of Attitudes of 1,705 Wind Power Project Neighbors. Lawrence Berkeley National Laboratory. Preliminary Results Webinar. January 30, 2018.*

# Outline Of The Presentation

**Part I. National Survey Project Background**

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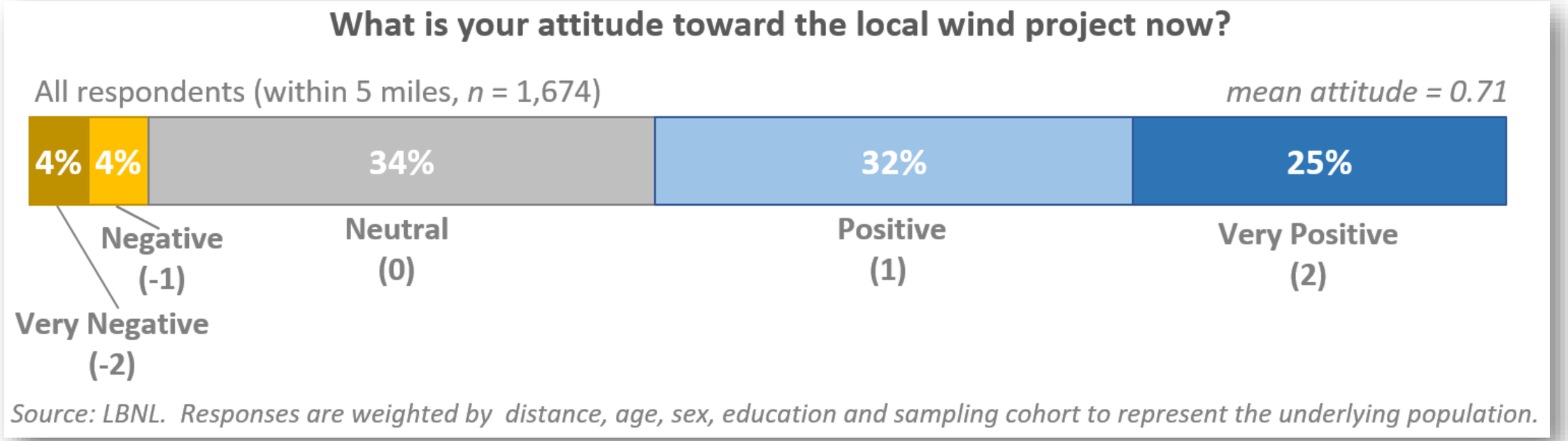
- Bi- And Tri-Variate Correlations
- Multivariate Regression

**Part IV. Next Steps & Outreach**

# A Majority Of Respondents Have Positive Attitudes
## But What Explains Differences Across Respondents?

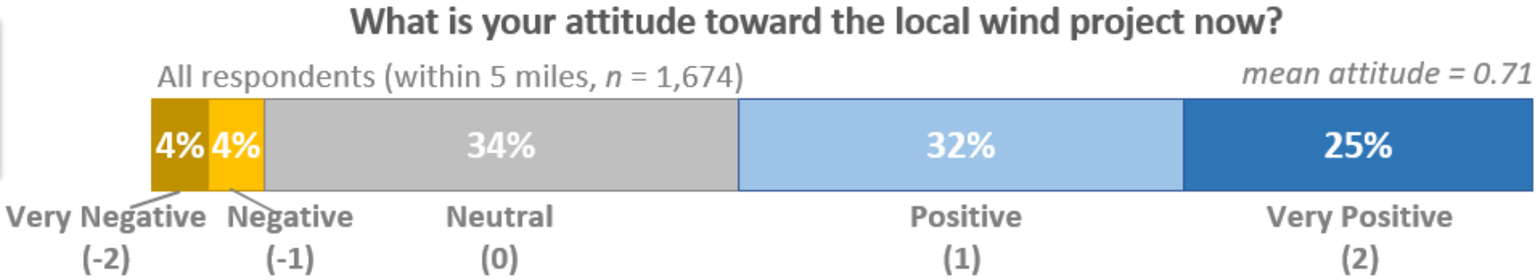


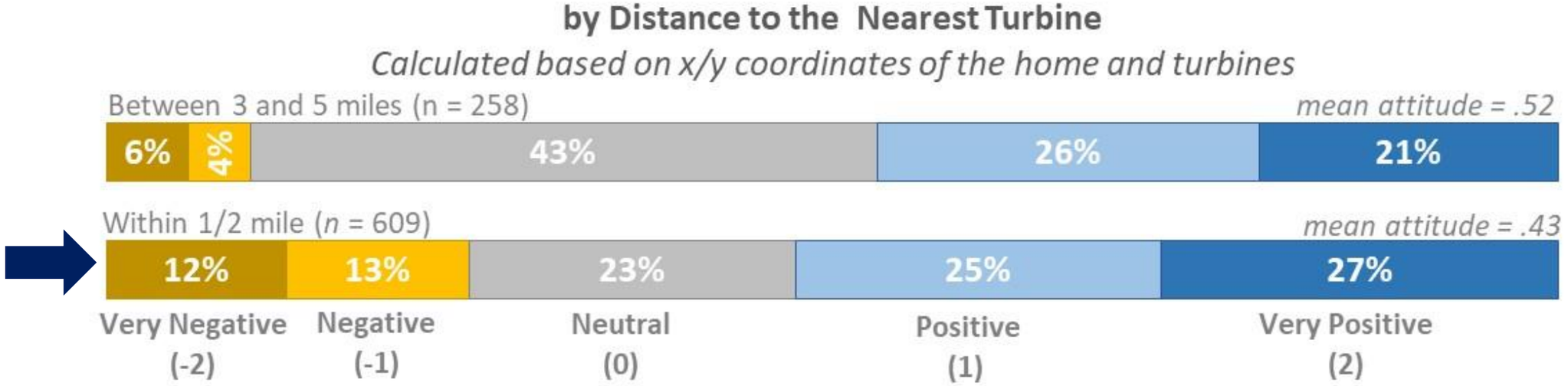

**How About?**

- Wind project characteristics
- Compensation
- Sensory perceptions
- Planning process perceptions
- Related attitudes
- Demographics

# Compared To Those Further Away, Respondents Who Live Closer Are Both More Positive And More Negative

**Wind Project Characteristics**

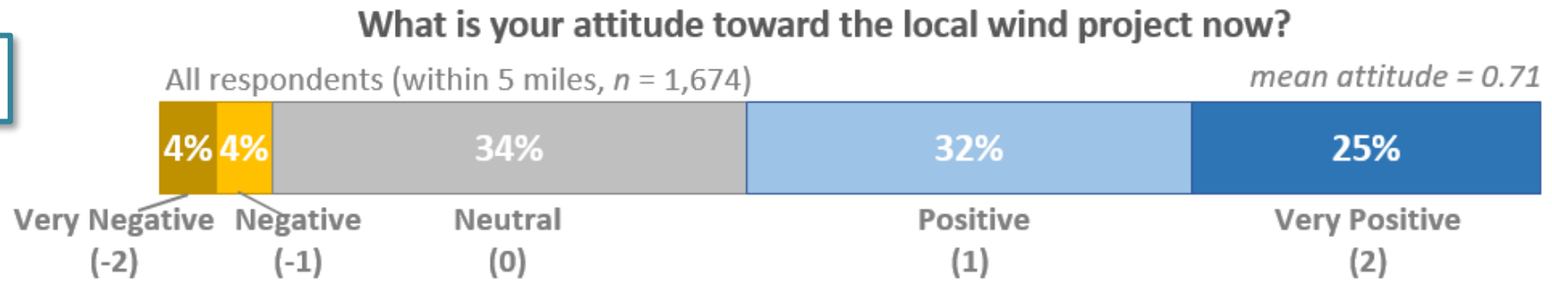


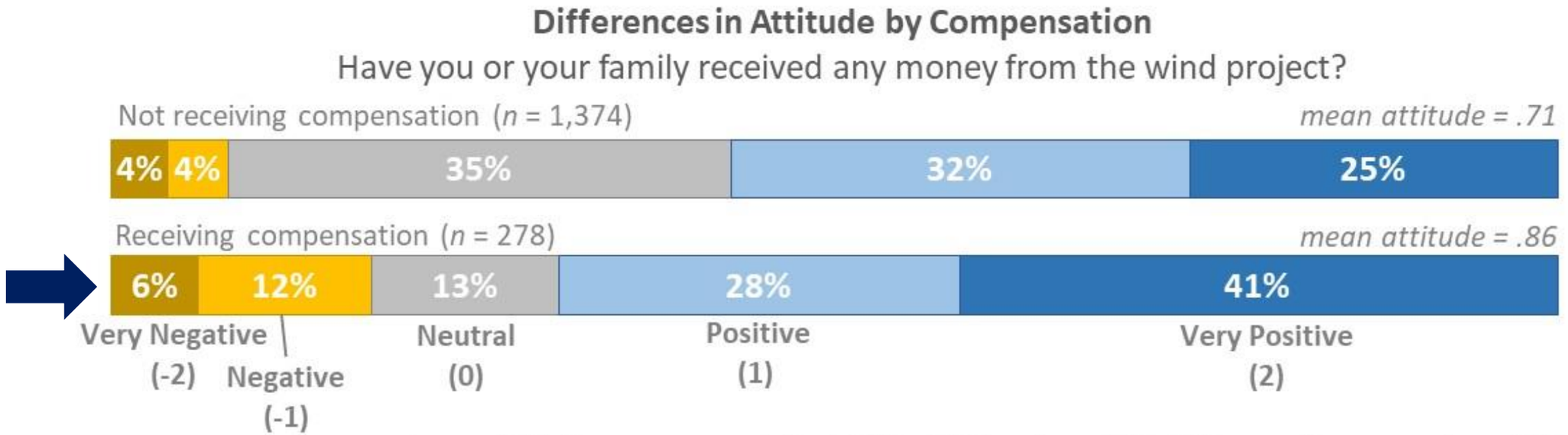




*Source: LBNL. Responses are weighted. Chi2 = 7.78 (p-value = <0.001). Difference of means p-value = .407*

# Similarly, Respondents Who Receive Compensation Are Both More Positive And More Negative

**Compensation**

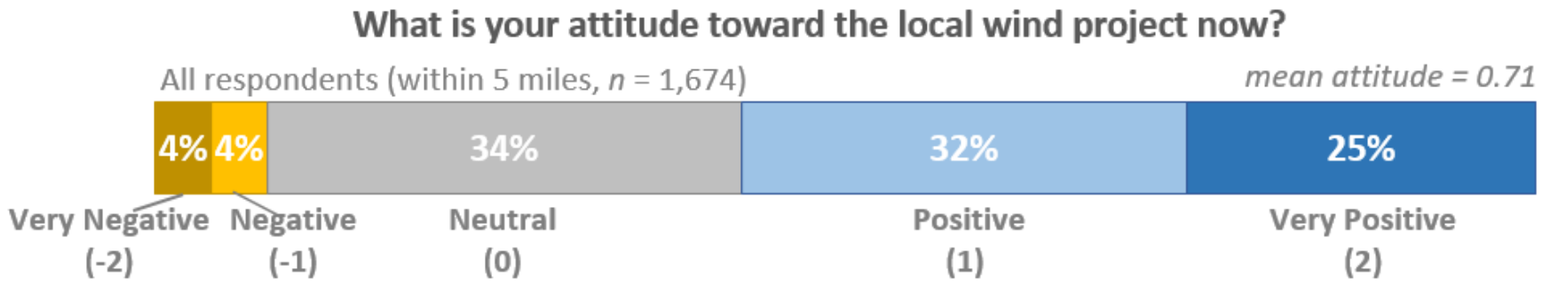


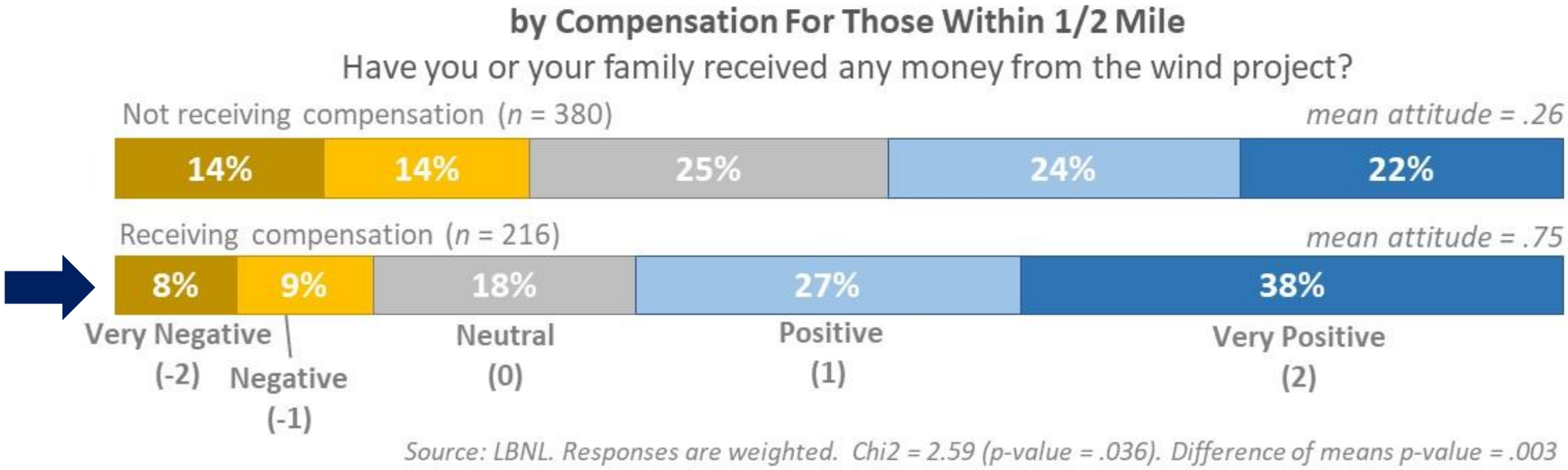




*Source: LBNL. Responses are weighted. Chi2 = 2.47 (p-value = .046). Difference of means p-value = .538*

# When Focusing On Those Living Within ½ Mile, Compensated Respondents Appear More Positive

**Wind Project Characteristics and Compensation**

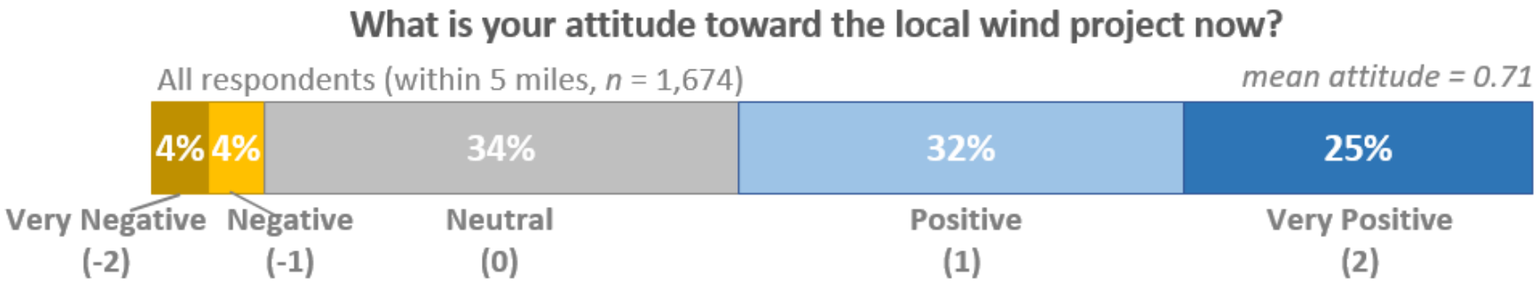


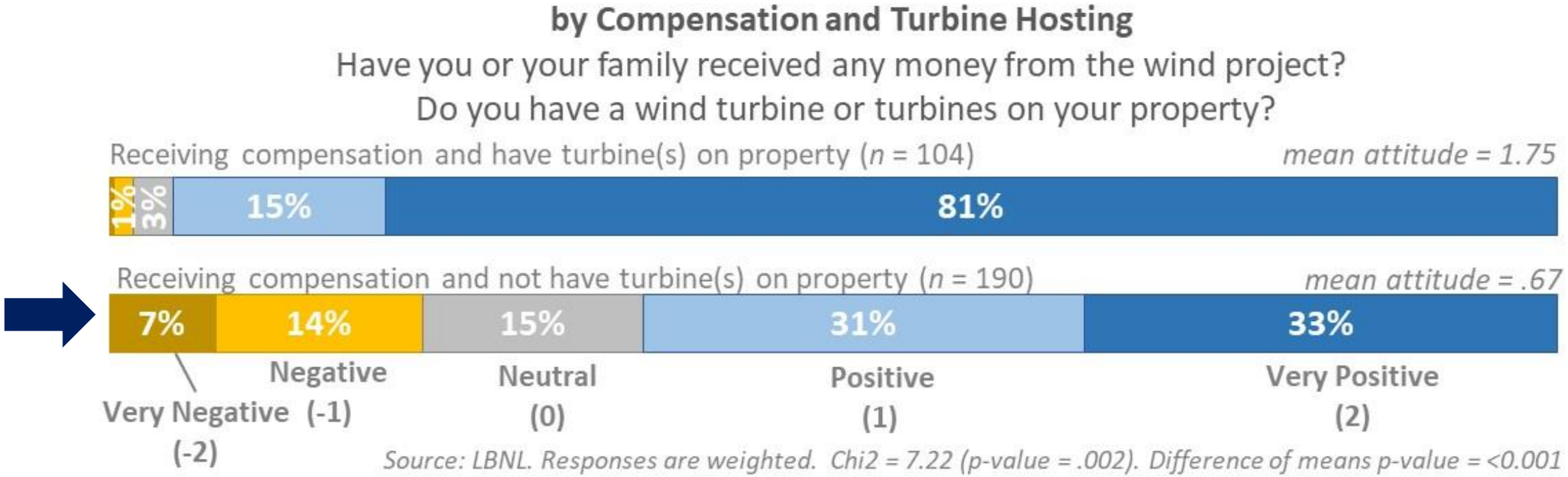




*Source: LBNL. Responses are weighted. Chi2 = 2.59 (p-value = .036). Difference of means p-value = .003*

# Of Compensated Respondents, Those That Host Turbines On Their Property Appear More Positive

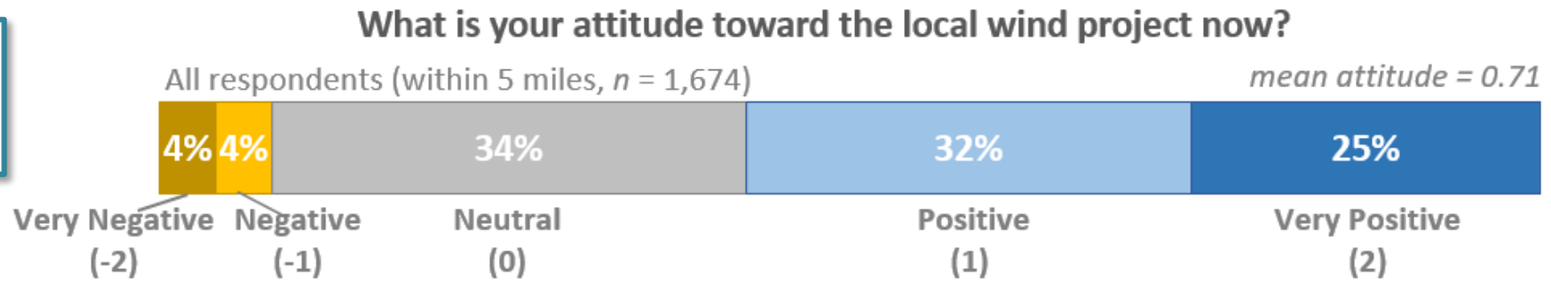
**Compensation**

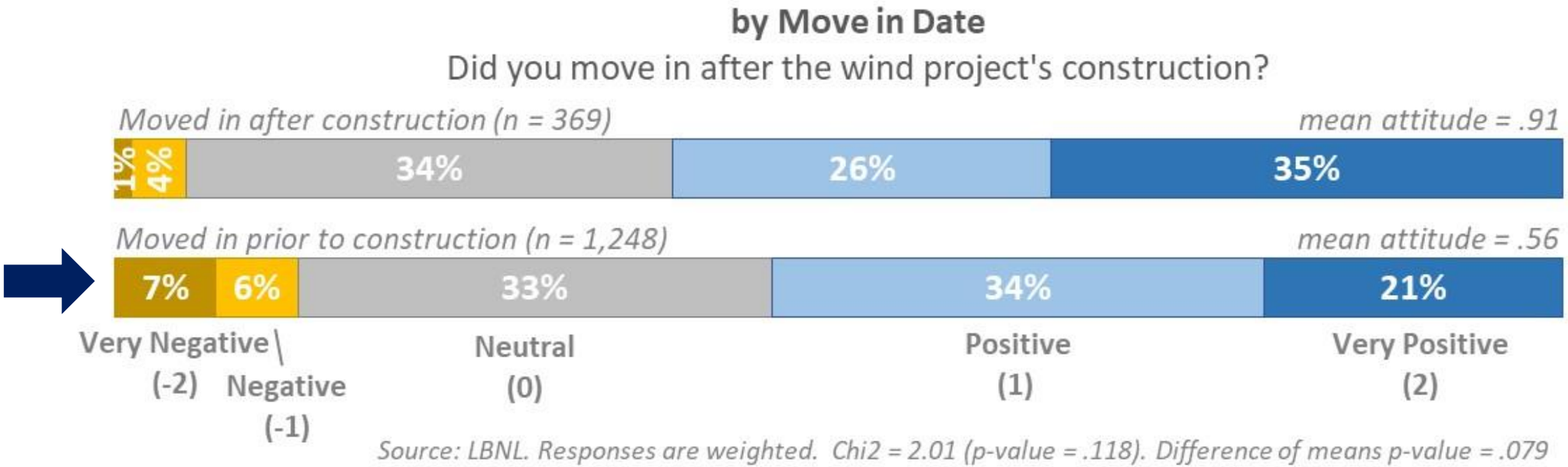


# Moving In After Construction Has Only A Weak Correlation With Attitude By Itself

**Arrival Into Area**

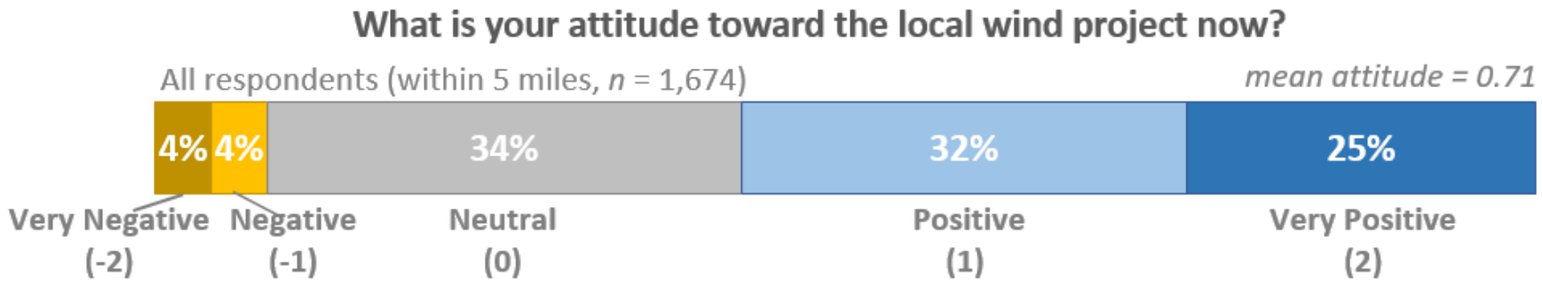


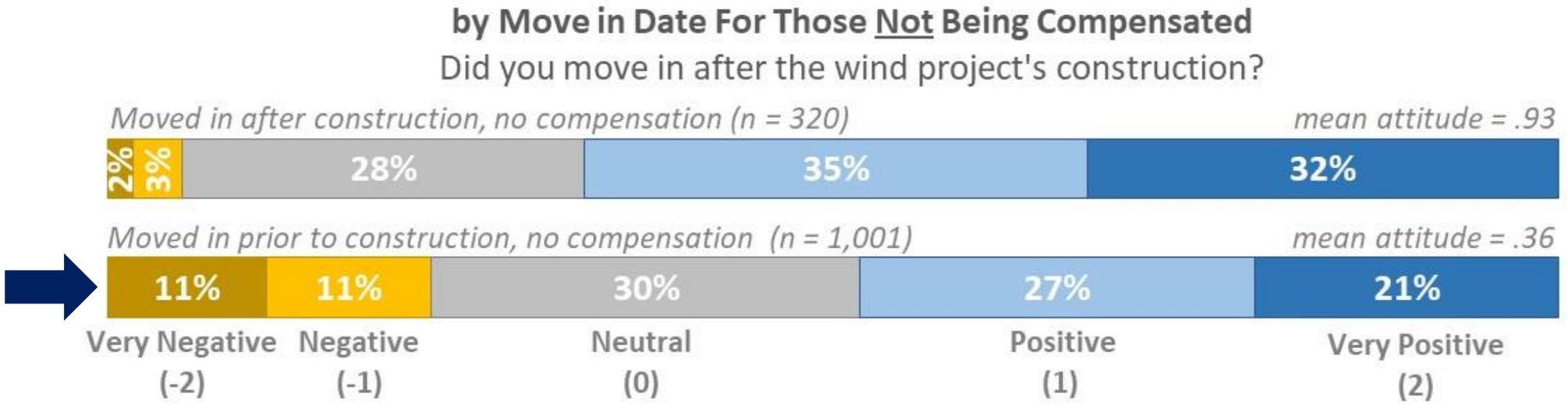




*Source: LBNL. Responses are weighted. Chi2 = 2.01 (p-value = .118). Difference of means p-value = .079*

# But When Respondent Compensation Is Controlled For, Moving Into The Area Appears To Be A Much Stronger Predictor of Attitude

**Arrival Into Area and Compensation**

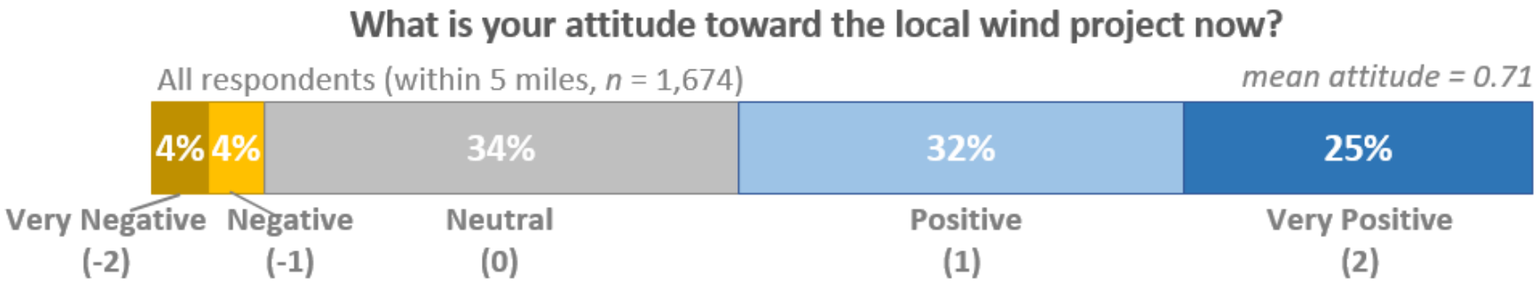


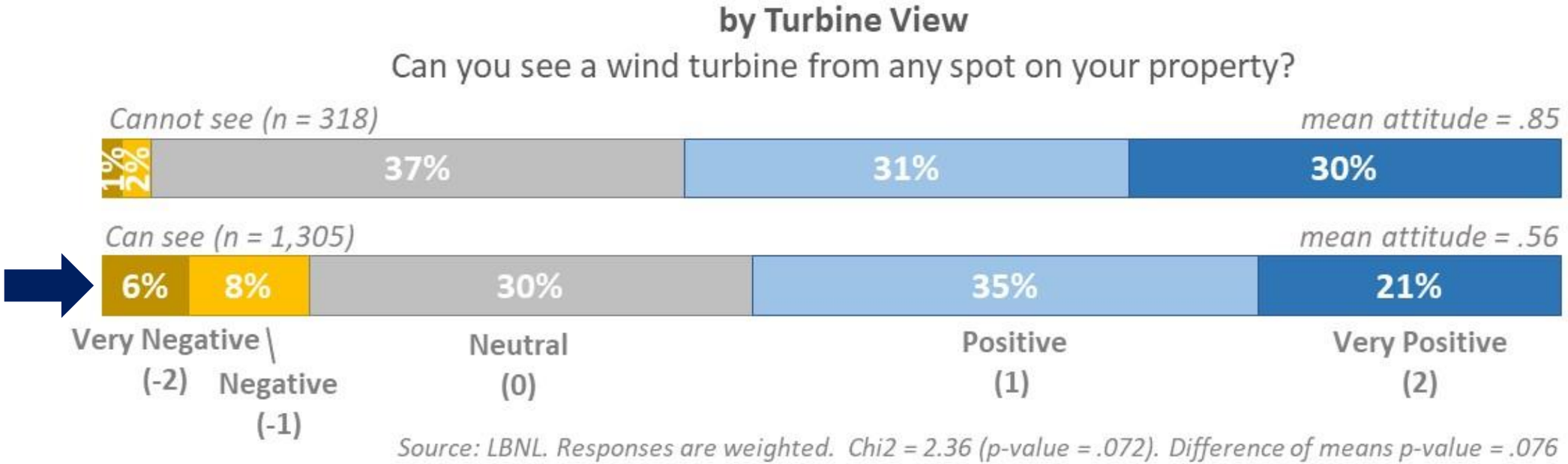




*Source: LBNL. Responses are weighted. Chi2 = 9.02 (p-value = <0.001). Difference of means p-value = <0.001*

# Whether One Can See the Turbines Does Not Appear To Lead To Strongly Different Attitudes

**Sensory Perceptions**

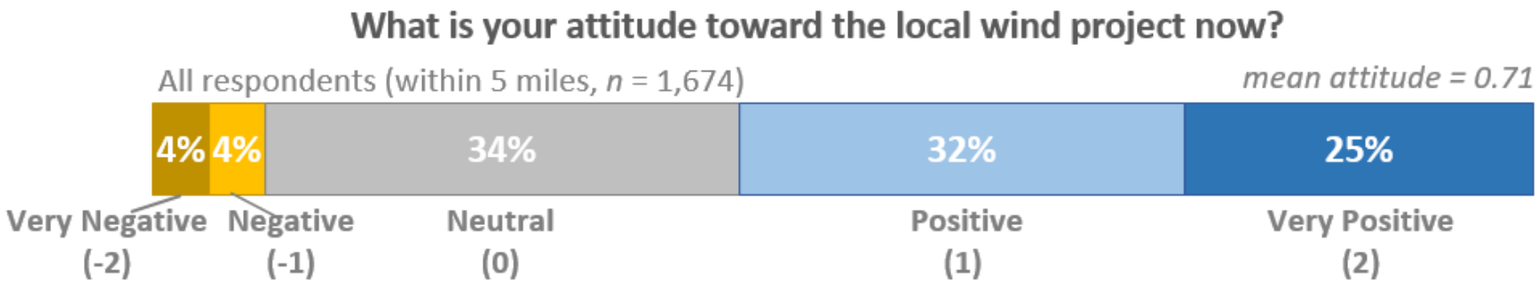


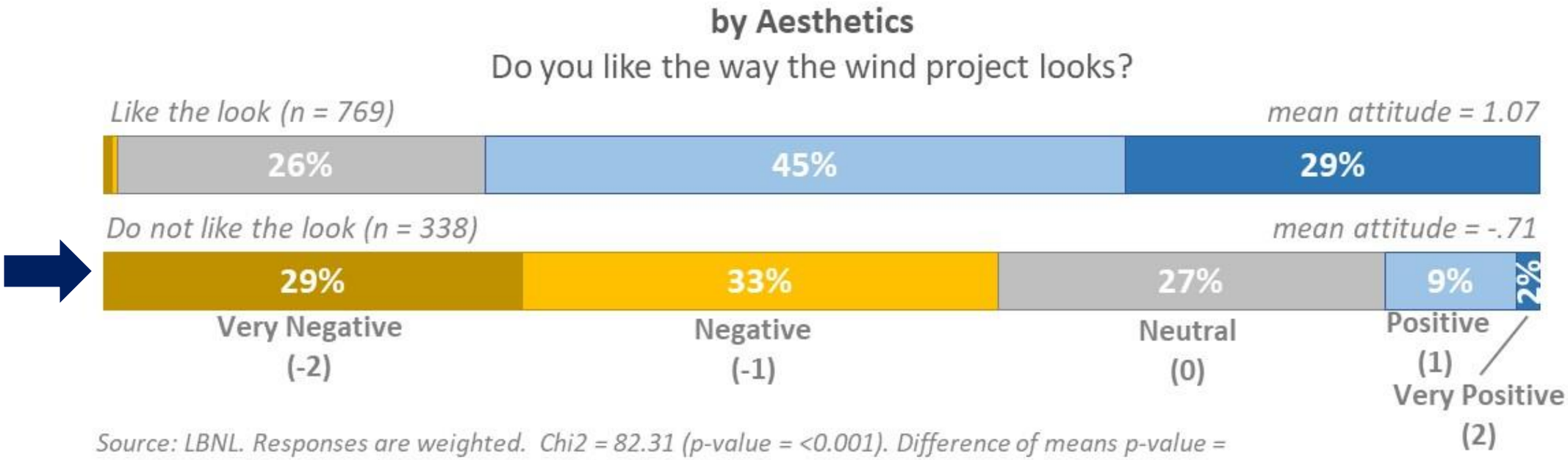




*Source: LBNL. Responses are weighted. Chi2 = 2.36 (p-value = .072). Difference of means p-value = .076*

# But Liking The Way The Turbines Look (Or Not) Appears To Be Strongly Correlated With Attitude

**Sensory Perceptions**

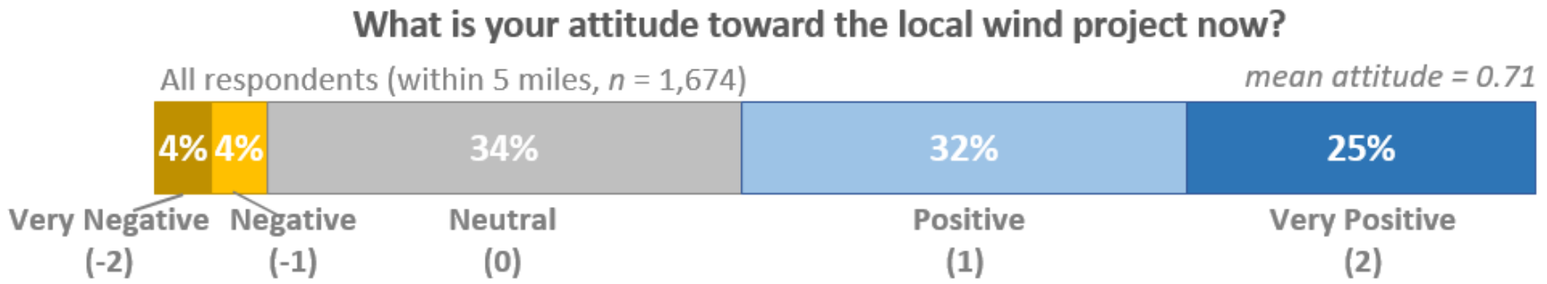


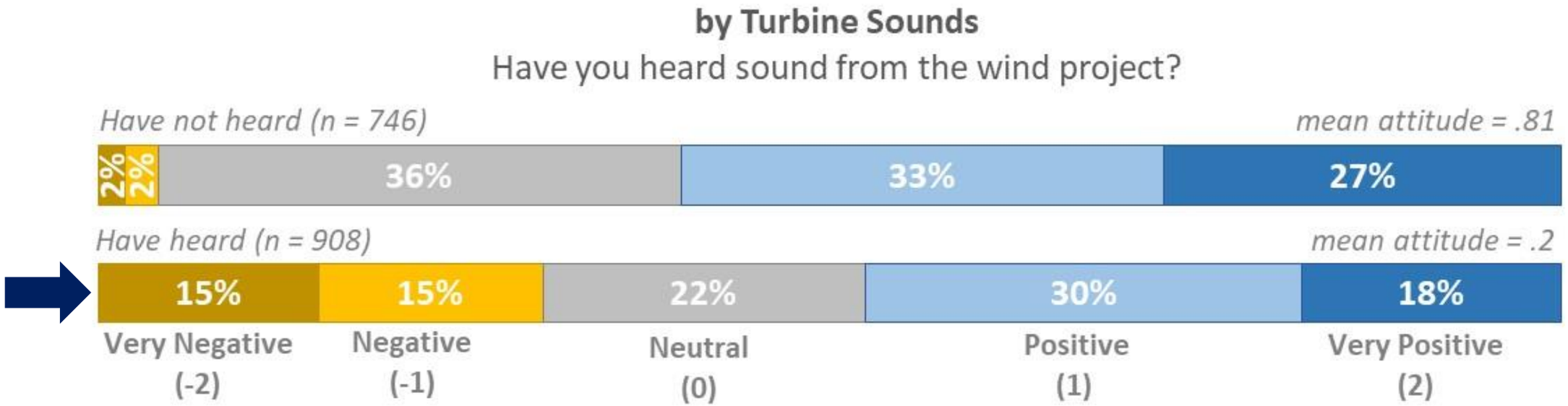




*Source: LBNL. Responses are weighted. Chi2 = 82.31 (p-value = <0.001). Difference of means p-value =*

# Hearing The Turbines Leads To Both More Negative Attitudes, But Hearing Is Correlated With Distance

**Sensory Perceptions**

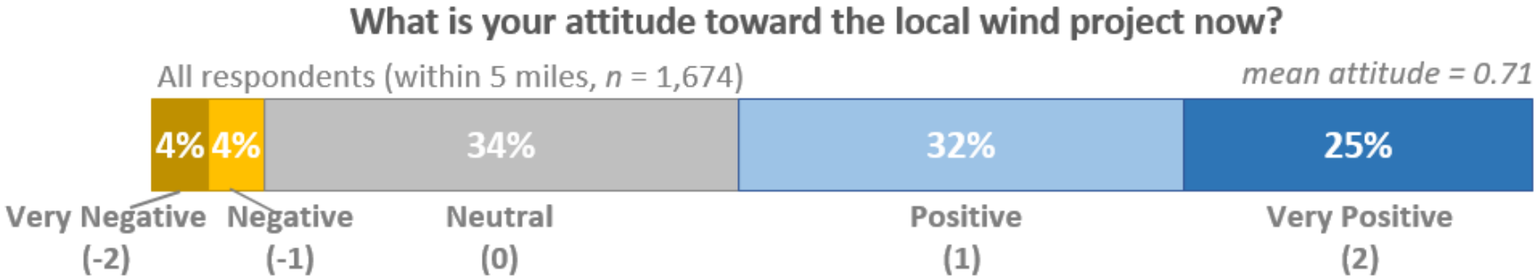


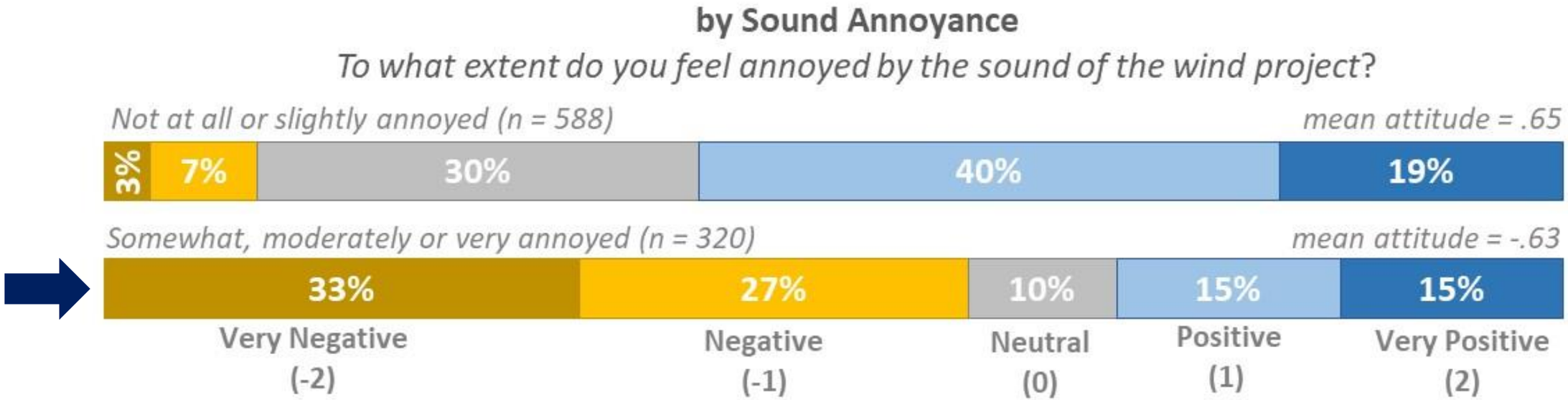




*Source: LBNL. Responses are weighted. Chi2 = 10.55 (p-value = <0.001). Difference of means p-value = .004*

# But Being Annoyed By Those Sounds Has A Much Stronger Affect On Attitudes

**Sensory Perceptions**

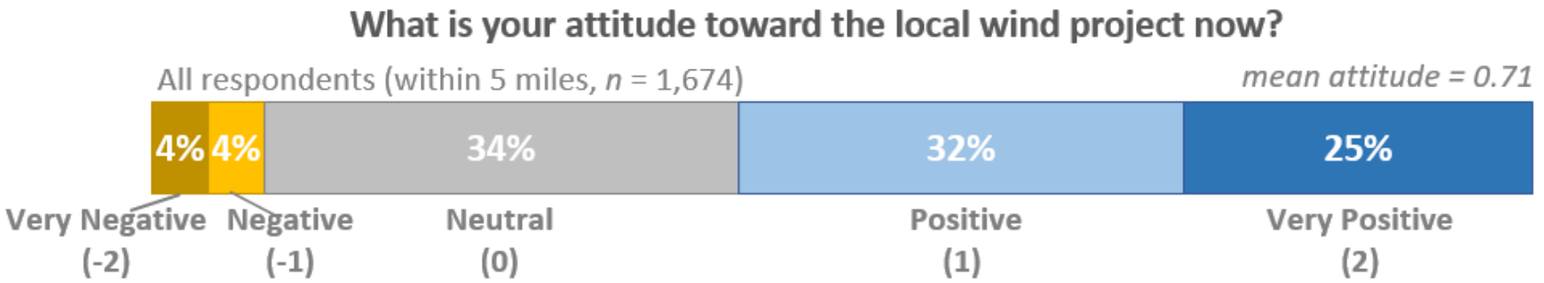


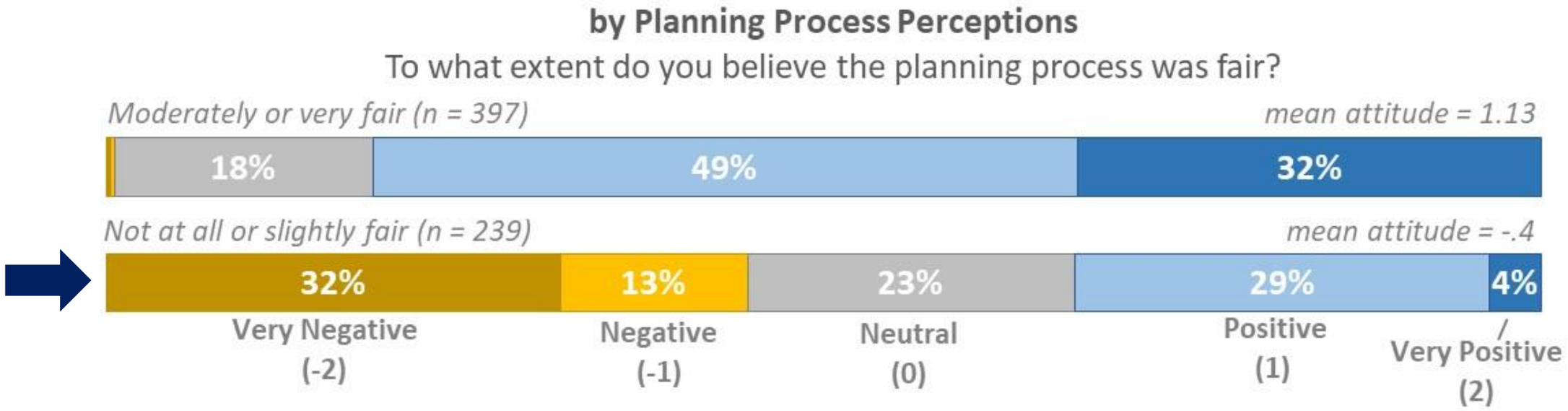




*Source: LBNL. Responses are weighted. Chi2 = 6.93 (p-value = <0.001). Difference of means p-value = .007*

# Respondent Perceptions Of Planning Process Fairness Appears Strongly Tied To Attitudes

**Planning Process Perceptions**

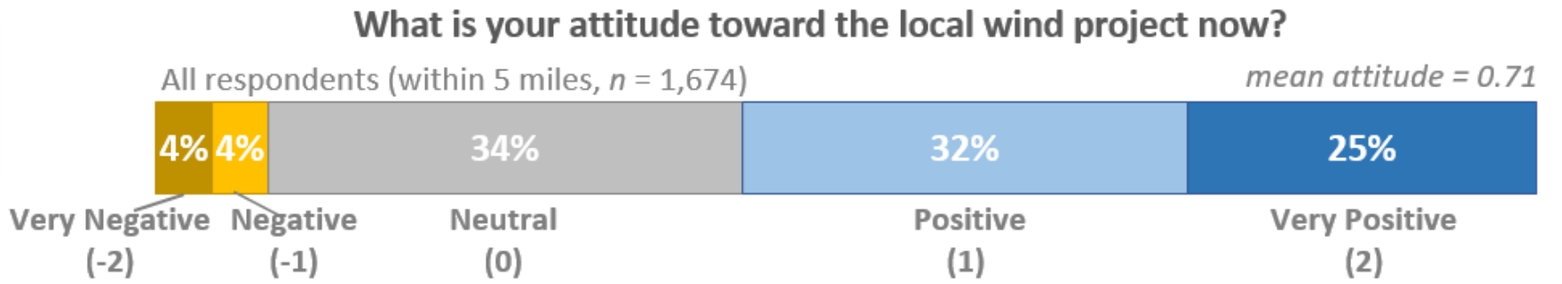


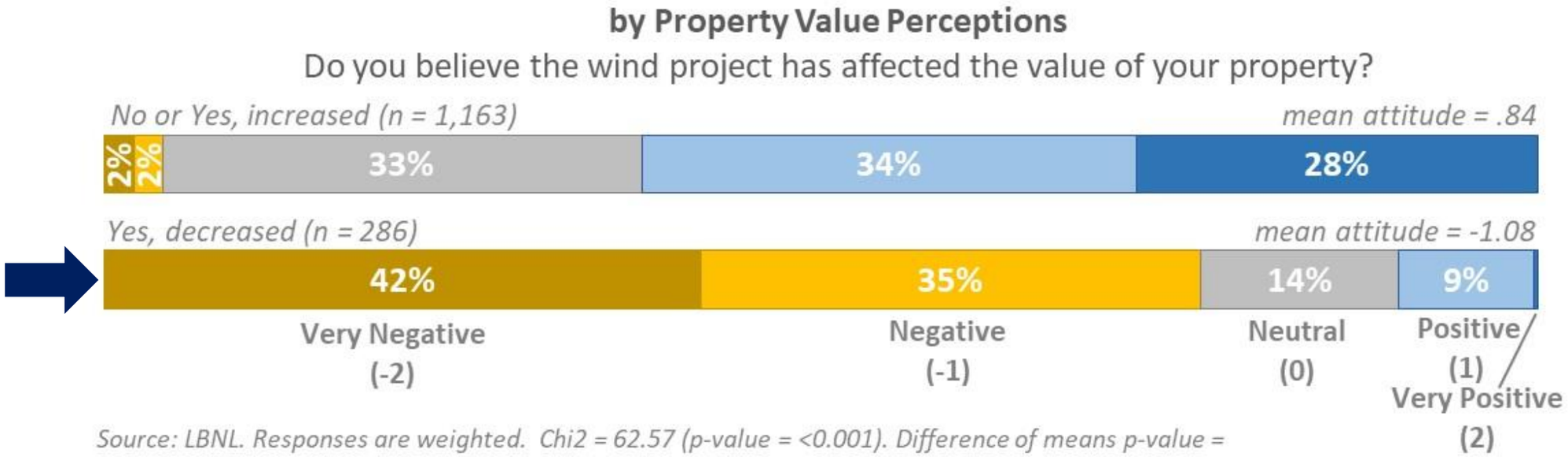




*Source: LBNL. Responses are weighted. Chi2 = 14.42 (p-value = <0.001). Difference of means p-value =*

# Similarly, Property Value Impact Perceptions Appear To Be Strongly Tied To Attitudes

**Related Attitudes**



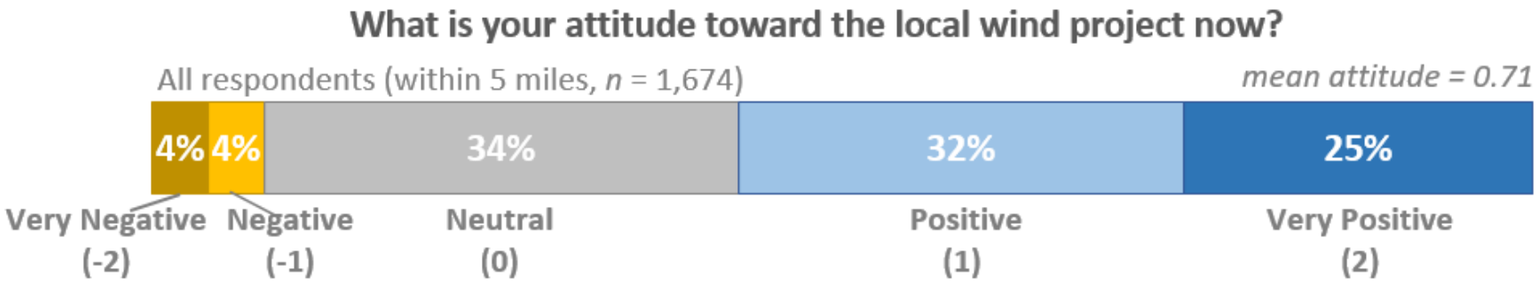



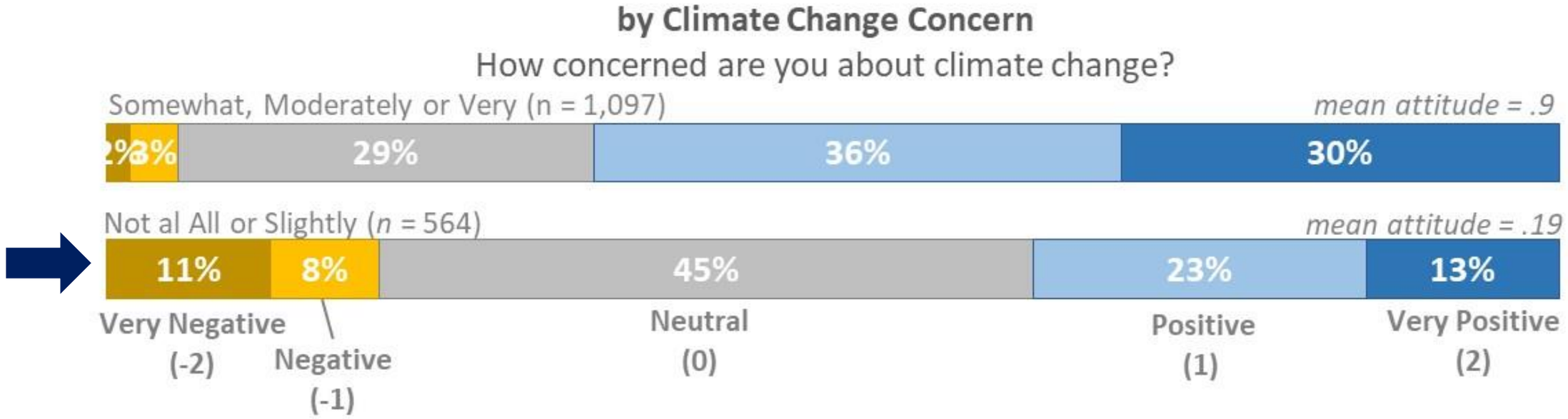

*Source: LBNL. Responses are weighted. Chi2 = 62.57 (p-value = <0.001). Difference of means p-value =*

See a supplemental slide for additional detail on perceived property value impacts

# Respondents Who Are Not At All Or Slightly Concerned With Climate Change Are Less Positive

**Related Attitudes**

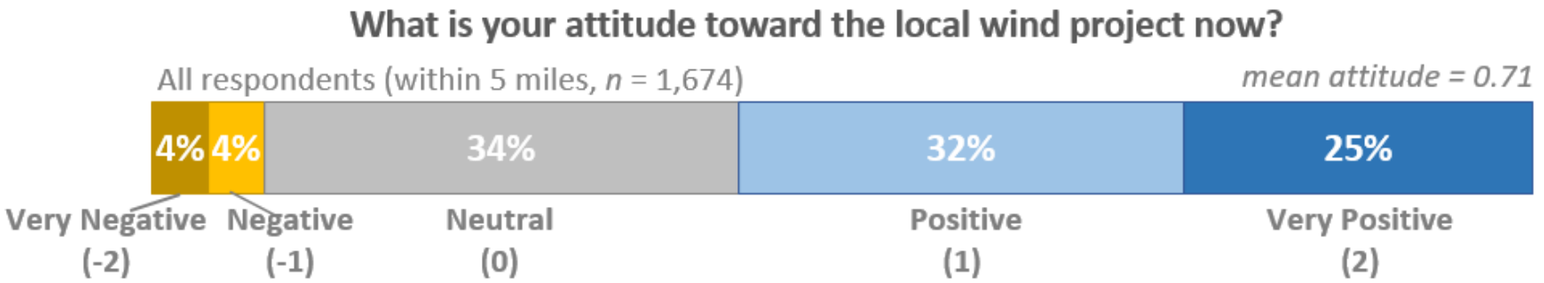


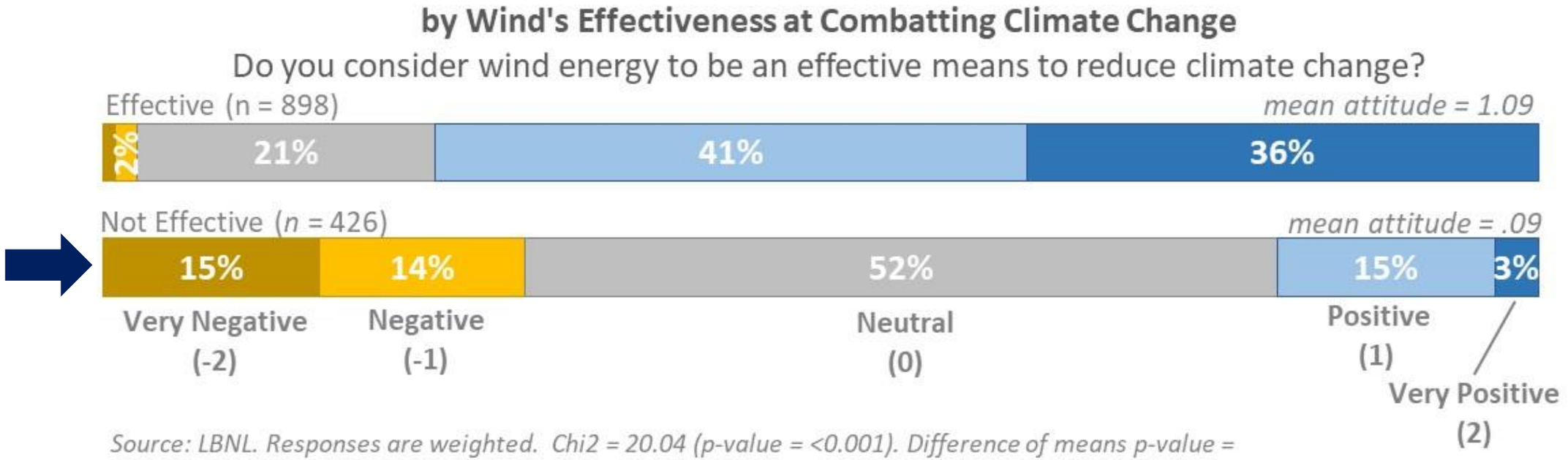




*Source: LBNL. Responses are weighted. Chi2 = 6.9 (p-value = <0.001). Difference of means p-value = <0.001*

# Perceptions About Wind Energy's Effectiveness At Combatting Climate Change Is Strongly Tied To Attitude

**Related Attitudes**

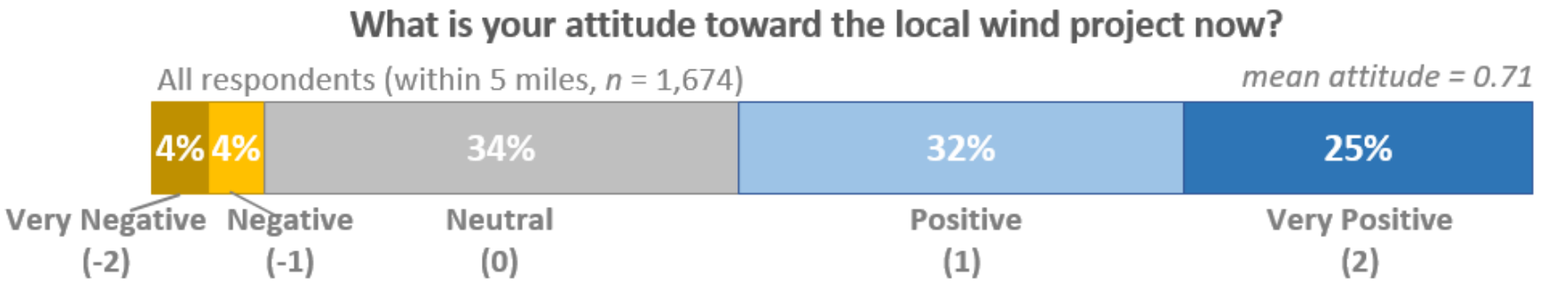


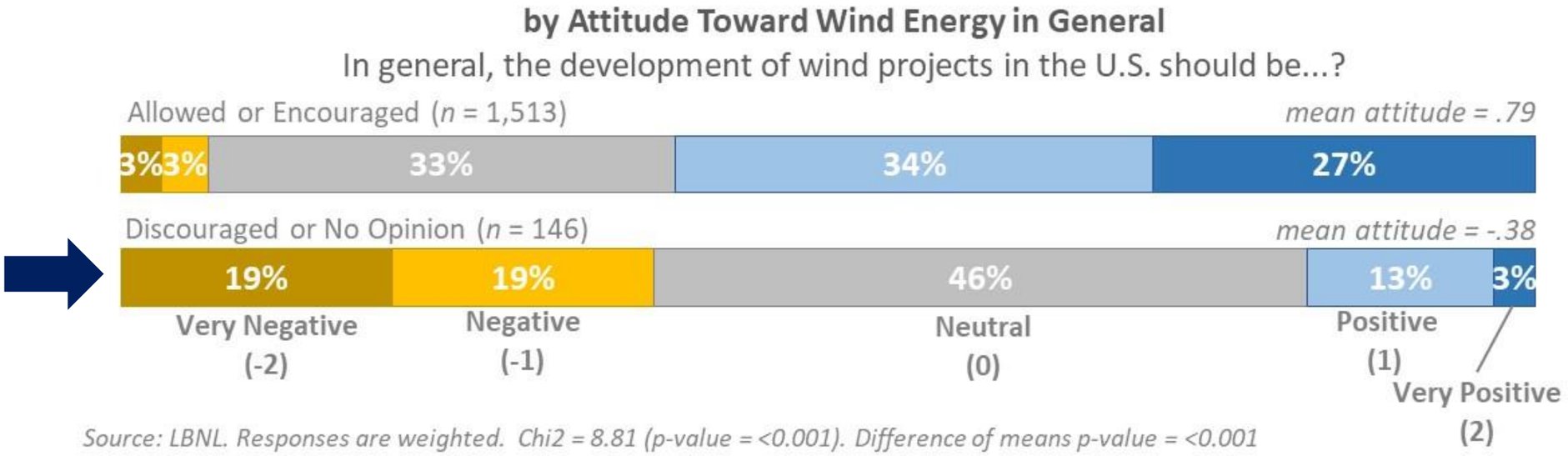




*Source: LBNL. Responses are weighted. Chi2 = 20.04 (p-value = <0.001). Difference of means p-value =*

# Attitudes Toward Wind Energy Development In General Are Strongly Tied To Attitudes About The Local Project

**Related Attitudes**



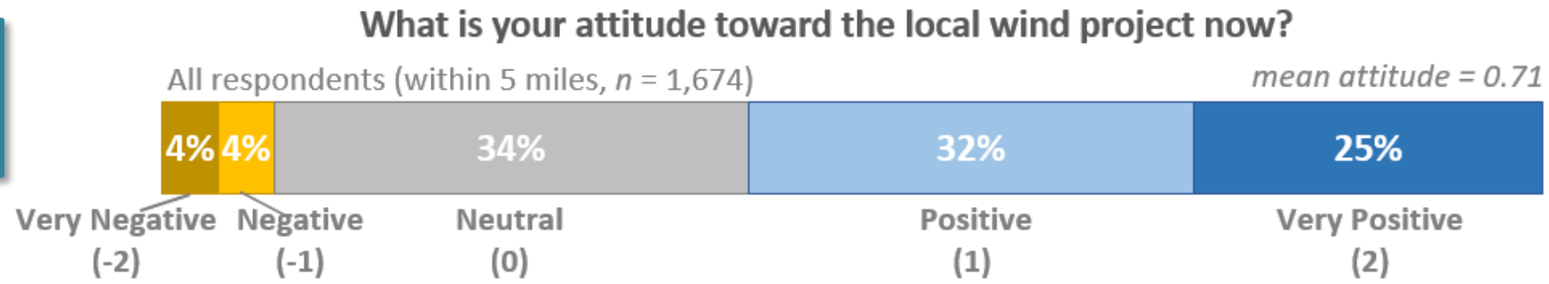



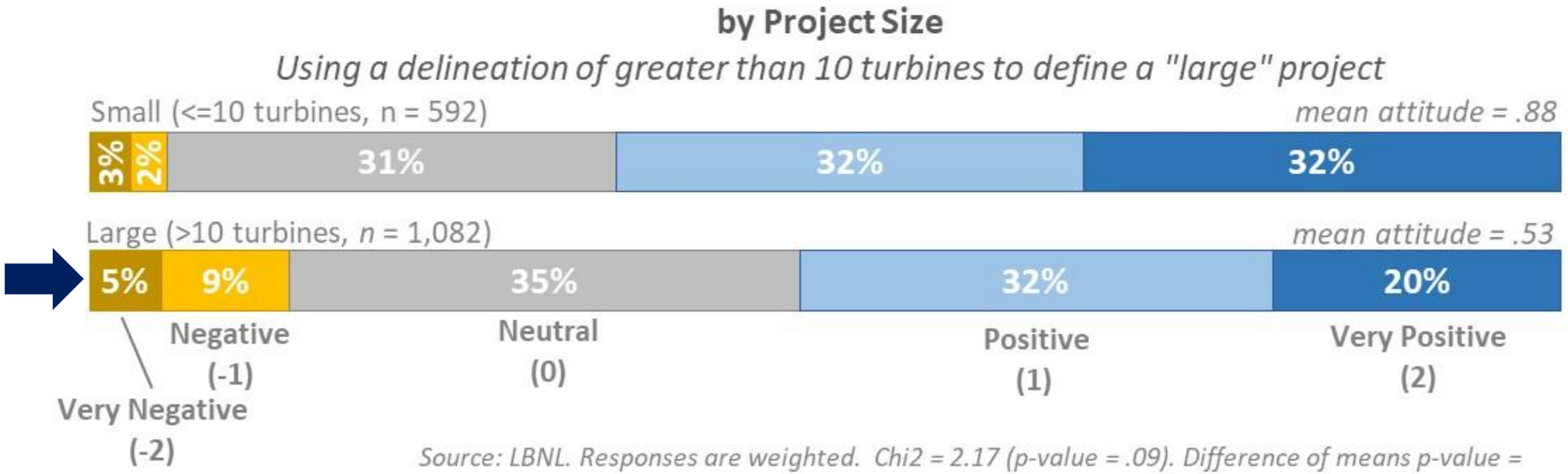

*Source: LBNL. Responses are weighted. Chi2 = 8.81 (p-value = <0.001). Difference of means p-value = <0.001*

Therefore there is a lack of evidence to support the not-in-my-back-yard (NIMBY) effect within this dataset.

# Respondents Appear Slightly More Positive Near Smaller Projects In This Bivariate Analysis

**Wind Project Characteristics**



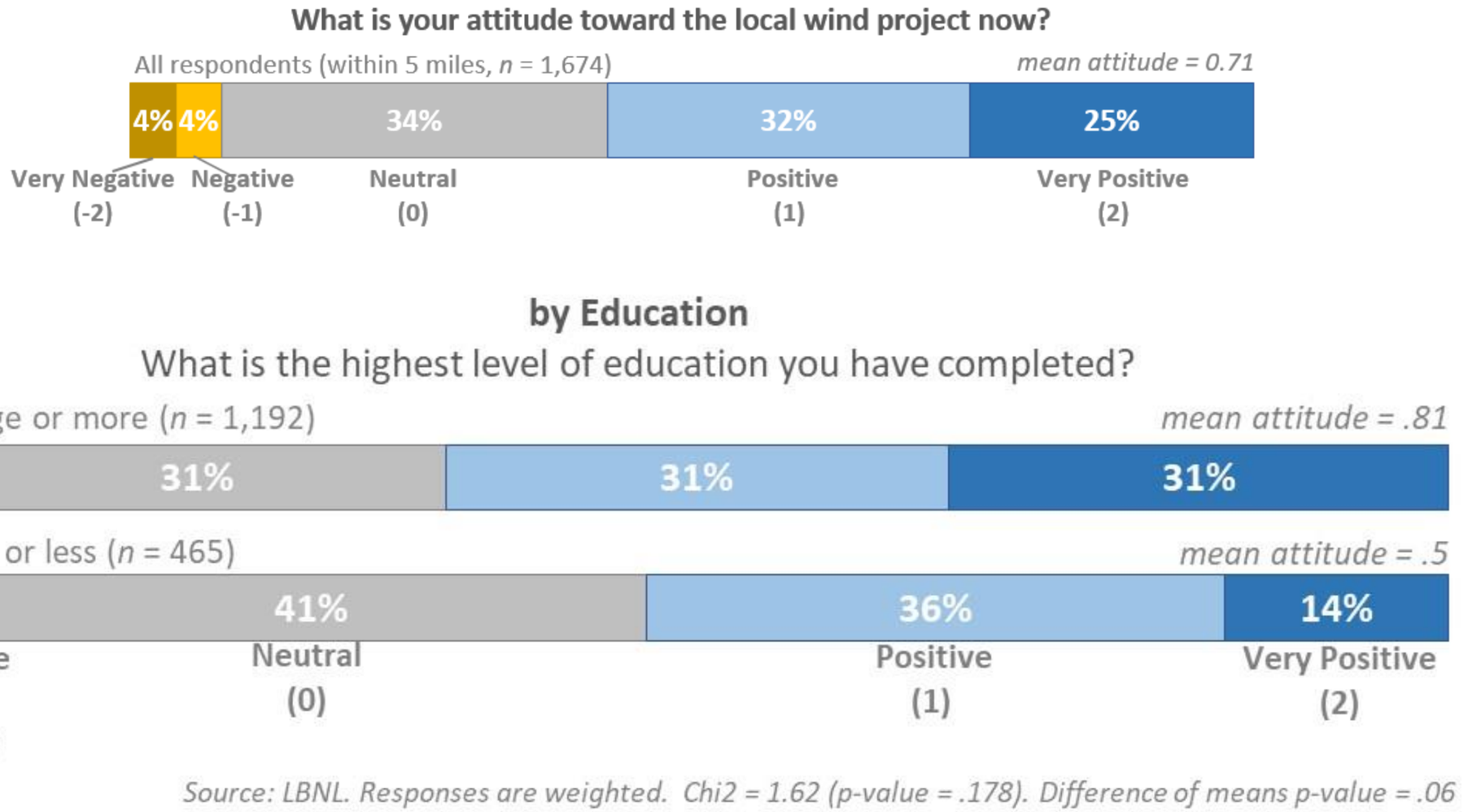

Other Wind Project Characteristics Investigated:

- Year of installation
- Total turbine height

*Source: LBNL. Responses are weighted. Chi2 = 2.17 (p-value = .09). Difference of means p-value =*

# The Respondent's Level Of Education Does Not Appear To Be A Predictor Of Positive Or Negative Attitudes

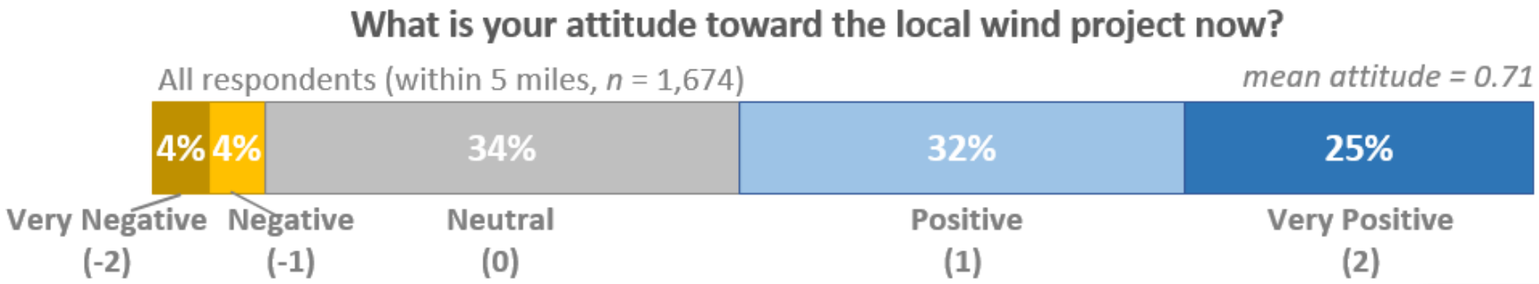
**Demographics**

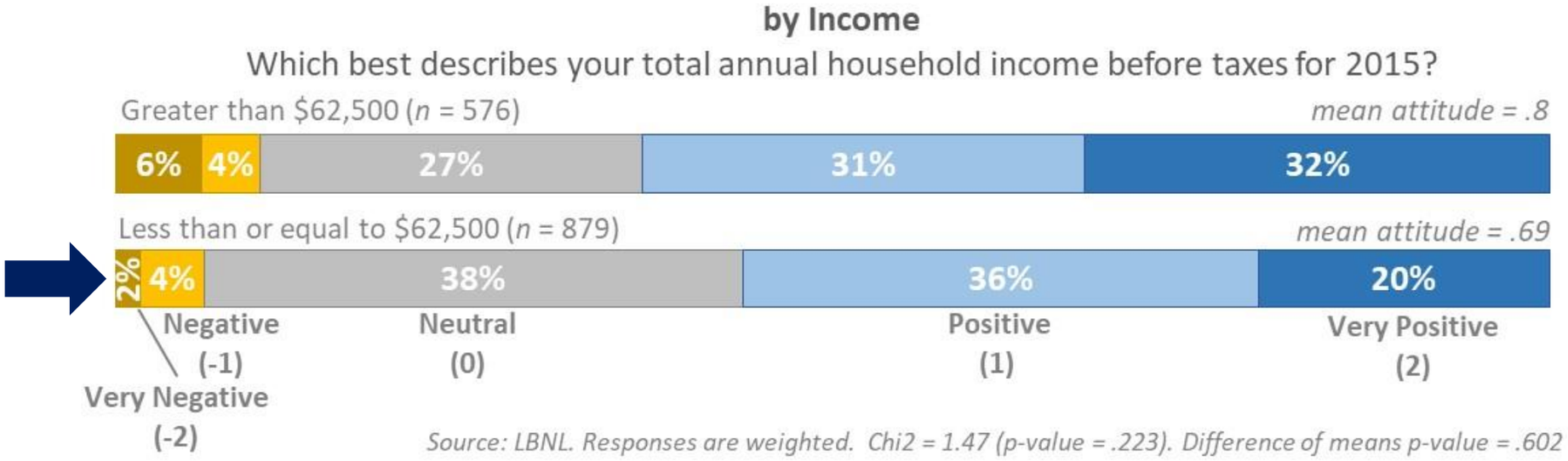



*Source: LBNL. Responses are weighted. Chi2 = 1.62 (p-value = .178). Difference of means p-value = .06*

# The Respondent's Income Level Does Not Appear To Be A Predictor Of Positive Or Negative Attitudes

**Demographics**




*Source: LBNL. Responses are weighted. Chi2 = 1.47 (p-value = .223). Difference of means p-value = .602*

Other Demographic Characteristics Also Not Found To Be Correlated with Attitude:

- Primary/secondary residence
- Gender
- Race
- Age

# Outline Of The Presentation

**Part I. National Survey Project Background**

**Part II. Survey Frame Overview**

**Part III. Overall Analysis of Attitudes Results**

- Bi- And Tri-Variate Correlations
- Multivariate Regression

**Part IV. Next Steps & Outreach**

# Results Are Strong, With Reasonably High Independence Among Independent Variables

**Multivariate Regression Analysis**

**Dependent Variable:** attitudes toward local project

**Independent Variables:**

1. planning process and arrival into area
2. related attitudes
3. sensory perceptions
4. project characteristics, compensation
5. demographics

***Basic Stats***

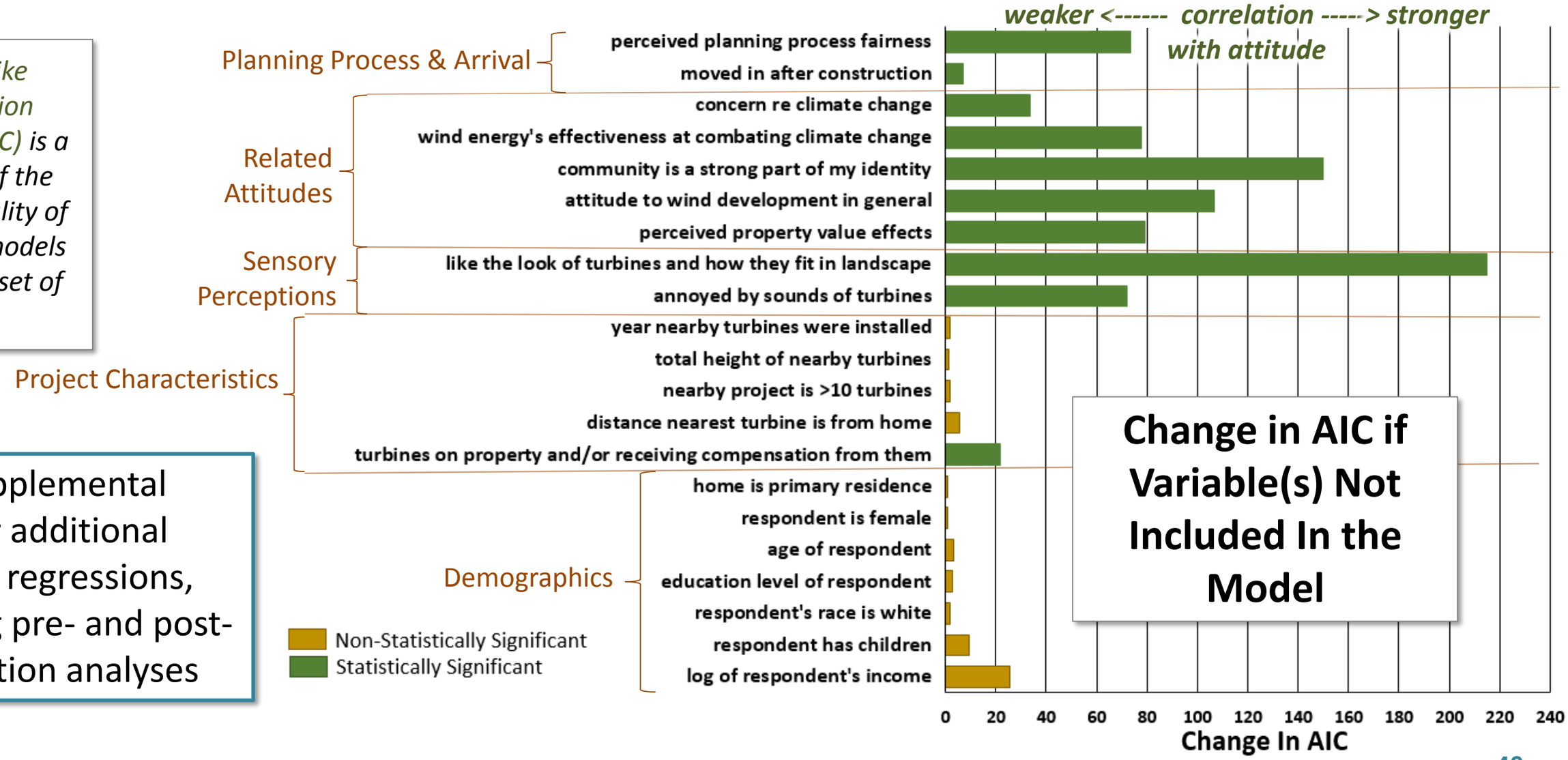
*Overall R-Squared: 0.67*

*Variance Inflation Factor (VIF): mean 1.65; sd 0.49; max 3.03*

*Note: This presentation shows linear regression results, but ordered logit results with and without multiple imputation are similar*

# Certain Variables Explain Attitudes Much Better than Others

*The Akaike information criterion (AIC) is a measure of the relative quality of statistical models for a given set of data*




See a supplemental slides for additional detail on regressions, including pre- and post-construction analyses

# Preliminary Conclusions:
## Overall Analysis Of Attitudes Of 1705 Wind Power Project Neighbors

- A majority of respondents are positive, including individuals within ½ mile and those who are not compensated, but with a notable minority who hold concerns
- Perceptions of planning process fairness are strong predictors of attitude
- Being able to see and hear the turbines does not strongly drive attitudes, but annoyance to the sounds, and how well the turbines are perceived to fit in the landscape, does
- Compensation can positively influence attitudes. Differences exist between those that host and do not host a turbine on their property. Community compensation is preferred by uncompensated respondents *(see supplemental slides).*
- There is a strong relationship between attitudes of wind energy in general and attitudes locally
- Wind's perceived effectiveness in combatting climate change affects attitudes
- The stronger one's attachment to the community, the more positive one's attitude is found to be
- Neither respondent demographics nor local wind project characteristics are correlated with attitudes
- Individuals arriving after construction are significantly more positive than those there before, and their attitudes are more strongly impacted by community attachment, sound annoyance, and if the home is the primary residence *(see supplemental slides)*
- There is a lack of evidence of a not-in-my-back-yard (NIMBY) effect
- A large majority of respondents, even those within ½ mile and not being compensated, believe that their property values have not been adversely impacted, but a minority do *(see supplemental slides).*
- Living near a wind project is preferred over other large scale energy plants, except solar *(see supplemental slides).*

# Preliminary Researcher Takeaways

- Stakeholders seeking to improve attitudes might pay special attention to planning process fairness, perceived aesthetics and sound annoyances, and how wind plays a role in combating climate change
- Compensation might be used to improve attitudes, but it might also adversely affect them, especially for those who are not hosting turbines; community compensation might also be explored
- A majority of residents, even those within close proximity to U.S. turbines, have positive attitudes, and it appears that over time, as people move in and out of the community, that might improve.

# Outline Of The Presentation

**Part I. National Survey Project Background**

**Part II. Survey Frame Overview**

**Part III. Overall Analysis of Attitudes Results**

**Part IV. Next Steps & Outreach**

# Upcoming Outreach & Next Steps

## Upcoming Outreach

- Webinar Series:
  - **February 13, 2018:** Wind Power Project Planning Process Fairness and Attitudes
  - **February 27, 2018:** Predicting Audibility Of and Annoyance To Wind Power Project Sounds Using Modeled Sound
  - **March 13, 2018:** Comparing Strongly Annoyed Individuals with Symptoms near U.S. Turbines to Those in Surveyed European Communities
- AWEA Siting Compliance Conference, Memphis (March 2018)

*source: hingemarketing.com*

## Next Steps

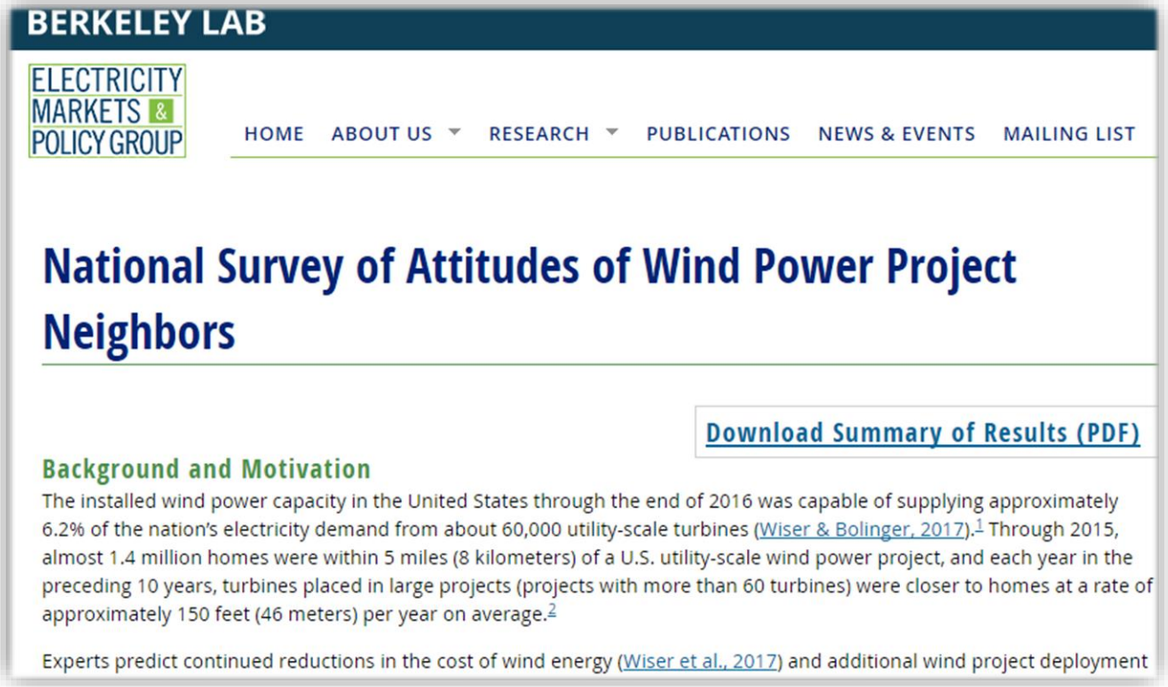
- Submit additional journal papers (spring/summer 2018)
- Release the analysis data (fall 2018)

# Questions?

Ben Hoen: bhoen@lbl.gov

Joe Rand: jrand@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:

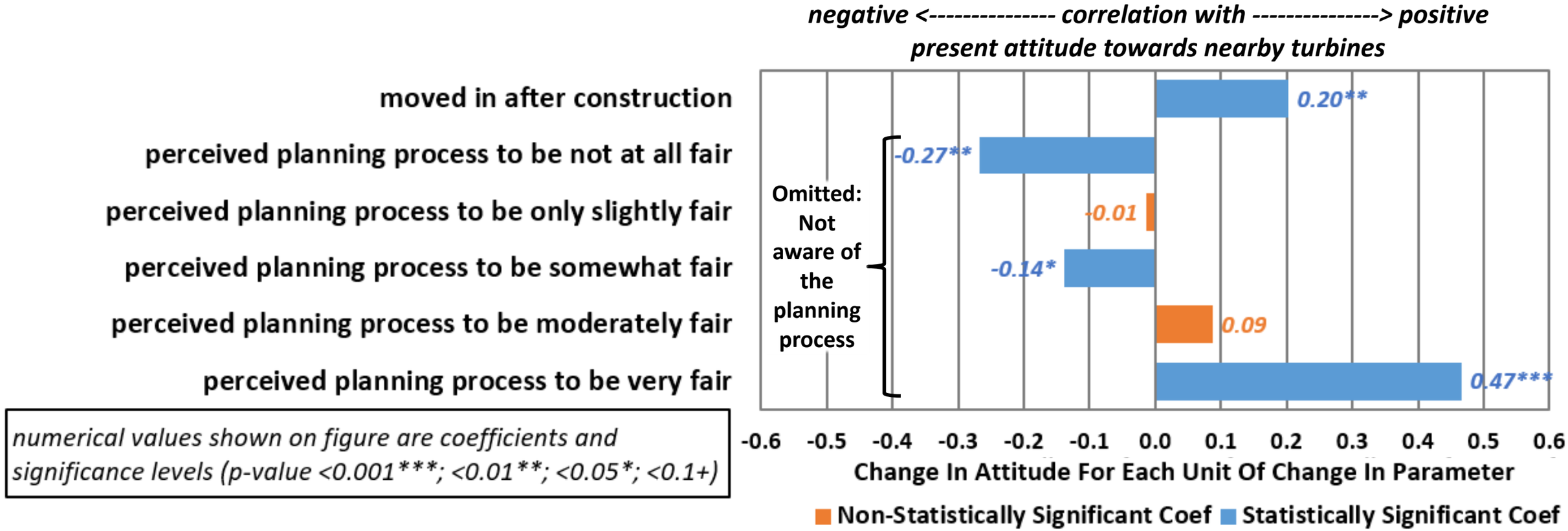
*Hoen, B., J. Firestone, J. Rand, D. Elliott, G. Hübner, J. Pohl, R. Wiser, E. Lantz (2018) Overall Analysis of Attitudes of 1,705 Wind Power Project Neighbors. Lawrence Berkeley National Laboratory. Preliminary Results Webinar. January 30, 2018.*

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

# Supplemental Slides

# **Planning Process and Arrival:** Perceptions About the Planning Process Are Strongly Correlated with Attitudes, as Is When Respondents Moved Into the Area

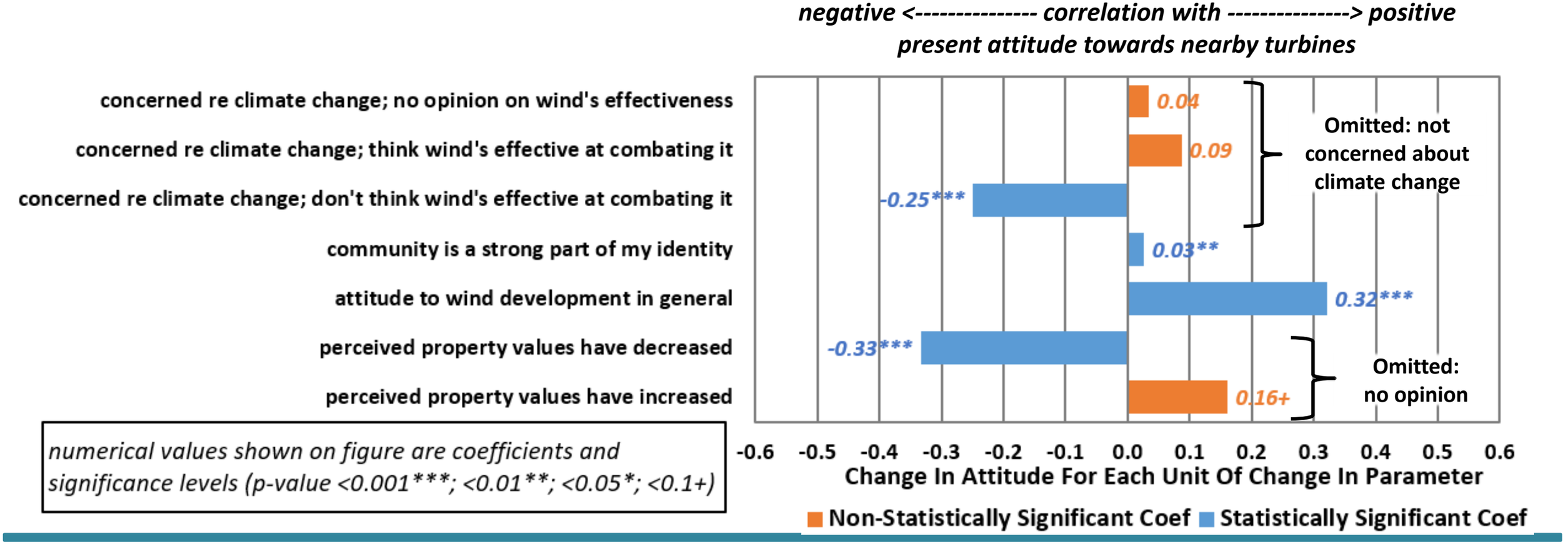
For respondents there before construction, perceptions that the planning process was fair or not are strongly correlated with positive and negative attitudes, respectively. Post-construction respondents had more positive attitudes than pre-construction respondents.




*numerical values shown on figure are coefficients and significance levels (p-value <0.001***; <0.01**; <0.05*; <0.1+)*

# **Related Attitudes:** Beliefs About Property Values, Wind Development, Community and Climate Are Correlated with Both Positive and Negative Attitudes

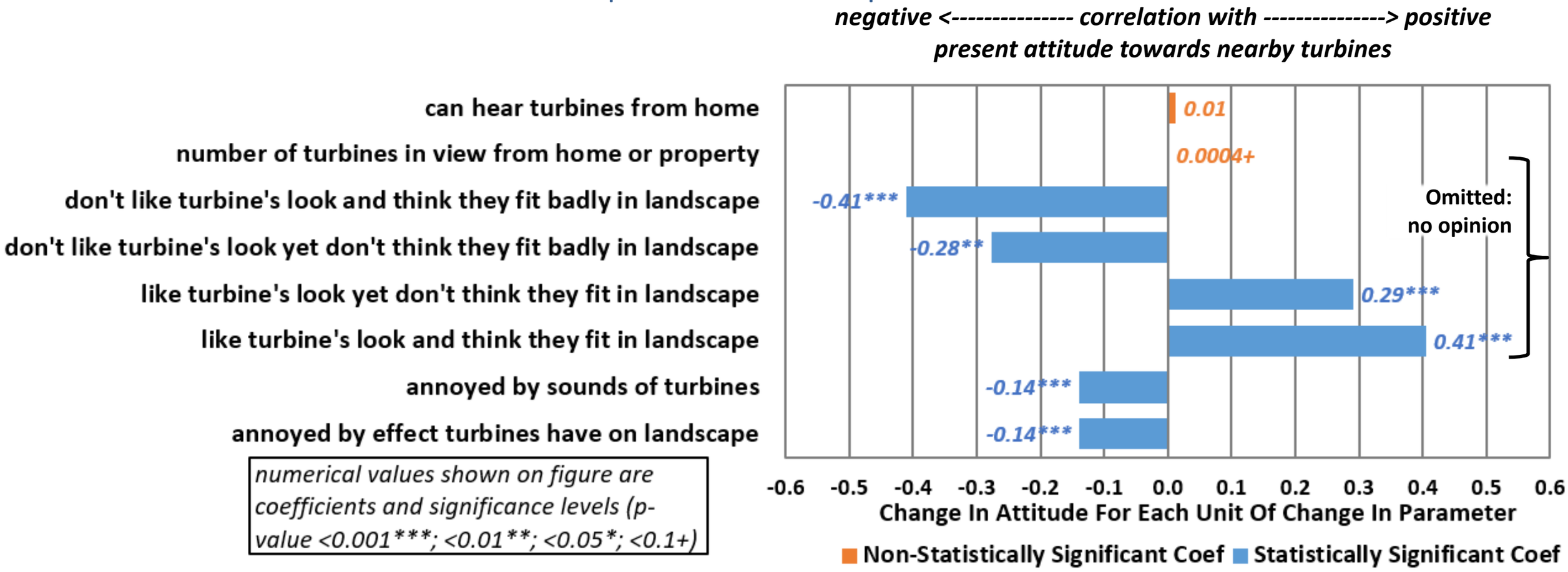
Concerns and decreased property values and belief that wind energy is not able to combat climate change correlate with negative attitudes. Strongly identifying with the community and supporting wind development in general correlate with positive attitudes.




*numerical values shown on figure are coefficients and significance levels (p-value <0.001***; <0.01**; <0.05*; <0.1+)*

# **Sensory Perceptions:** Some Sensory Perceptions of the Wind Project Are Strongly Correlated with Attitudes

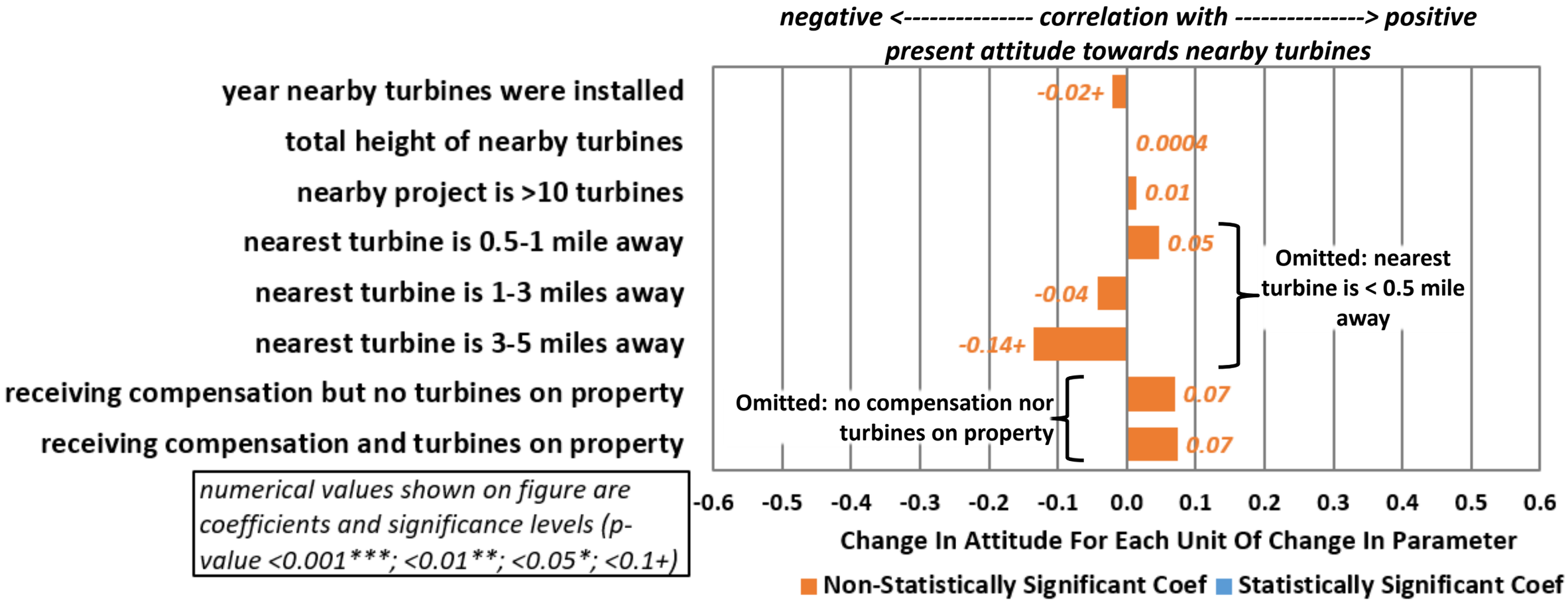
The ability to see or hear the turbines are not correlated with attitudes, but how one perceives those inputs are.




*numerical values shown on figure are coefficients and significance levels (p-value <0.001***; <0.01**; <0.05*; <0.1+)*

# **Project Characteristics:** Wind Project Characteristics Are Not Correlated with Attitudes

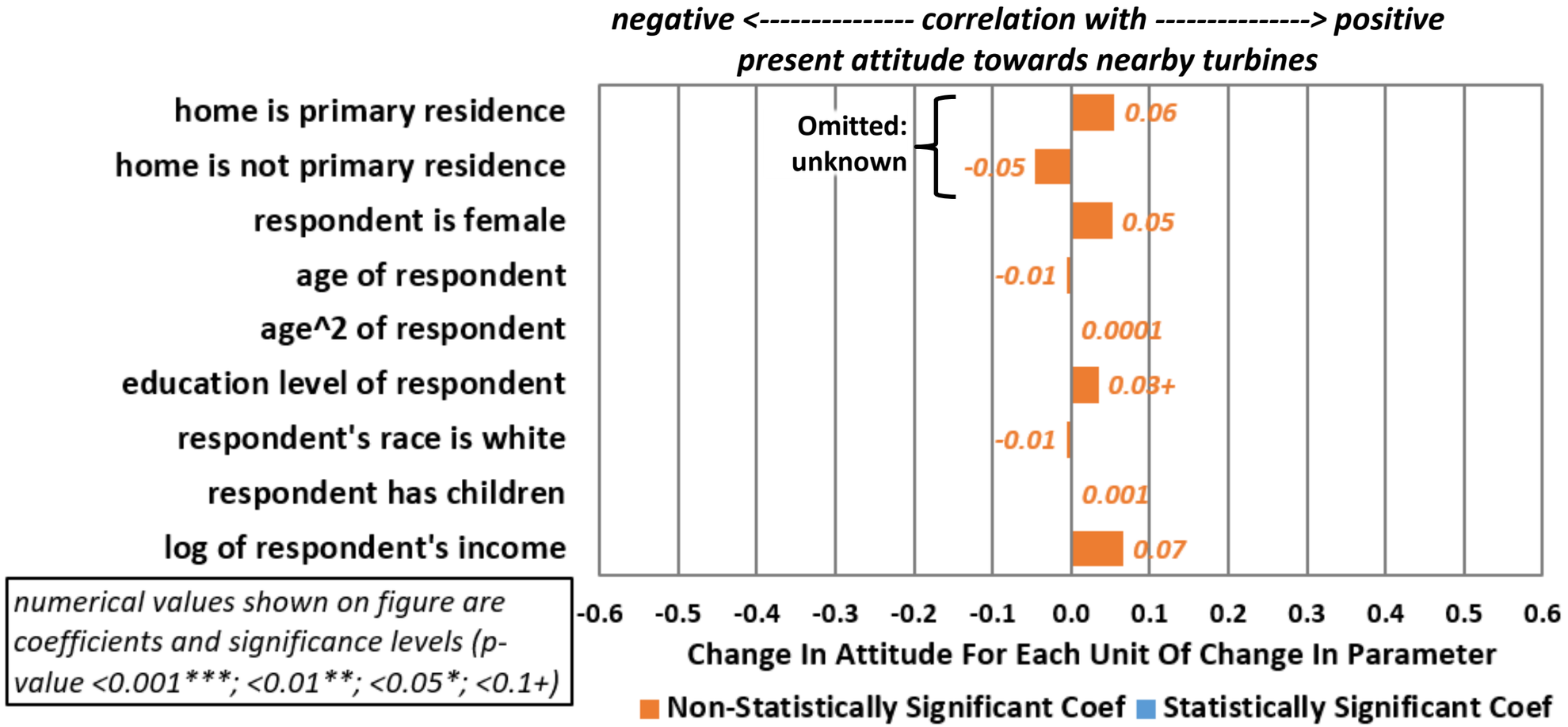
This includes if respondents are being compensated, their distance from, number of, and the height and installation year of the turbines.




*numerical values shown on figure are coefficients and significance levels (p-value <0.001***; <0.01**; <0.05*; <0.1+)*

# **Demographic Characteristics:** Respondent Demographic Differences Are Not Correlated with Attitudes

This includes income, education, age, gender, race, and if the home is a primary residence or not.

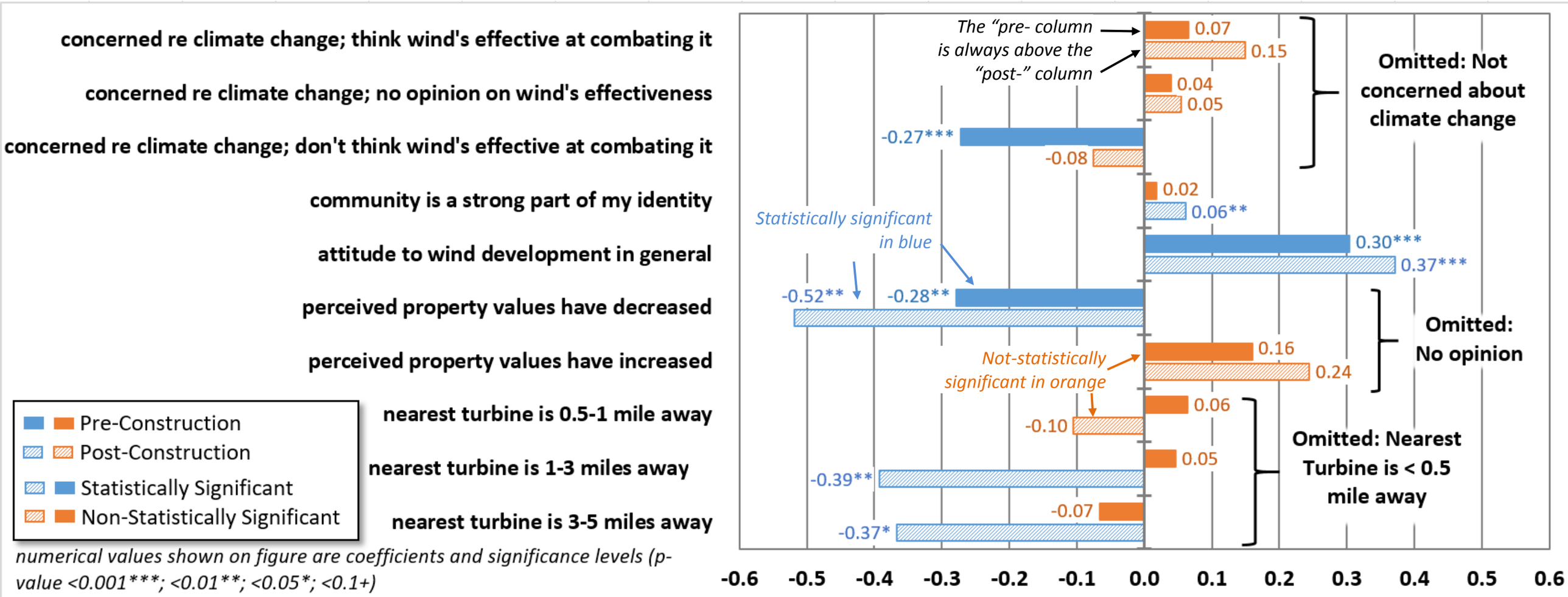



*numerical values shown on figure are coefficients and significance levels (p-value <0.001***; <0.01**; <0.05*; <0.1+)*

# Comparing Pre- Vs. Post-Construction Coefficients

Pre- attitudes are tied to beliefs that wind cannot combat climate change, property values, general attitudes towards wind.

Post- attitudes are tied to community, distance from turbines, property values, and general attitudes.

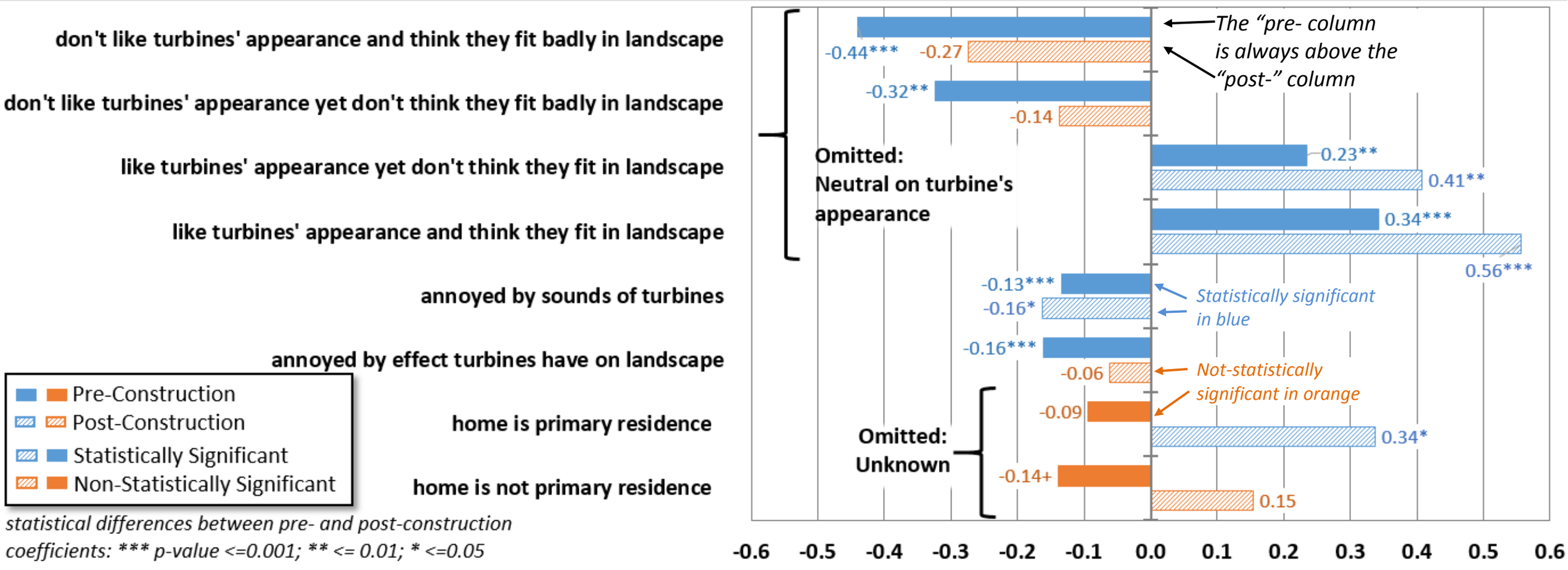



*numerical values shown on figure are coefficients and significance levels (p-value <0.001***; <0.01**; <0.05*; <0.1+)*

# Comparing Pre- Vs. Post-Construction Coefficients

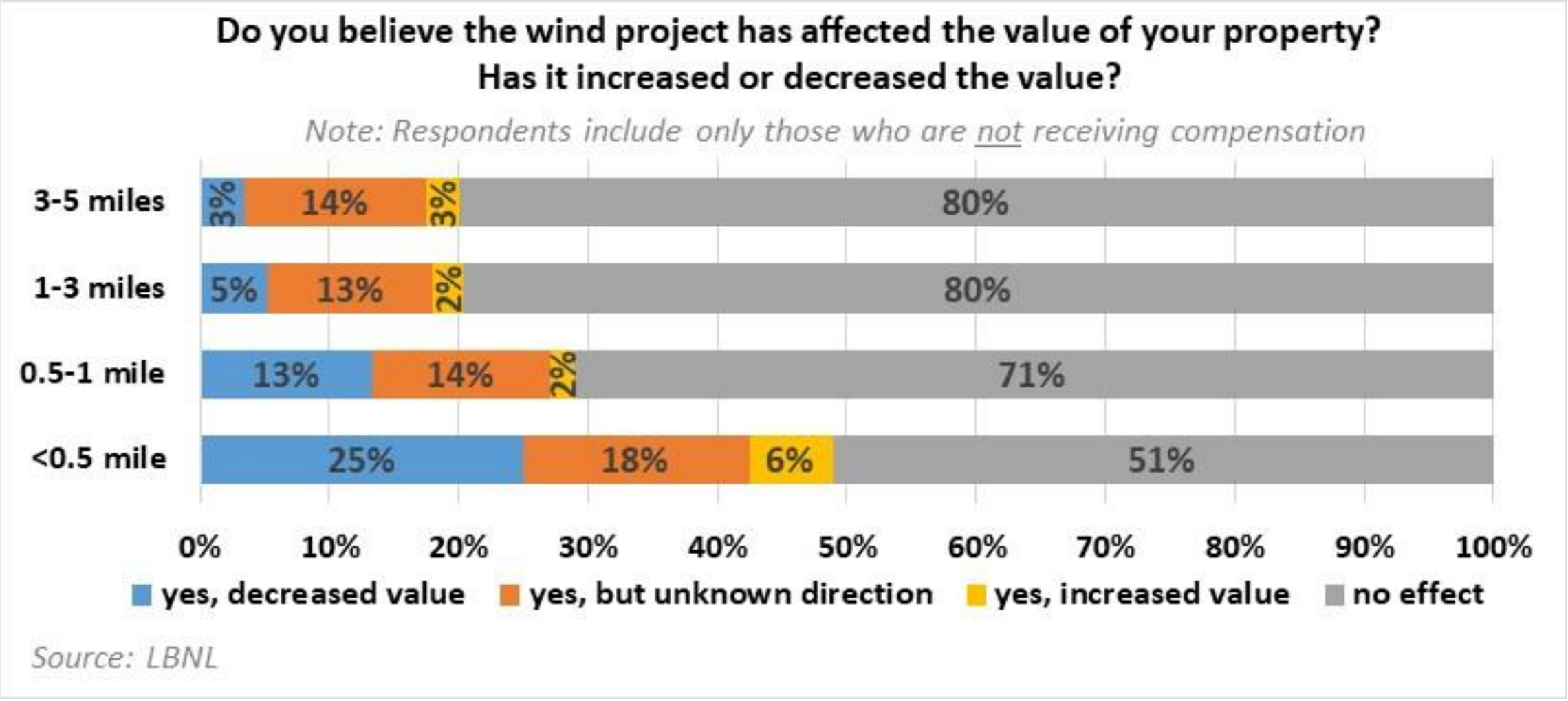
Pre- attitudes are strongly tied to the appearance and fit of turbines, and annoyance.

Post- attitudes are tied to appearance, sound annoyance, and if the home is the primary residence.

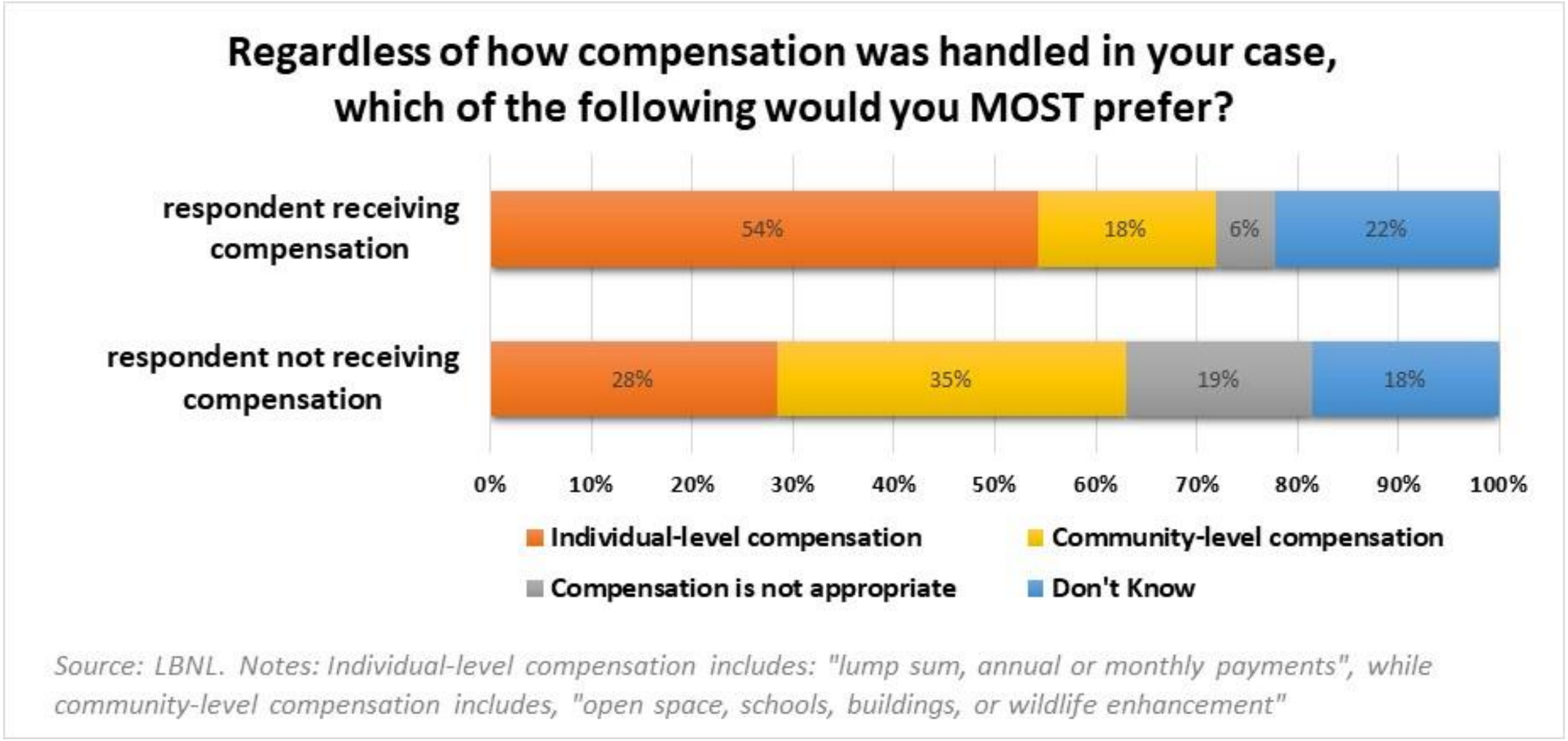



*statistical differences between pre- and post-construction coefficients: *** p-value <=0.001; ** <= 0.01; * <=0.05*

# Roughly One-Quarter Of Uncompensated Respondents Within ½ Mile Believe That Property Values Were Adversely Affected, Meaning The Large Majority Do Not. Further Away, Those Percentages Are More Lopsided.



# A Majority Of Respondents, Including Those Already Receiving Compensation, Have A Preference For Individual and Community Compensation




*Source: LBNL. Notes: Individual-level compensation includes: "lump sum, annual or monthly payments", while community-level compensation includes, "open space, schools, buildings, or wildlife enhancement"*

# For Those Who Live Within ½ Mile Of A Turbine, And Were There Prior To The Project's Construction, Living Near A Wind Project Is Preferred Over All Other Sources Except A Solar Plant, For Which Preferences Are Similar