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Estimation of Non-Energy Impacts from Energy Efficiency

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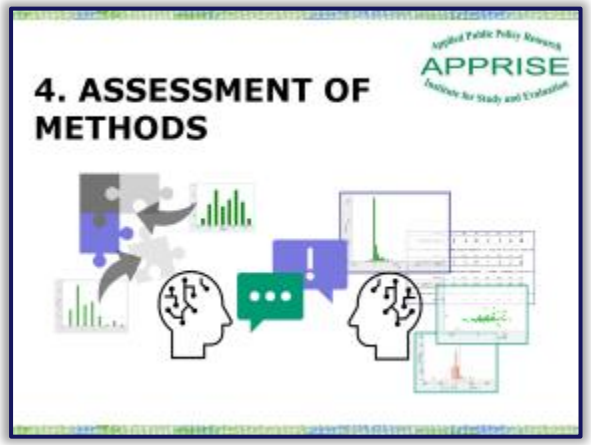
April 12, 2022

Presentation Overview



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1. OVERVIEW OF NON-ENERGY IMPACTS

Non-Energy Impacts

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Background

Societal Benefit Example

Reduced emissions positively impact the environment

- Economic
- Environmental
- Health & Safety

Ratepayer Benefit Example

Reduced usage improves affordability and may reduce collections costs

- Affordability
- Collections Costs
- System Reliability

Participant Benefit Example

Air sealing increases comfort

- Health & Safety
- Affordability
- Indoor Air Quality
- Noise
- Water Usage
- Maintenance

- NEIs accrue to participants, utility ratepayers, and society
- May be included in cost-effectiveness tests

Non-Energy Impacts

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Typical Approach to Estimation

Review Past Studies

Select Benefits for Inclusion

Average of Past Study Impacts

Non-Energy Impacts

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Typical Approach to Estimation

Review Past Studies

Select Benefits for Inclusion

Average of Past Study Impacts

Challenges in the Literature

Past Estimates

- Out of date
- Applicability

Research Quality not Assessed

- Approach
- Sample Size
- Statistical Significance

Documentation Lacking

- Methodology
- Assumptions
- Limitations

NEI Valuation Methods

Non-Survey Estimation Examples
• Health – Lit Review: Use estimates of weatherization impact on asthma
• Economic – Calculation: Multipliers applied to expenditures
• Water – Analysis: Estimate savings by analyzing water bills
• Maintenance – Projections: Estimate reduction in reduced lighting replacements labor cost

NEI Valuation Methods

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Survey-Based Approaches	
Contingent Valuation	• Respondent assigns a dollar value
Direct Scaling	• Respondent values NEI as a % of energy savings
Labeled Magnitude Scaling	• Respondent values NEI on a scale relative to energy savings

Non-Survey Estimation Examples
• Health – Lit Review: Use estimates of weatherization impact on asthma
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Contingent Valuation

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Method

Survey Question

- Asks respondents to assign a dollar value associated with the NEI

"Could you put a *positive or negative dollar value* on the change in winter comfort? *What is that dollar value* from the change in winter comfort?"

Calculation

- Outliers dropped
- No other adjustment

Advantages

- Most Direct Method
- No Scaling Assumption
- Wide Use in Literature

Disadvantages

- Unbounded Responses
- No Point of Reference
- Low Response Rate

Direct Scaling

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Method

Survey Question

- Asks respondents to value an NEI as a % of their energy savings

"How does the dollar value from the change in winter comfort compare to the energy savings — *10% of energy savings, 20%, 30%, etc*.?"

Calculation

- Apply % to program savings
- Use reported or analyzed bill savings

Advantages

- Quantitative Analysis
- Familiar Point of Reference
- Consistent Results

Disadvantages

- Difficult to Comprehend
- Difficult to Answer

Labeled Magnitude Scaling

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Method

Survey Question

- Asks respondents to value an NEI as more or less than energy savings

"Would you say [the value of the NEI] is *more value, less value, or the same value* to you as any [program savings]?"

Calculation

- Develop multiplier corresponding to each response
- Apply response to program savings

Advantages

- Easy to Answer
- Consistent Results
- High Response Rates

Disadvantages

- Restricted Responses
- Qualitative Data

2. APPRISE NEI STUDIES

Billing Analysis Results

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Market Rate Program

Program Group	Analysis Group		
	#	Change in Bill Amount	% Change
HEA w/ No Measures	305	-$37***	-7.4%
Thermostat Only	277	-$38***	-8.4%
Water Heater Only	350	-$29***	-7.0%
Heating System	1,651	-$46***	-9.7%
HPwES	374	-$104***	-22.8%
All Programs	**2,957**	**-$50*** **	**-10.7%**

Billing Analysis Results

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All Programs	**2,957**	**-$50*** **	**-10.7%**

Low Income Program

	Analysis Group		
	#	Change in Bill Amount	% Change
Electric Baseload	4,903	-$63***	-6.4%
Air Sealing and/or Insulation, no HVAC	135	-$33	-2.1%
With HVAC Measures	350	-$32	-2.2%
All Job Types	**5,388**	**-$60*** **	**-5.9%**

APPRISE NEI Surveys

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Survey Timelines (2021)

			Response Rate
Market Rate	FEBRUARY 22	MARCH 28	67%
Low Income	JANUARY 20	MARCH 8	60%

At least nine contact attempts per customer

Voicemails left every third call

Methodology

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Significant Analysis Steps

Outlier values for provided dollar amounts were dropped

Valuation of $0 assigned to respondents who said they experienced no change in NEI

Negative savings values (reported and actual) set to 0 for purposes of scaling.

Labeled Magnitude Scaling — Two different sets of multipliers were used (see next slides).

LMS Multiplier Values

PNNL Multipliers

- Pacific Northwest National Laboratory
- Study of NEIs for LED lights
  - (Ledbetter et al. 2019)
- Five-point scale with energy savings as an anchor
- Derived multipliers from chemistry literature

PNNL Scale	Multiplier Value	APPRISE Scale	Multiplier Value
Much More	1.55	More	1.35
Somewhat More	1.18		
Same Value	1	Same	1
Somewhat Less	0.82	Less	0.65
Much Less	0.475		

LMS Multiplier Values

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In-Sample Multipliers

- Average percentage response for those who answered both questions
- Combined responses of groups with similar expected values and few observations
- Multipliers between zero and one

Examples of in-sample multipliers from market rate program

LMS Response	Safety			PNNL Scale
	Therm.	HVAC,DHW	HPwES	
More Value	0.30	0.68	0.44	1.35
Same Value	0.20	0.70	0.40	1
Less Value	-	0.30	0.15	0.65

Reported vs Actual Savings

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Low Income Program HVAC Participants

Reported vs Actual Bill Savings ($)

Inflation of Reported Savings Values

Reported often zero vs actual non-zero

Survey Responses Relate to Perceived Savings

3. NEI VALUATIONS

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Winter Comfort

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Market Rate

Participant Group	Weighted Annual Mean NEI Value						
	Contingent Valuation	Direct Scaling		LMS – PNNL Multipliers		LMS – In-Sample Multipliers	
		Reported	Actual	Reported	Actual	Reported	Actual
Thermostat Only	$38	$9	$6	$23	$23	$9	$8
Water Heater Only	<$1	$0	$1	$1	$12	<$1	$2
Heating System	$75	$89	$18	$207	$44	$76	$17
HPwES	$78	$120	$29	$273	$91	$100	$34
All	$64	$76	$16	$177	$45	$65	$17

- Estimates were much lower for thermostat only and water heater only customers, as we would expect with winter comfort.
- HPwES customers had the highest estimates, as expected for winter comfort.

Winter Comfort

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Market Rate

Participant Group	Weighted Annual Mean NEI Value	
	Contingent Valuation	[redacted]
Thermostat Only	$38	
Water Heater Only	<$1	
Heating System	$75	
HPwES	$78	
All	$64	

- Estimates were much lower for thermostat only and water heater only customers, as we would expect with winter comfort.
- HPwES customers had the highest estimates, as expected for winter comfort.

Health

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Low Income

Participant Group	Weighted Annual Mean NEI Value						
	Contingent Valuation	Direct Scaling		LMS – PNNL Multipliers		LMS – In-Sample Multipliers	
		Reported	Actual	Reported	Actual	Reported	Actual
Electric Baseload	$1,382	$39	$20	$31	$52	$11	$21
Air Sealing & Insulation	$68	$56	$3	$84	$12	$28	$4
HVAC	$2,157	$110	$11	$195	$28	$97	$14
All	$1,413	$50	$18	$57	$47	$24	$19

- The estimated NEI values using the CV method were clearly skewed by extreme responses for Baseload and HVAC customers.
- NEI estimates for Air Sealing and Insulation customers were relatively low compared to expectations.

Health

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Low Income

Participant Group	Weighted Annual Mean NEI Value			
	Contingent Valuation	[redacted]	LMS – PNNL Multipliers	[redacted]
			Reported	Actual
Electric Baseload	$1,382		$31	$52
Air Sealing & Insulation	$68		$84	$12
HVAC	$2,157		$195	$28
All	$1,413		$57	$47

- The estimated NEI values using the CV method were clearly skewed by extreme responses for Baseload and HVAC customers.
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Main Findings

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NEI Valuations Using LMS with Reported Savings and In-Sample Multipliers

Market Rate

Participant Group	Non-Energy Impact					Total NEI
	Winter Comfort	Summer Comfort	Safety	Health	Noise	
Thermostat Only	$9	$5	$3	$1	$1	$19
Water Heater Only	<$1	$6	$8	<$1	$6	$21
Heating System	$76	$38	$62	$31	$66	$273
HPwES	$100	$126	$23	$44	$39	$332

NEI Values

- As expected, thermostat only customers had low values for each NEI
- Water heater only customers also had very low values for each NEI
- Heating system customers had highest NEI value for noise, second-highest for all others.
- HPwES customers had highest NEI value overall, and for most of the NEIs. HPwES work was the most extensive, so this makes sense.

Main Findings

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NEI Valuations Using LMS with Reported Savings and In-Sample Multipliers

Low Income

Participant Group	Non-Energy Impact					Total NEI
	Winter Comfort	Summer Comfort	Safety	Health	Noise	
Electric Baseload	$72	$40	$34	$11	$39	$196
Air Sealing and Insulation	$72	$58	$36	$28	$34	$228
HVAC	$74	$88	$82	$97	$45	$386

NEI Values

- Winter comfort estimates were comparably high for all three groups
- Summer comfort estimates were high for HVAC, as expected
- Safety estimates were high for HVAC
- Health estimates were high for HVAC and very low for baseload
- Noise estimates were middling for all three groups
- Total estimates were very high for HVAC; baseload not much lower than air sealing/insulation

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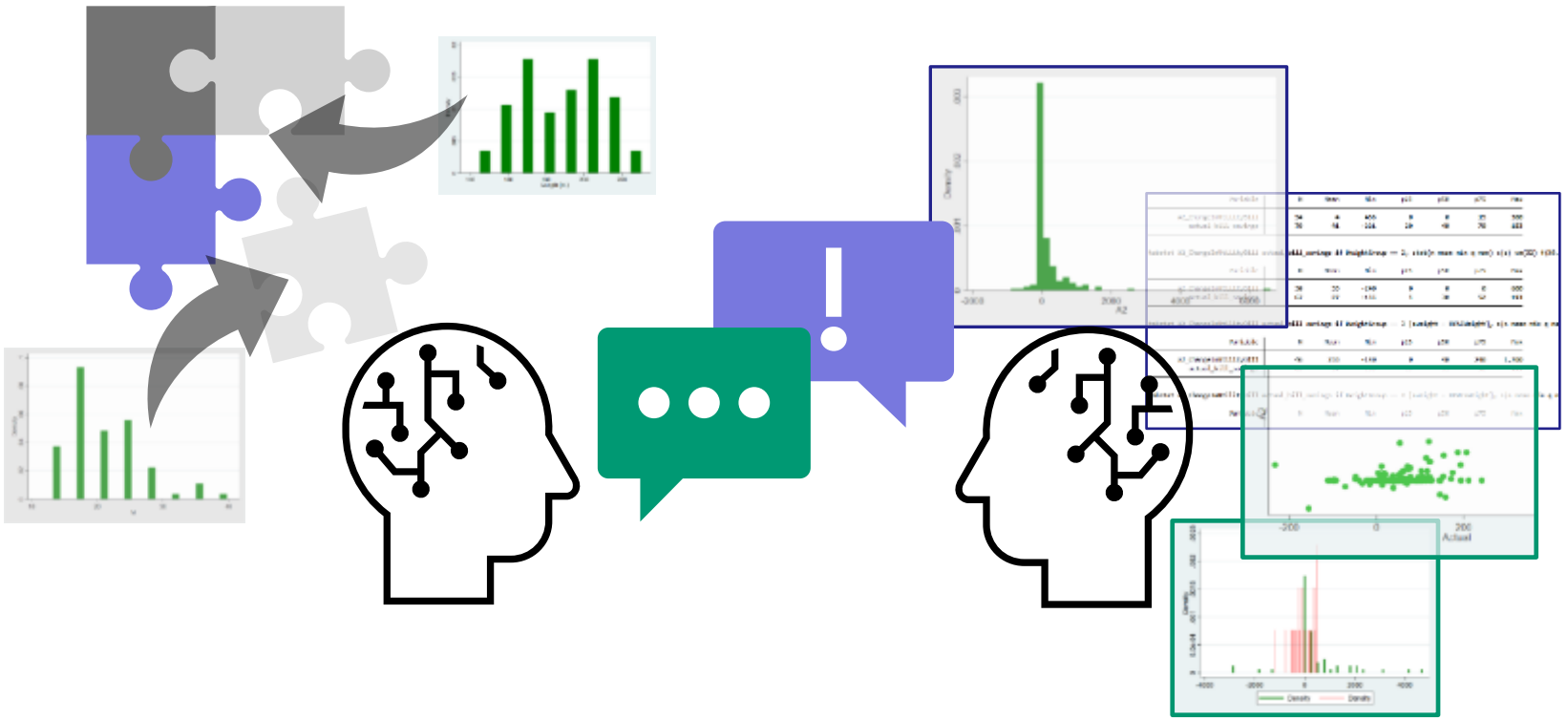
4. ASSESSMENT OF METHODS



Scaling Method Considerations

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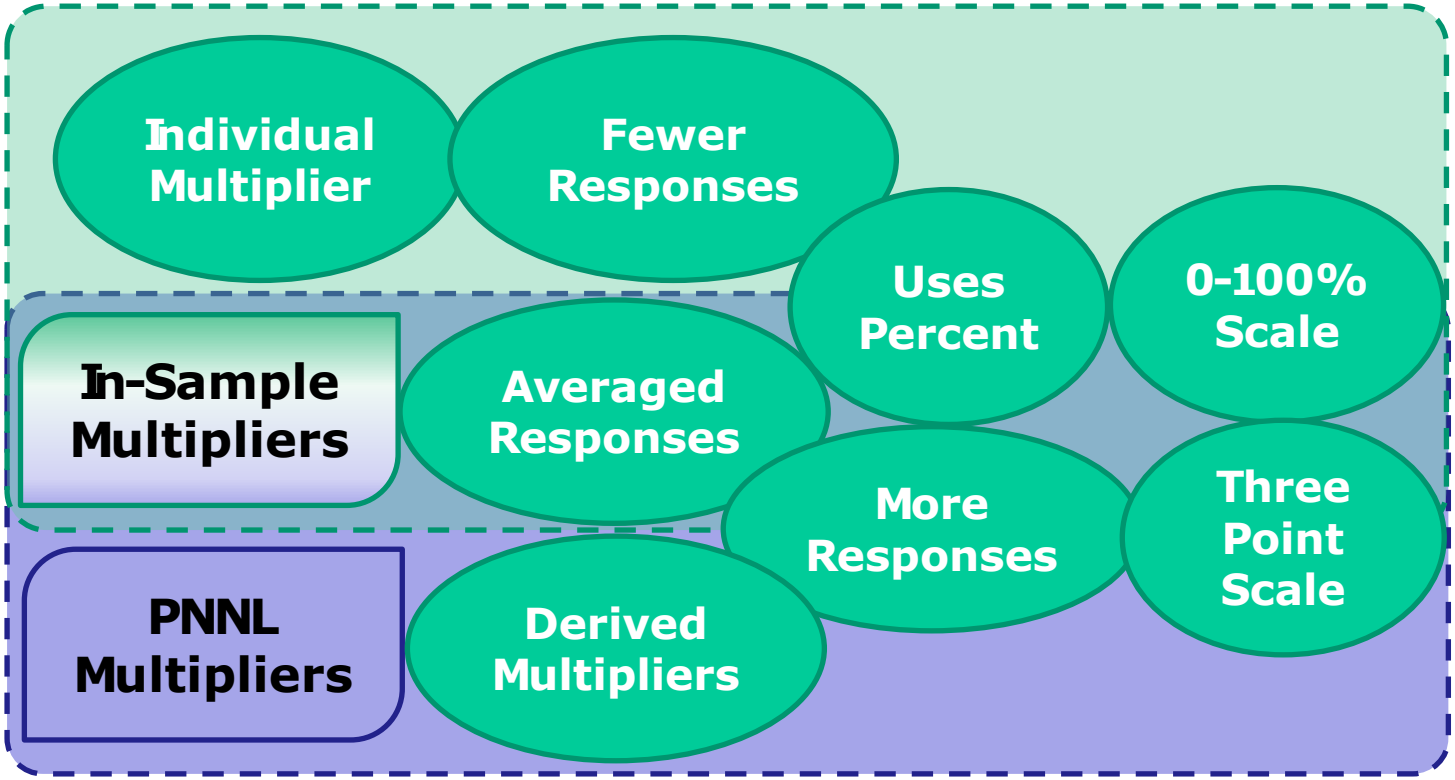

Direct Scaling

Labeled Magnitude Scaling

Key Features

- NEIs Scale with Savings
- Easier to Value with an Anchor
- No Negative Values

Response Consistency

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CV and LMS

Market Rate
- Mostly consistent
- Dollar values corresponded to qualitative answers

Low income
- Very inconsistent
- Dollar values often contradicted qualitative answers

Percentage

Usually ordinally consistent

Produces lower values than implied by qualitative answers

Response Bias?

Many say "More value"

Dollar values are inflated

Percentage responses show clustering

Understand Participant Responses → In-depth Interviews → Test Survey Questions

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5. LESSONS FOR FUTURE RESEARCH

Improving NEI Valuations

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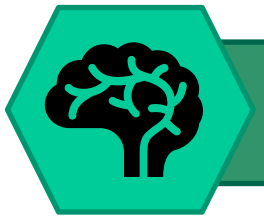
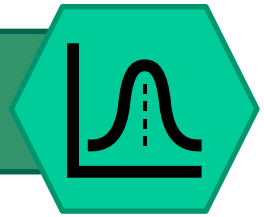
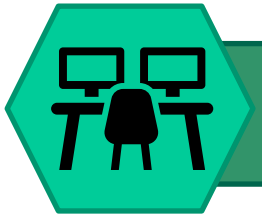


Cognitive Interviews

Large Samples





Compare Findings

Survey Design

Conduct in-depth interviews

□□□

Use survey of specific program

□□□

Collect a large sample

□□□

Weight results

□□□

Be transparent and compare to expectations

□□□

Compare to other studies

□□□

Design surveys carefully

Conclusion

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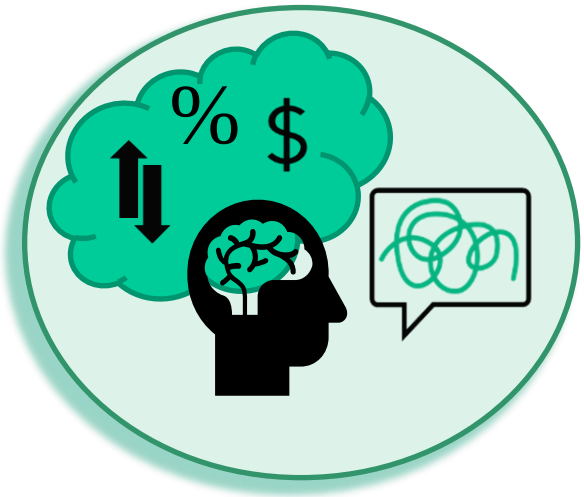


NEIs are difficult for participants to value

Anchors and qualitative labels may help

Cognitive interviews and research needed

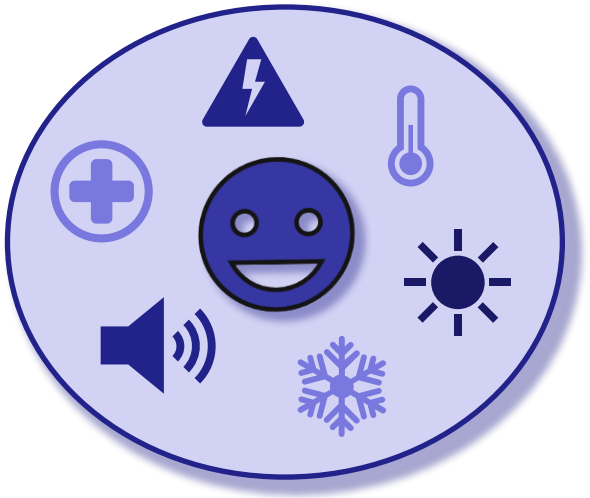
Participant NEIs are difficult to measure

Surveys may be the best approach

Total NEI benefits can be large for some

But many experience no impact

Analysis should account for measurement uncertainty



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