CARNEGIE MELLON RESEARCH:

NEW METHODS & CROSS-CUTTING APPLICATIONS

-RAPID SWITCH WORKSHOP-
PRINCETON UNIVERSITY
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MODIFIED OUTLINE

I. An elaboration and proposed tools for the

Concept Note: Towards a conceptual framework for prioritizing bottlenecks

→ *Tracking technical and social readiness*

→ *Linking physical and social science research*

II. Application to

1. Transportation mode choice: preferences + behavior → infrastructure design

2. Deployment and integration of Negative Emission Technologies:

technical innovation and resource requirements → social acceptance

RAPID SWITCH COLLABORATIVE PROJECTS TO ADDRESS METHODS DEVELOPMENT AND SPECIFIC APPLICATIONS

NEW METHODS

- Survey-informed consumer choice and impact models
- Improved methods for assessing and communicating technology readiness
- Statistical and ML methods for scenario classification

APPLICATIONS

1. Transportation mode choice, vehicle transitions, urban design and infrastructure
2. System to track NET costs, performance, public & political support, potential adoption, and innovation needs
3. Classify SSP scenarios by vulnerability to political and socioeconomic barriers. Early signposts? VOI?

I. TRANSPORTATION: MODE CHOICE SURVEY ANALYSIS

WholeTraveler
TRANSPORTATION BEHAVIOR STUDY

DOE sponsored → LBNL, INL, CMU, Stanford

Fit multinomial choice models using logistic and cluster-based regression and ML methods. . .

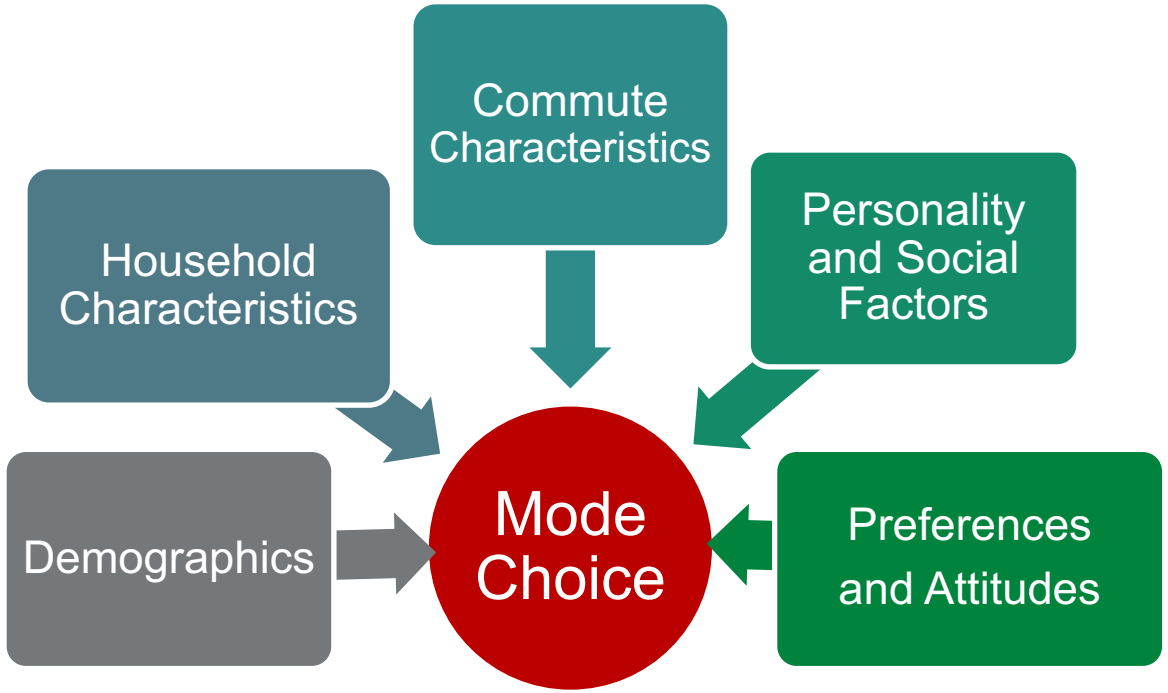
Motivation: Plan Bay Area 2050

- "…state-mandated, integrated long-range transportation and land use plan" (Metropolitan Transportation Commission, 2019).
- "…integrates transportation, land use, and housing to meet greenhouse gas reduction targets".

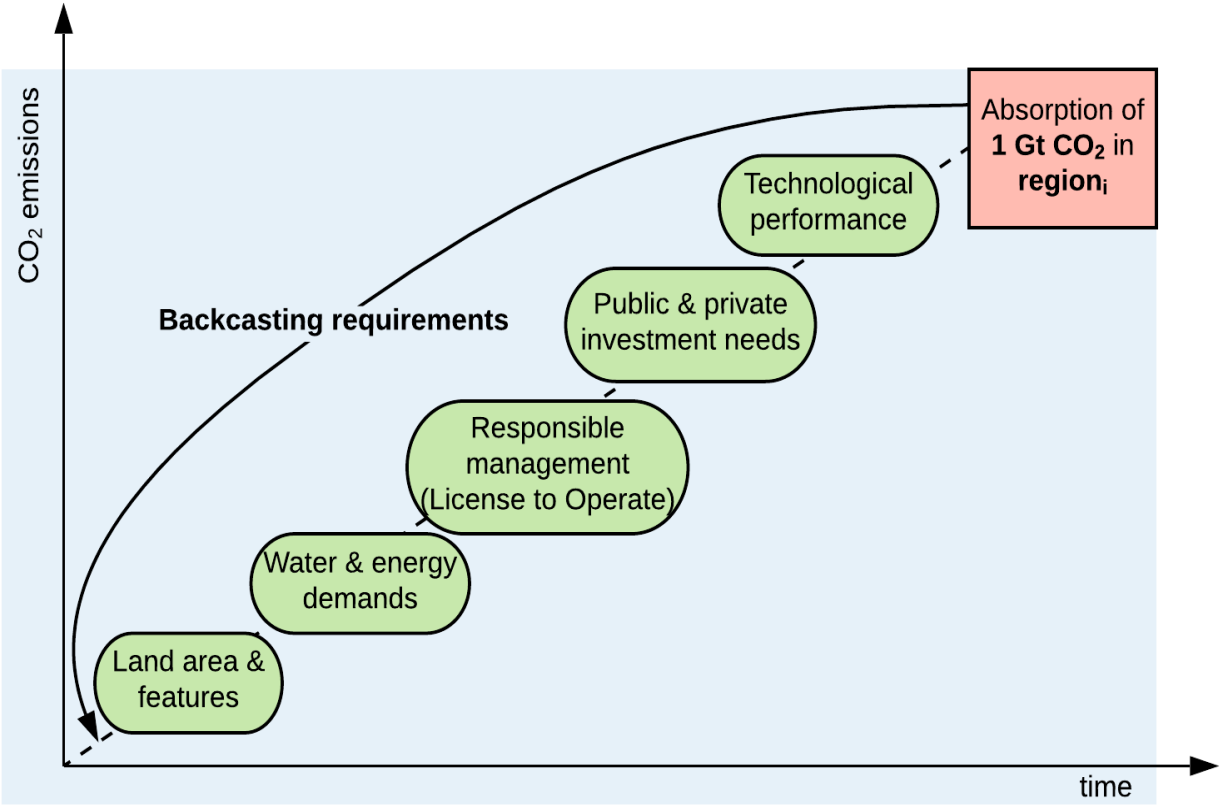
Phase 1 Survey

- Demographic, location specific, preference for mode attributes, human characteristics data

n = 1,045



2. INNOVATION, DEPLOYMENT, AND INTEGRATION OF GIGATONNE-SCALE NEGATIVE EMISSIONS TECHNOLOGIES



Focus is primarily on U.S., although China, India, Brazil, and other important NET markets will be considered.

NETs are critical components of 1.5°C mitigation pathways, but limited information is available to plan, deploy and integrate these technologies into local and national economies.

We propose developing a common framework and public tools to analyze gigatonne-scale NETs with a three-phase approach:

1. Dynamic assessment of the state of NET costs, performance, potential adoption, and innovation needs.
2. Techno-economic analysis of bottom-up engineering and resource requirements needed to capture 1 Gt of CO_2 for each of the primary forms of NETs.
3. Provide and track information sharing to cross-fertilize advances in NET technologies, public participation methods, and integration with the electricity grid and liquid fuel systems.

PROPOSED NET PROJECT FOCUS AND DELIVERABLES

- Develop an evaluation and tracking system for the Technology Readiness Level (TRL) of potential NETs, documenting their innovation, cost, resource needs, deployment, performance, and public and political support.
- Technologies considered will include but not be limited to:
  - bioenergy with carbon capture and storage
  - direct air capture with storage,
  - enhanced weathering of minerals,
  - afforestation and reforestation,
  - biochar and soil carbon sequestration
- The interactive web product will also support an online NET atlas and roadmap allowing users to identify the most important technologies and regions for prioritized R&D and early deployment, as well as opportunities for synergies with other NET markets.

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PREVIOUS AND ONGOING RESEARCH ACTIVITIES

1. **Generating linked technology-socioeconomic scenarios for emerging energy transitions.**
   ***Applied Energy*, *239*: 1402-1423,**
   Small, M.J., Wong-Parodi, G., Kefford, B.M., Stringer, M., Schmeda-Lopez, D.R., Greig, C., Ballinger, B., Wilson, S. and Smart, S. **(2019).**

2. **Why Rapid and Deep Decarbonization isn't Simple: Linking Bottom-up Socio-technical Decision-making Insights with Top-down Macroeconomic Analyses. (2019)**
   Presented at the 22nd Annual Conference on Global Economic Analysis, Warsaw, Poland.
   Turner Cotterman (Advisors: Mitchell Small, Stephen Wilson, Gabrielle Wong-Parodi).

3. **Human risk perception and behavior for energy systems and climate adaptation**
   - Transportation: vehicle transitions and mode choice
     Describing the users: Understanding adoption of and interest in shared, electrified, and automated transportation in the San Francisco Bay Area. *Transport. Res. D: Transport and Environment.*
     Spurlock, Sears, Wong-Parodi, G., et al.. 2019.
   - Information strategies: usability, access and trust in scientific information
     A Decision-Centered Method to Evaluate Natural Hazards Decision Aids by Interdisciplinary Research Teams. *Risk Analysis*. Wong-Parodi, G. and Small, M.J., 2019.

Applied Energy 239 (2019) 1402–1423

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Generating linked technology-socioeconomic scenarios for emerging energy transitions

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HIGHLIGHTS

- A Bayesian network model is used to generate scenarios for a new energy technology.
- Scenarios consider technical and sociopolitical factors and their interactions.
- Application to CCS predicts that improvements in both sets of factors are necessary.

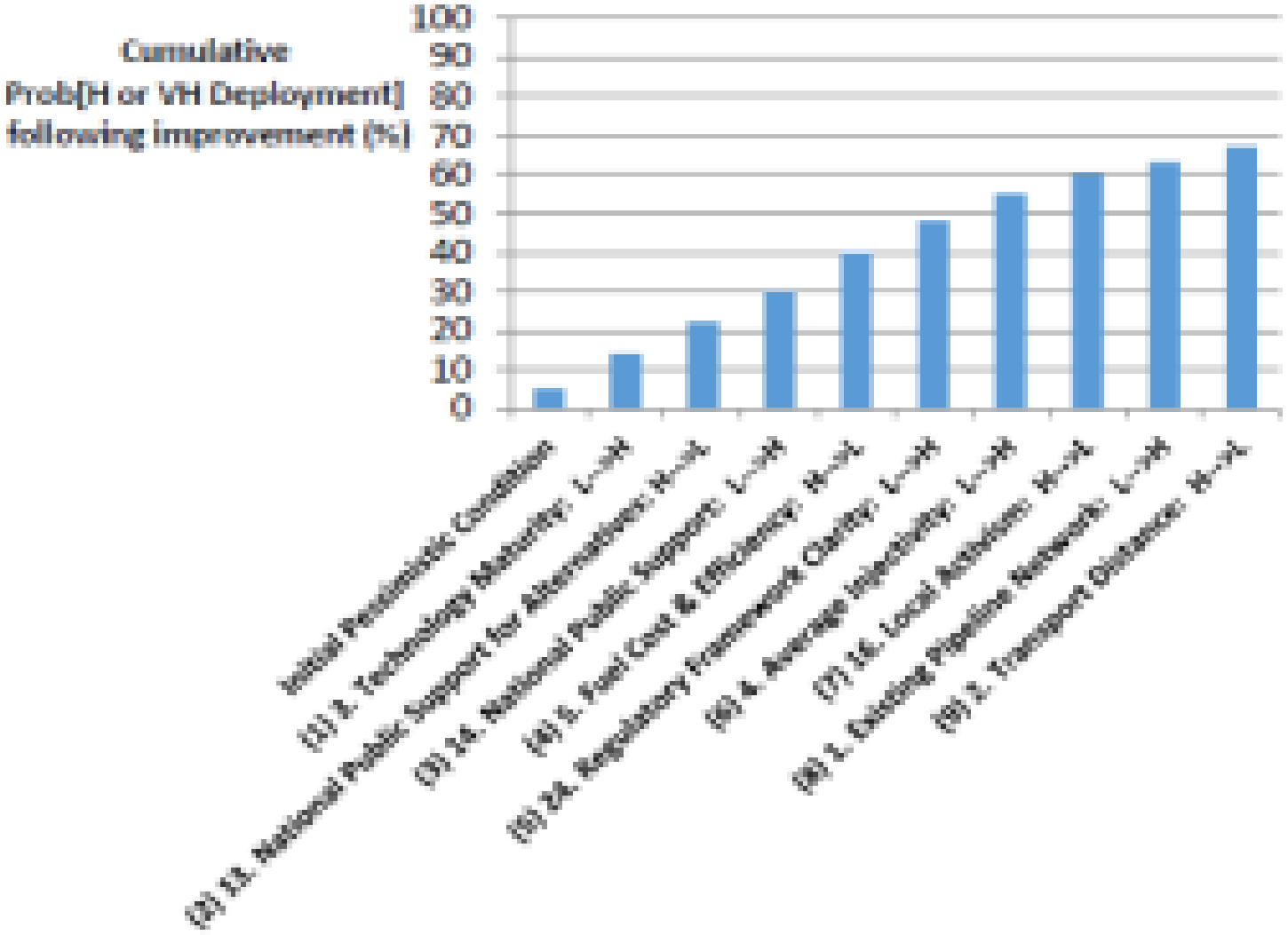
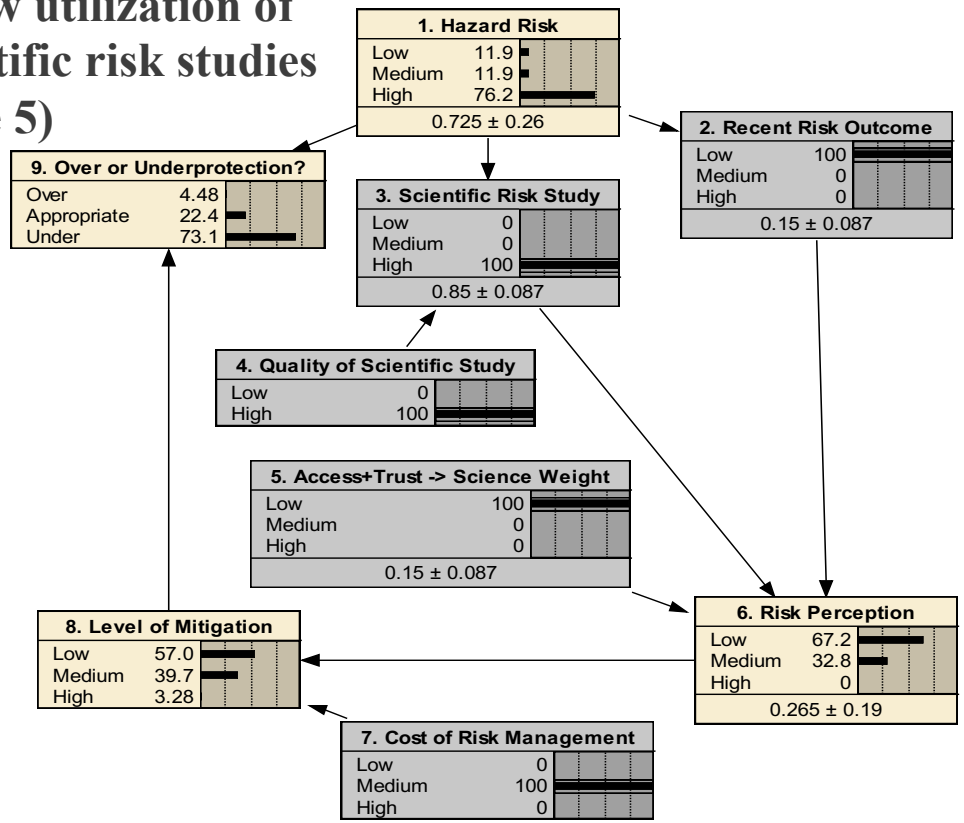


Fig. 4. Cumulative effect of sequentially improving model factors beginning with the fully pessimistic scenario. (Factors chosen so that the Prob[H or VH Deployment] is predicted to increase maximally at each step.)

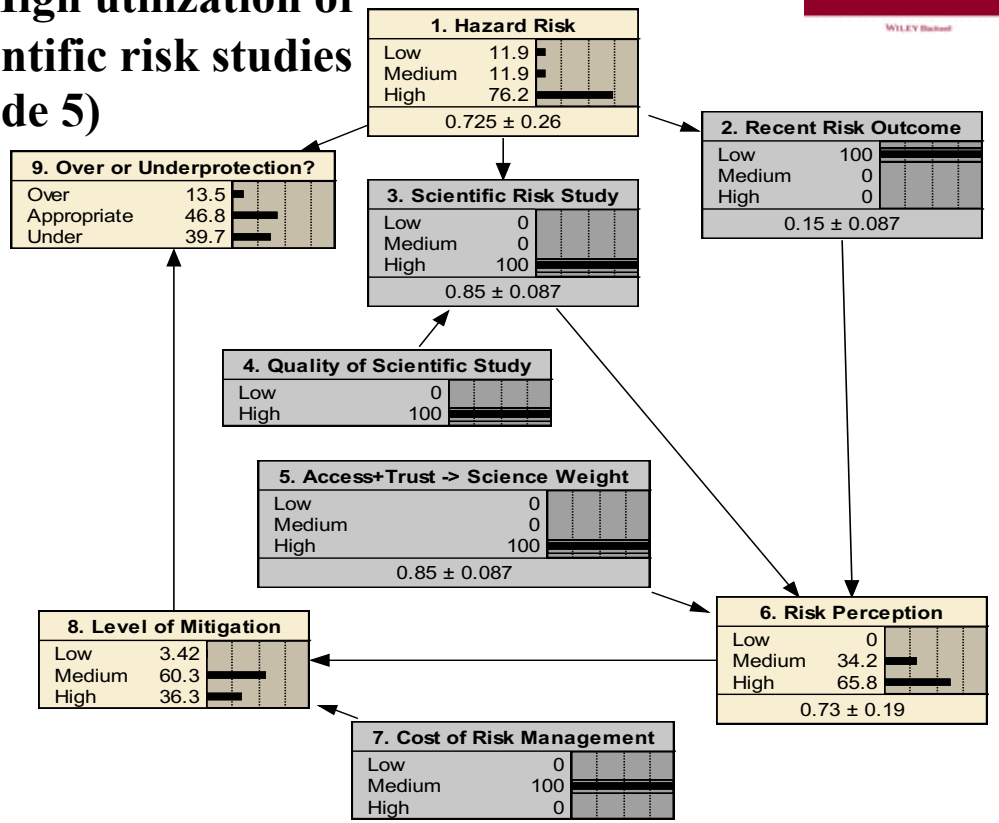
VALUE OF INFORMATION: SCIENTIFIC QUALITY, ACCESS, USABILITY, TRUST → UTILIZATION

A Decision-Centered Method to Evaluate Natural Hazards Decision Aids by Interdisciplinary Research Teams. 2019. Gabrielle Wong-Parodi & Mitchell J. Small

a) Low utilization of scientific risk studies (Node 5)



b) High utilization of scientific risk studies (Node 5)



OTHERS INTERESTED IN COLLABORATION

- **Klaus Keller and Vivek Srikrishnan**

  Earth and Environmental Systems Institute, Pennsylvania State University

  Garner, G., Reed, P. and Keller, K., 2016. Climate risk management requires explicit representation of societal trade-offs. *Climatic Change 134*(4), pp.713-723.

  Morris, J., Srikrishnan, V., Webster, M. and Reilly, J., 2018. Hedging strategies: electricity investment decisions under policy uncertainty. The Energy Journal, 39(1), pp.101-122.

- **Ahmed Abdulla**

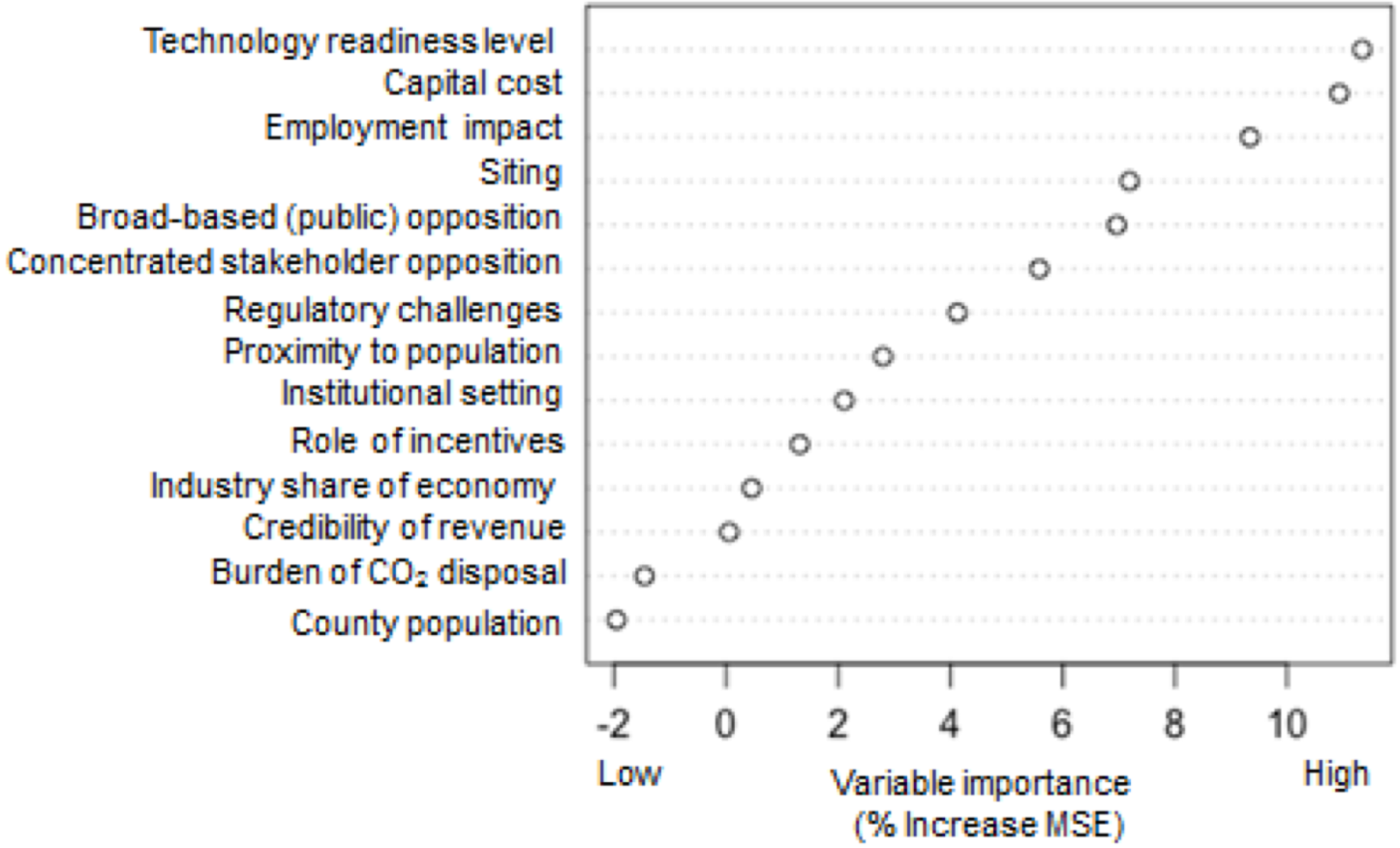
  School of Global Policy and Strategy and Deep Decarbonization Initiative, UC San Diego

  Babacan, O., Abdulla, A., Hanna, R., Kleissl, J. and Victor, D.G., 2018. Unintended Effects of Residential Energy Storage on Emissions from the Electric Power System. Environmental science & technology, 52(22), pp.13600-13608.

  Abdulla, A., Vaishnav, P., Sergi, B. and Victor, D.G., 2019. Limits to deployment of nuclear power for decarbonization: Insights from public opinion. *Energy Policy*, *129*, pp.1339-1346.

  → **Public perception constrains the deployment of energy technologies**
  → **Researchers struggle to incorporate these constraints in energy system models.**

Failure reasons not traditionally considered



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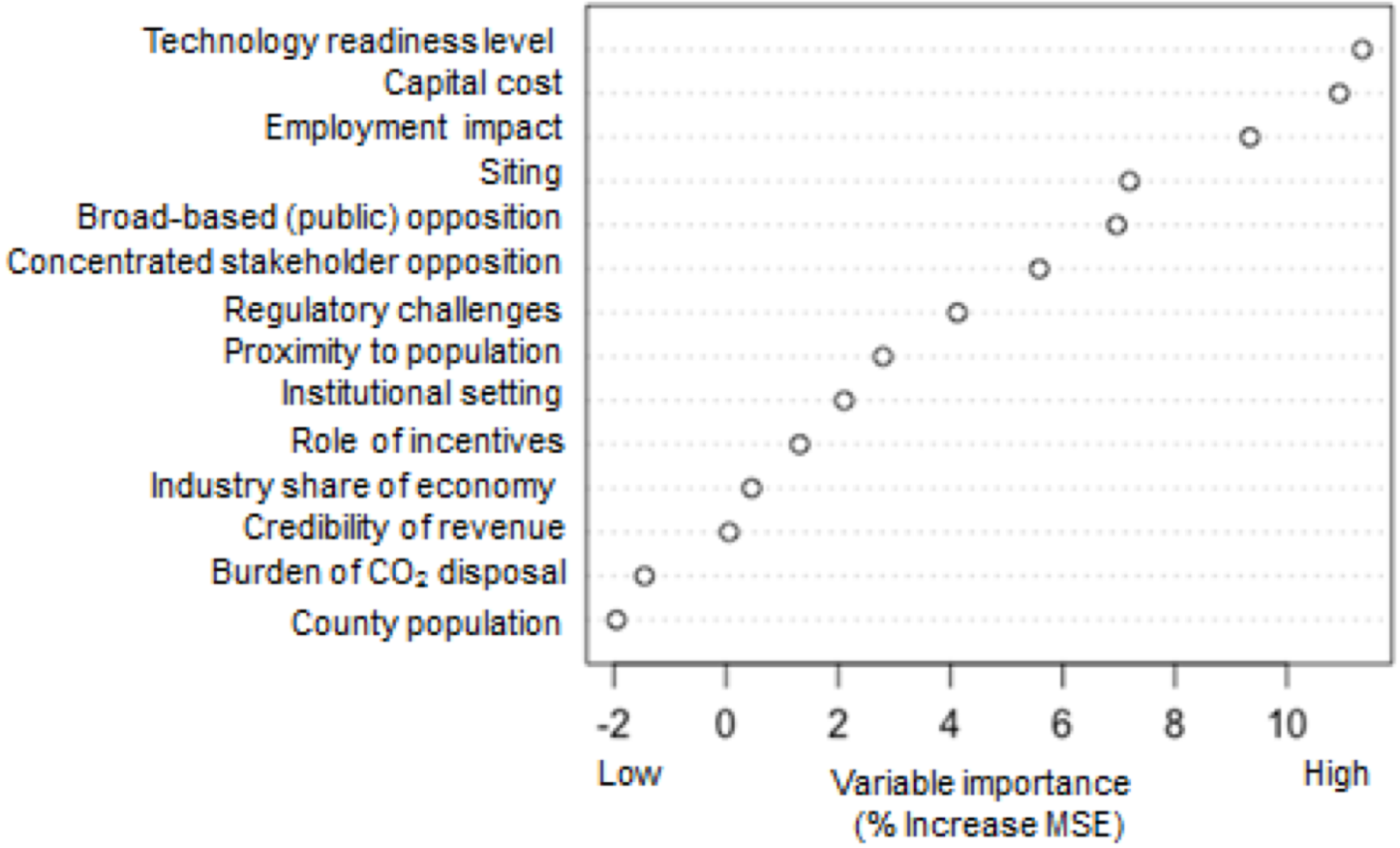

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