Assessing public perceptions of energy tradeoffs with discrete choice analysis

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Carnegie Mellon University

Motivation

Union of Concerned Scientists
Science for a healthy planet and safer world

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GLOBAL WARMING > REDUCE EMISSIONS

How Much Will the Clean Power Plan Cost?

FACT: The benefits of the EPA's Clean Power Plan far outweigh the costs

Contents

- Climate benefits worth billions >
- Billions in health benefits >
- Minimal upfront costs, with lower electricity bills to follow >
- Cost-effective solutions to cut carbon >
- Share the facts about the Clean Power Plan >

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What do individuals think about the **tradeoffs** between increased bills and climate or health objectives?

How does information on climate and health benefits affect support for these types of policies?

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Previous work on tradeoff perceptions

- Portfolio selection tool with tradeoffs (Fleishman-Mayer et. al., 2014)
- Individuals respond more strongly to attributes of energy use than to source (Ansolabehere & Konisky, 2014)
- Health frames can motivate changes to energy use more than economic cost (Asensio & Delmas, 2014)

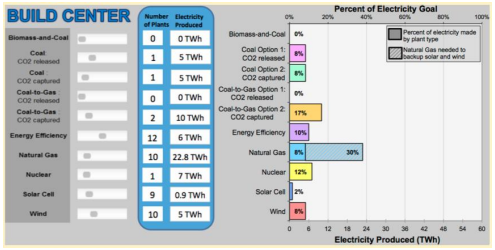
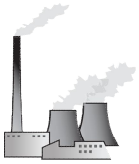


Image credit: Fleishman-Mayer et. al. 2014

Research questions

- How do individuals make tradeoffs across the different attributes of electricity generation?
  - climate change
  - health related air pollution
  - economic costs (electricity bills)
- What is the effect of providing climate change and health information when making these tradeoffs?

OR



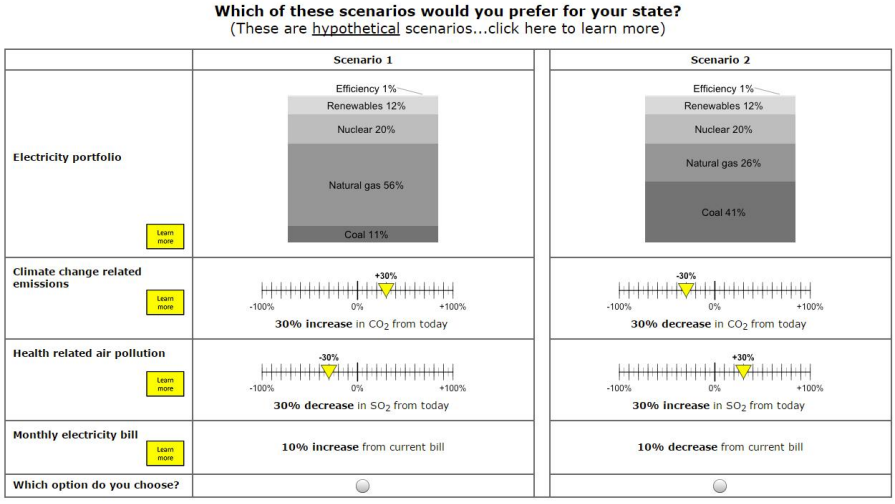
Discrete choice survey

- Well-established method in marketing, transportation research (Train, 2009)

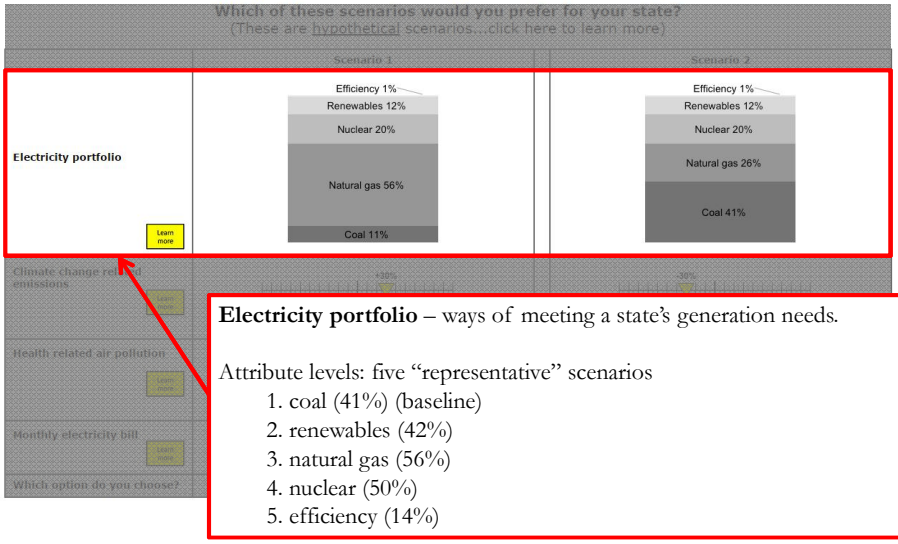
Image credit: Market Research Bulletin

- Emerging method in the energy & environment space:
  - Climate change and energy security (Longo et. al., 2008)
  - Estimating implicit discount rates for lighting (Min et. al., 2014)
  - Preferences for electric vehicles (Helveston et. al., 2015)
  - Energy efficiency (Davis & Metcalf, 2014)
  - Renewables and electricity bills in Germany (Kaenzig, 2013)
- **Our survey:** Individuals respond to 16 comparisons of discrete electricity "futures" with different attribute levels

Example choice screen



Example choice screen

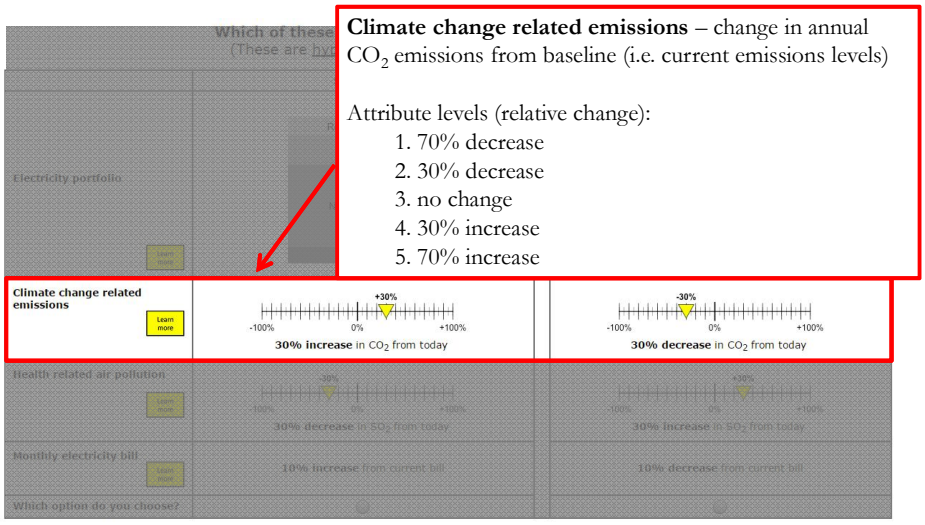


Electricity portfolio – ways of meeting a state's generation needs.

Attribute levels: five "representative" scenarios

1. coal (41%) (baseline)
2. renewables (42%)
3. natural gas (56%)
4. nuclear (50%)
5. efficiency (14%)

Example choice screen

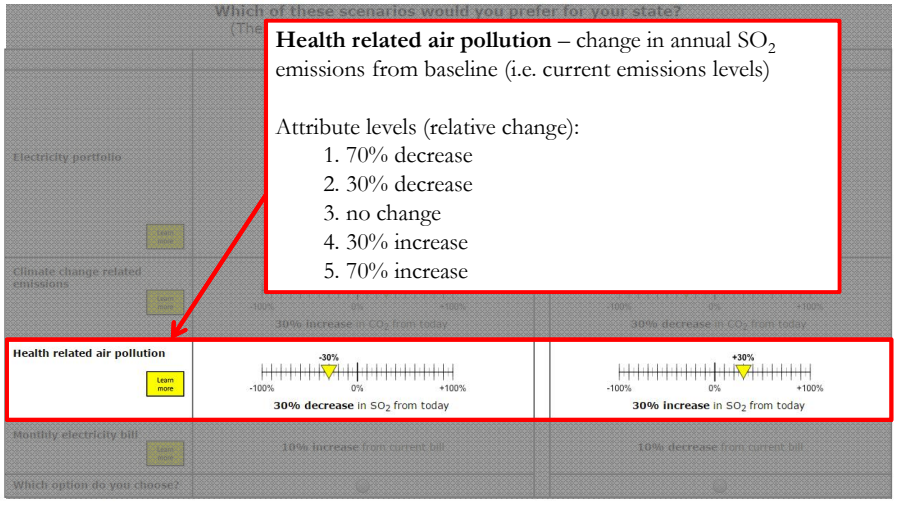


Climate change related emissions – change in annual CO_2 emissions from baseline (i.e. current emissions levels)

Attribute levels (relative change):

1. 70% decrease
2. 30% decrease
3. no change
4. 30% increase
5. 70% increase

Example choice screen

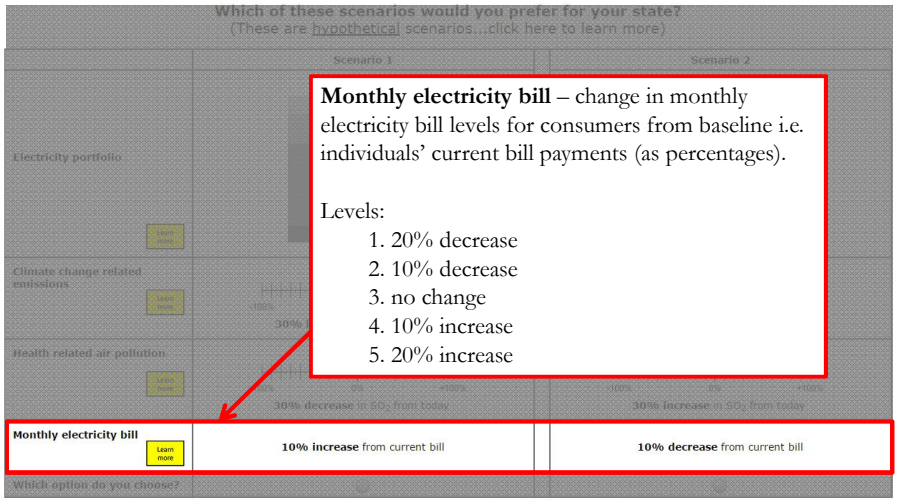


Health related air pollution – change in annual SO_2 emissions from baseline (i.e. current emissions levels)

Attribute levels (relative change):

1. 70% decrease
2. 30% decrease
3. no change
4. 30% increase
5. 70% increase

Example choice screen



Effect of emissions information

- Randomized controlled trial with different emissions attributes shown in the task.

Experimental Group	Information that respondents see
Group 1	All four attributes (portfolio, bill, CO_2, and SO_2)
Group 2	Portfolio, bill, and CO_2 only (no information on SO_2)
Group 3	Portfolio, bill, and SO_2 only (no information on CO_2)
Group 4	Portfolio and bill only (no information on CO_2 or SO_2)
Group 5	All attributes + monetized damages for CO_2 and SO_2

Example choice screen

(No SO_2 emissions / health information)

Which of these scenarios would you prefer for your state?
(These are hypothetical scenarios...click here to learn more)

	Scenario 1	Scenario 2
Electricity portfolio Learn more	Efficiency 1% Renewables 12% Nuclear 20% Natural gas 56% Coal 11%	Efficiency 1% Renewables 12% Nuclear 20% Natural gas 26% Coal 41%
Climate change related emissions Learn more	+30% -100% 0% +100% **30% increase** in CO_2 from today	-30% -100% 0% +100% **30% decrease** in CO_2 from today
Monthly electricity bill Learn more	**10% increase** from current bill	**10% decrease** from current bill
Which option do you choose?	○	○

Example choice screen

Which of these scenarios would you prefer for your state?
(These are hypothetical scenarios...click here to learn more)

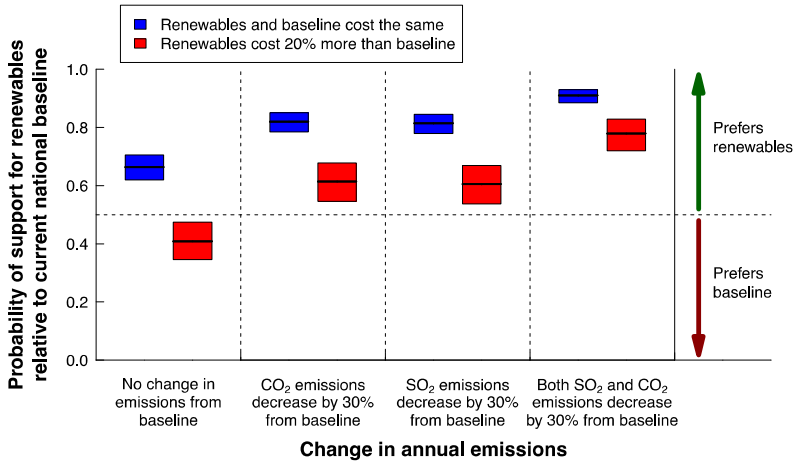
	Scenario 1	Scenario 2
Electricity portfolio Learn more	Efficiency 1% Renewables 12% Nuclear 20% Natural gas 26% Coal 41%	Efficiency 1% Renewables 42% Nuclear 20% Natural gas 26% Coal 11%
Climate change related emissions Learn more	+70% -100% 0% +100% **70% increase** in CO_2 from today **$2B increase** in climate change costs	-30% -100% 0% +100% **30% decrease** in CO_2 from today **$800M decrease** in climate change costs
Health related air pollution Learn more	-30% -100% 0% +100% **30% decrease** in SO_2 from today **$800M decrease** in health costs	+70% -100% 0% +100% **70% increase** in SO_2 from today **$2B increase** in health costs
Monthly electricity bill Learn more	**10% increase** from current bill	**10% decrease** from current bill
Which option do you choose?	○	○

Modeling and sample

- Random utility mixed logit model (Train, 2009)
  - Linear model based on attribute levels
  - Estimate random effects coefficients for emissions and bills
  - Logit coefficients provide insight on probability and willingness-to -pay
- 1,006 participants from Amazon's Mechanical Turk
  - Recruited proportionally from U.S. states
  - Random assignment to experimental groups

Probability of support

(Group 4: all emissions information)



Probability of support

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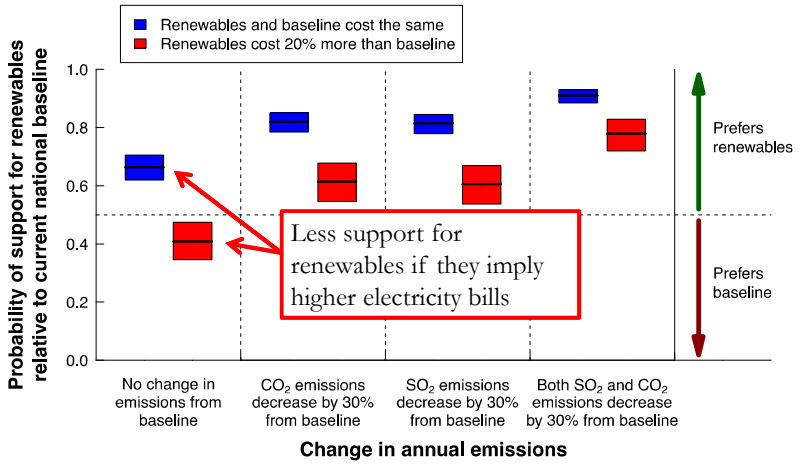

Probability of support

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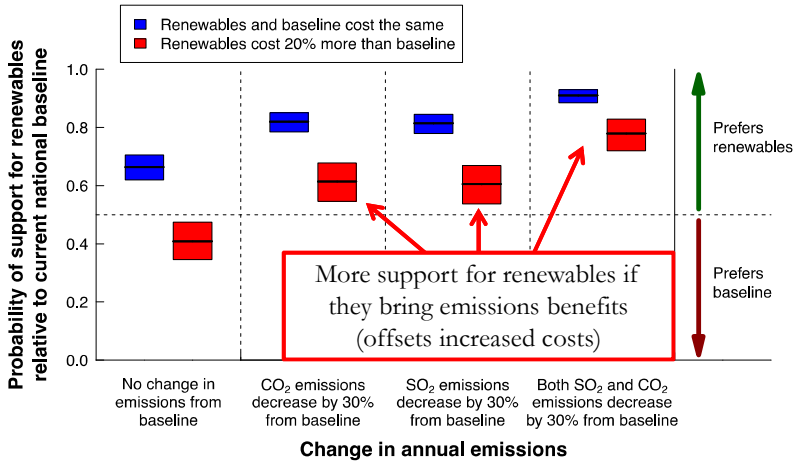
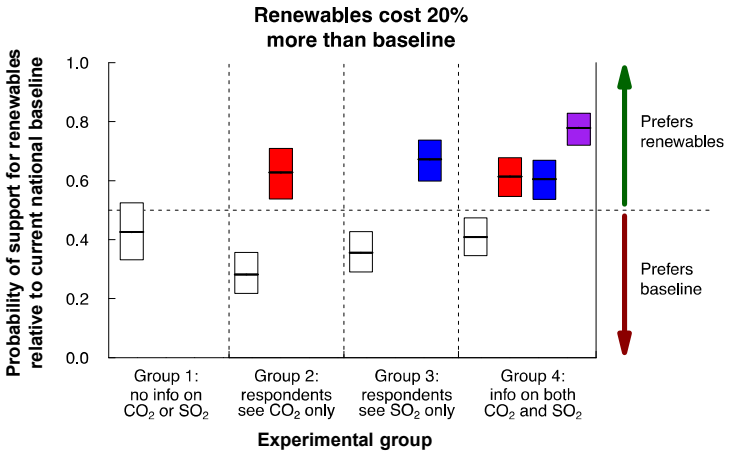


J12

Probability of support

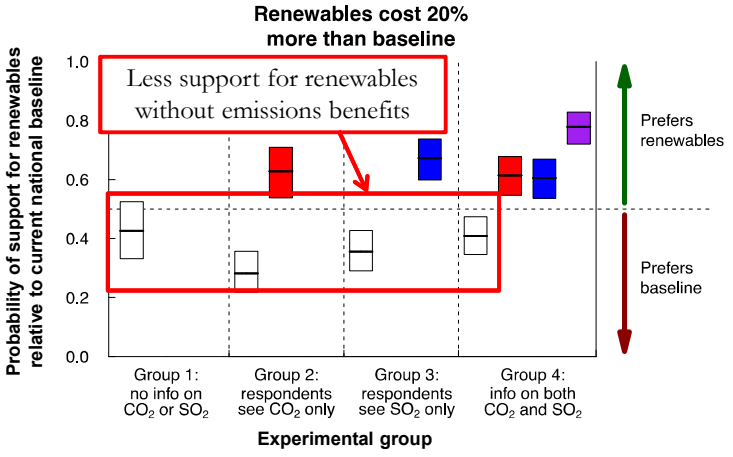
(Across groups with different emissions information)



J12

Probability of support

(Across groups with different emissions information)



Slide 19

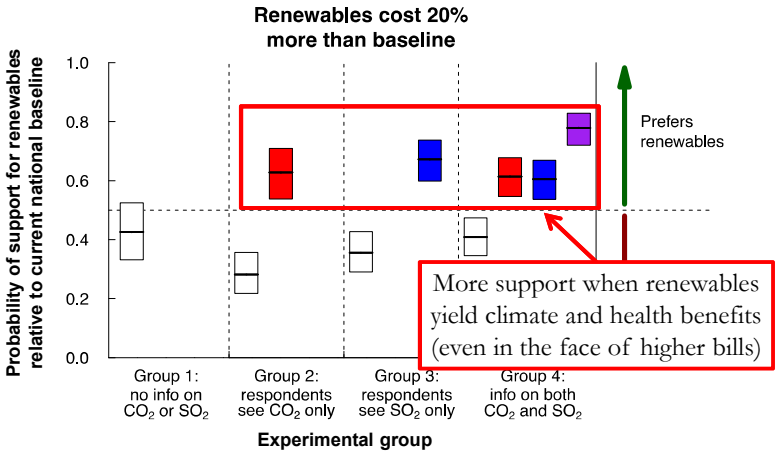
J12 I think these figures are way too small, maybe try to think of some ways to maybe show part of each figure so you can make them larger?
Jenna, 10/14/2016

Slide 20

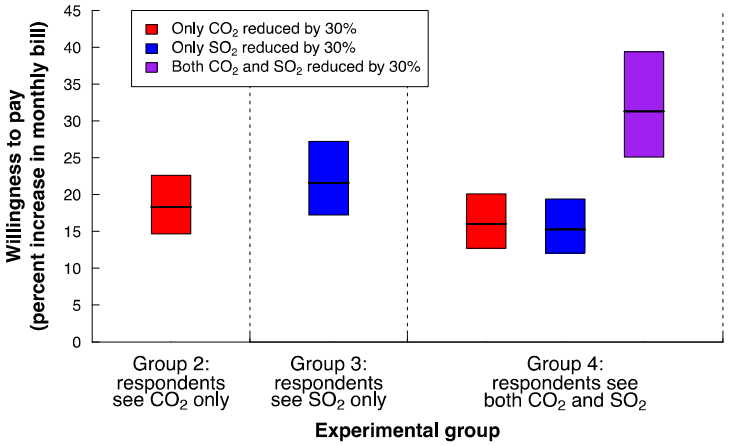
J12 I think these figures are way too small, maybe try to think of some ways to maybe show part of each figure so you can make them larger?
Jenna, 10/14/2016

Probability of support

(Across groups with different emissions information)

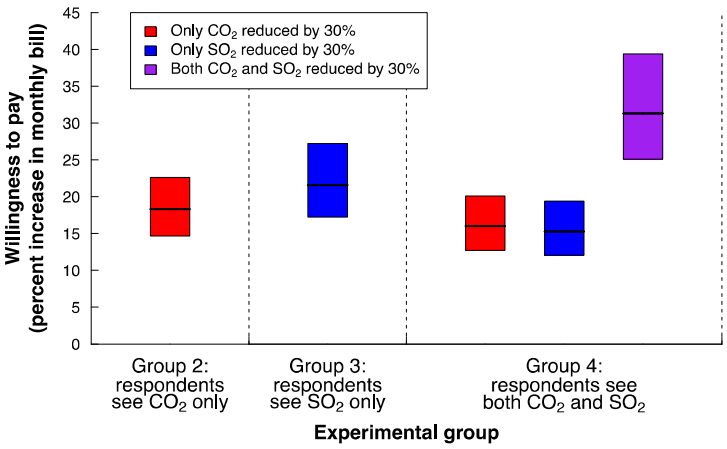


Willingness-to-pay



Implicit WTP ($ per ton of emissions reduced):

$100-130 per ton of CO_2
$60,000-110,000 per ton of SO_2



Conclusions

- Preferences for lower bills, emissions
  - Outcomes more important than source
  - Acceptance of higher bills for climate and health benefits possibly a form of altruism
- Climate vs. health benefits
  - Comparable increase in support from reducing either pollutant, larger increase with both
- Limitations of stated choice studies
  - Hypothetical choices, survey design can affect results (Louviere, 2006)
  - Cognitive biases in stated preference studies (Fischhoff, 2005)

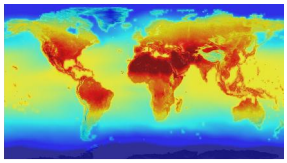


Image credit: NASA, eChinacities

Policy implications

- Technology “neutral” policies for emissions reductions?
- Communicate information on emissions reductions, particularly health information
- Consider co-optimizing climate mitigation policies across multiple health and climate objectives

Acknowledgements

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  - Center for Climate and Energy Decision Making (NSF SES-0949710 and SES-1463492)
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  - Center for Behavioral and Decision Research

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