

# **Non-energy Impacts Of C&I Energy Efficiency Measures Provide Substantial Program Benefits Above Carbon Reduction**

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# Agenda

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- **Project Background**
- **Research Objectives**
- **Overview of Approach**
- **NEI Estimation Details**
- **Examples of NEIs**
- **Results**
- **Conclusion and Limitations**

# Background

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## What are Non-Energy Impacts (NEIs)?

- *NEIs* include positive or negative effects attributable to energy efficiency programs apart from energy savings.
- *Participant Impacts* – NEIs that directly benefit a program partner, stakeholder, trade ally, participant, or the participant's household.
  - Examples include lower operations and maintenance costs, or increased sales or revenue.

## Why estimate NEIs:

- **Regulatory cost-effectiveness testing** – Positive NEIs (NEBs) demonstrate effective use of resources in regulatory filings.
- **Other uses of NEIs include:**
  - *Program marketing /targeting* – Demonstrate full value of programs to customers;
  - *Benefit/cost analysis for customers* – Optimal decision making for customers;
  - *Program refinement* –Utilities adjust programs to improve participation;
  - *Portfolio development* – Set of programs that maximize benefits to society;

# Research Objectives

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## Primary Objective

### Quantify NEIs (focus of presentation)

- Estimated NEIs for commercial and industrial retrofit projects completed in 2010.
- Gross NEIs per unit of energy savings resulting from the following measures:
  - **Prescriptive electric** (*5 end uses*): HVAC, Lighting, Motors & drives, Refrigeration, Other
  - **Prescriptive gas** (*4 measure categories*): Building envelop, HVAC, Water heat, Other
  - **Custom electric** (*6 end uses*): CHP/Cogen, HVAC, Motor & drives, Lighting, Refrigeration, Other
  - **Custom gas** (*4 measure categories*): Building envelop, HVAC, Water heat, Other

### Secondary Objective (inconclusive results)

- Examine the relationship between NEIs and program attribution.
  - Do participants who receive NEIs show a different attribution rate?
  - Do expectations of receiving NEIs impact free ridership?

# Background

## Stated Valuation TekMarket Works (2007)

### Contribution

- Break out NEIs into 13 mutually exclusive categories
- Ask survey respondents to approximate values for NEI categories

### Limitation

- Difficult for respondents to monetize
- Resulted in many "don't know" or extreme values

## Engineering Based Estimates Optimal Energy (2008)

### Contribution

- Use engineering formulas to estimate operational impact of EE technology

### Limitation

- Limited to lighting
- Assumption based – Does not explore other sources of costs and benefits

## Blended Approach DNV GL 2012

- Use self-reported responses to mutually exclusive NEI categories
- Use trained energy analysts to conduct in-depth interviews
- Probe into potential sources of NEIs – specific cost and revenue changes and metrics for estimating impacts

### Contribution

- Allow respondent to express NEI in familiar terms
- Construct standard formulas for estimating NEIs based on survey responses

responses

# Estimating NEIs

## Capturing cost and revenue changes by 13 NEI categories

NEI category	Probes						
	Labor <sup>1</sup>	Parts / materials	Training	Fuel <sup>2</sup>	Water	Fees / permits	Other
Operations & maintenance	✓	✓	✓	✓			✓
Administration	✓		✓				✓
Materials handling	✓						✓
Materials movement	✓	✓		✓			✓
Other labor	✓		✓				✓
Spoilage/defects	✓	✓					✓
Water usage					✓		
Waste disposal	✓	✓				✓	✓
Fees						✓	✓
Other costs							✓
Sales							✓
Rent revenues							✓
Other revenues							✓

### Close ended questions

- Identified NEI categories realized;
- Identified direction of impact.

### Open ended probes

- Identify specific changes that occurred;
- Cost and revenue categories impacted;
- Stated values for impacts where possible;
- Metrics used to estimate cost or revenue changes;
- Values for those metrics.

### Most frequently used impact metrics interviewers identified to compute NEIs:

- Frequency – number of times activity occurred, per year, and whether it was annual-recurring or one-time;
- Time spent – internal or external labor in units of time (e.g. minutes, hours, days);
- Quantity – number of relevant staff/purchased items (e.g. employees, contractors, parts);
- Salary – labor wage, as loaded value including employee benefits; and
- Cost – total cost (or \$ cost/each).

# Estimating NEIs

## Example: Custom Refrigeration Measure

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### Operations and Maintenance Cost Savings:

#### *Internal Labor:*

Saving 20/yr hours from staff having to change motors (Refrigeration case motors needing to be replaced)  
(Salary = \$18/hr – includes benefits) = 20 hrs/yr \* \$18/hr = \$360/yr

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Saving 10 hours week ( an hour per store) on less time having to cull spoiled packages  
(Salary = \$18/hr – includes benefits) = \$18/hr \* 10 hrs/week \* 52 weeks/yr = \$9,360/yr

#### *External Labor*

Estimates saving about \$3,500/yr on vendors coming in to deal with malfunctioning equipment

### Product Spoilage

Saving \$20 in meat department every day from products not spoiling as often due to better refrigeration  
(\$20/day \* 365 days/yr = \$7,300/yr)

Saving \$10 in produce department for every day from products not spoiling as often due to better refrigeration

(\$10/day \* 365 days/yr = \$3,650/yr)

# Estimating NEIs

## Example: Custom Refrigeration Measure

NEI Category	Cost/Revenue Category	Formula	Measures using formula
			n=x
Operation and Maintenance	Internal Labor	(Hours per year due to Old Equipment * Hours per year due to New Equipment)*Loaded wage per hour	145
		(Hours per year due to Old Equipment * Hours per year due to New Equipment)*Unloaded wage per hour	20
		(Hours per year due to Old Equipment * Hours per year due to New Equipment)* Times per year*Loaded wage per hour	10
		(Hours per year due to Old Equipment * Hours per year due to New Equipment)* Times per year*Unloaded wage per hour	1
		Hours per year due to New Equipment*Loaded wage per hour	9
		Hours per year due to New Equipment* Unloaded wage per hour	2
		Hours per year due to Old Equipment*Loaded wage per hour	49
		Hous per year due to Old Equipment * Times per year * Loaded wage per hour	7
		Hous per year due to Old Equipment * Times per year *Unloaded wage per hour	6
		Hours per year due to Old Equipment* Unloaded wage per hour	3
		No Calculation Required- Value stated upfront	38
		<b>Operation and Maintenance Internal Labor Total</b>	<b>290</b>

### Standard formulas helped:

- Identify incomplete and incorrectly calculated NEIs
- Verify NEIs applied to all relevant measures
- Identify double counting of NEIs
- Eliminate invalid NEIs
- Impute missing values
- Review and treat extreme values



# Estimating NEIs

## Ratio estimation: NEIs / energy savings by reporting category

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**Electric Measures** – \$ NEI / KWh savings

**Gas Measures** – \$ NEI / therm savings

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### NEIs adjusted for:

#### *Extreme Values*

- Reviewed interviewer notes and data for each metric;
- Most extreme values resulted from invalid assumptions regarding individual metrics ;
- Either corrected or set to missing.

#### *Missing Values*

- Missing values for individual metrics imputed based on average for reporting category;
- If cost or revenue category and direction of change identified imputed value based on average for reporting category.

#### *Invalid NEIs*

- Example: Some respondents un-realized increase in property values.

#### *Replace on failure measures*

- Measures with 100% Free Ridership due to timing considered replace on failure;
- For these measures, used % of NEI attributed the measure being EE vs. New Equipment from survey to discount the share of NEI that is attributed to the measure being new.

# Results

## NEIs / kWh savings by reporting category

		Average Annual NEI per Measure*					
Electric measures	n	NEI/kWh	90% CI Low	90% CI High	Stat Sig		
<b>Prescriptive</b>							
HVAC	27	\$ 7,687	\$ 0.0966	\$ 0.0544	\$ 0.1389	Yes	
Lighting	163	\$ 1,636	\$ 0.0274	\$ 0.0176	\$ 0.0372	Yes	
Motors and Drives	50	\$ 541	\$ 0.0043	\$ (0.0005)	\$ 0.0091	No	
Refrigeration	30	\$ 5	\$ 0.0013	\$ (0.0002)	\$ 0.0028	No	
Other	32	\$ 28	\$ 0.0039	\$ (0.0002)	\$ 0.0079	No	
<i>Total</i>	302	\$ 1,439	\$ 0.0274	\$ 0.0188	\$ 0.0360	Yes	
<b>Custom</b>							
CHP/Cogen	6	\$ (12,949)	\$ (0.0147)	\$ (0.0247)	\$ (0.0047)	Yes	
HVAC	20	\$ 5,584	\$ 0.0240	\$ 0.0003	\$ 0.0477	Yes	
Lighting	89	\$ 5,686	\$ 0.0594	\$ 0.0318	\$ 0.0871	Yes	
Motors and Drives	42	\$ 1,433	\$ 0.0152	\$ (0.0005)	\$ 0.0309	No	
Refrigeration	90	\$ 1,611	\$ 0.0474	\$ 0.0244	\$ 0.0705	Yes	
Other	29	\$ 15,937	\$ 0.0562	\$ 0.0038	\$ 0.1087	Yes	
<i>Total</i>	276	\$ 4,454	\$ 0.0368	\$ 0.0231	\$ 0.0506	Yes	
		Average Annual NEI per Measure*					
Gas measures	n	NEI/kWh	90% CI Low	90% CI High	Stat Sig		
<b>Prescriptive</b>							
Building Envelope	2	\$ 1,551	\$ 106.0306	\$ 77.4829	\$ 134.5783	Yes	
HVAC	50	\$ 755	\$ 39.4909	\$ 15.9353	\$ 63.0466	Yes	
Water Heater	47	\$ 129	\$ 7.6386	\$ (0.0348)	\$ 15.3120	No	
<i>Total</i>	99	\$ 439	\$ 24.4714	\$ 10.6578	\$ 38.2850	Yes	
<b>Custom</b>							
Building Envelope	46	\$ 922	\$ 14.0013	\$ 3.6883	\$ 24.3144	Yes	
HVAC	41	\$ 2,798	\$ 6.7199	\$ 4.4639	\$ 8.9759	Yes	
Water Heater	23	\$ 803	\$ 5.3508	\$ (14.5258)	\$ 25.2274	No	
Other	2	\$ 1,905	\$ 15.4066	\$ (165.9399)	\$ 196.7532	No	
<i>Total</i>	112	\$ 1,940	\$ 7.2522	\$ 4.3705	\$ 10.1339	Yes	

# Results

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## Operation and Maintenance

- HVAC – Decrease in annual maintenance of the HVAC systems. Reduced due to the automated thermostats;
- Lighting – Decreased internal and external labor time spent changing bulbs lower costs for purchasing new bulbs;
- Building envelope – Decreased labor hours due to the decrease in window, roof, door, or other miscellaneous repairs;
- CHP/Cogeneration - Increase in preventative maintenance and repairs due to new piece of equipment.

## Rent Revenue

- HVAC – Decrease in the utility costs allowed for lower rental rates; also increased comfort;

## Product spoilage

- HVAC – Reduced product spoilage accounted for 2.0% of average annual NEIs;
- Motors and Drives – Reduced product spoilage accounted for nearly 30% of average annual NEIs;
- Refrigeration – Reduced product spoilage accounted for nearly 42% of average annual NEIs.

## Sales Revenue

- Lighting – New lighting enhances their retail display showroom resulting in increased sales.

## Waste Disposal

- Lighting – Respondents reported that they are no longer spending as much money or time disposing of used bulbs.

# Conclusions and Limitations

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## Conclusions

- Statistically significant NEI estimates across most reporting categories;
- Statistically significant correlation between program savings and the level of NEIs reported for prescriptive electric, custom electric and custom gas;
- Our analysis of attribution rates for participants who realized NEIs and those who did not report NEIs showed did not provide conclusive evidence that NEIs and attribution were correlated.

## Limitations

- While the evaluation team did capture information pertaining to resource savings, we did not obtain sufficient data to obtain statistically reliable resource savings estimates;
- Our research approach focused primarily on identifying annual NEIs. Consequently, the results may under estimate NEIs associated with one-time costs or benefits;
- The NEI estimates provided by this study were largely influenced by O&M cost reductions. Further research is required to examine the appropriate treatment of NEIs associated with maintenance over time;
- NEIs may be underestimated simply due to the nature of self report surveys.