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Energy Efficiency Program Evaluation

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Overview

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1. **Introduction**
2. **Evaluation**
3. **Achieving High Savings**
4. **Non-Energy Impacts**
5. **Recommendations**

- Usage Impacts
- Projected Savings
- Billing Analysis
- Surveys
- Observations & Inspections
- Cost Effectiveness
- Realization Rates

- High Users
- Major Measures
- Quality Installations
- Performance Measurement

- Health & Safety
- Affordability
- Water Cost
- Maintenance Cost
- Economic
- Environmental

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Introduction

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Nonprofit Research Institute

- Established in 2002
- Princeton, NJ

Mission

- Analyze data and information to assess and improve public programs

Research Areas

- Energy Efficiency & Renewables
- Energy Affordability

Clients

- Federal Government (DOE, HHS)
- State Governments
- Utility Companies
- Nonprofits

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Why Energy Efficiency?

Energy Efficiency "The Invisible Fuel"

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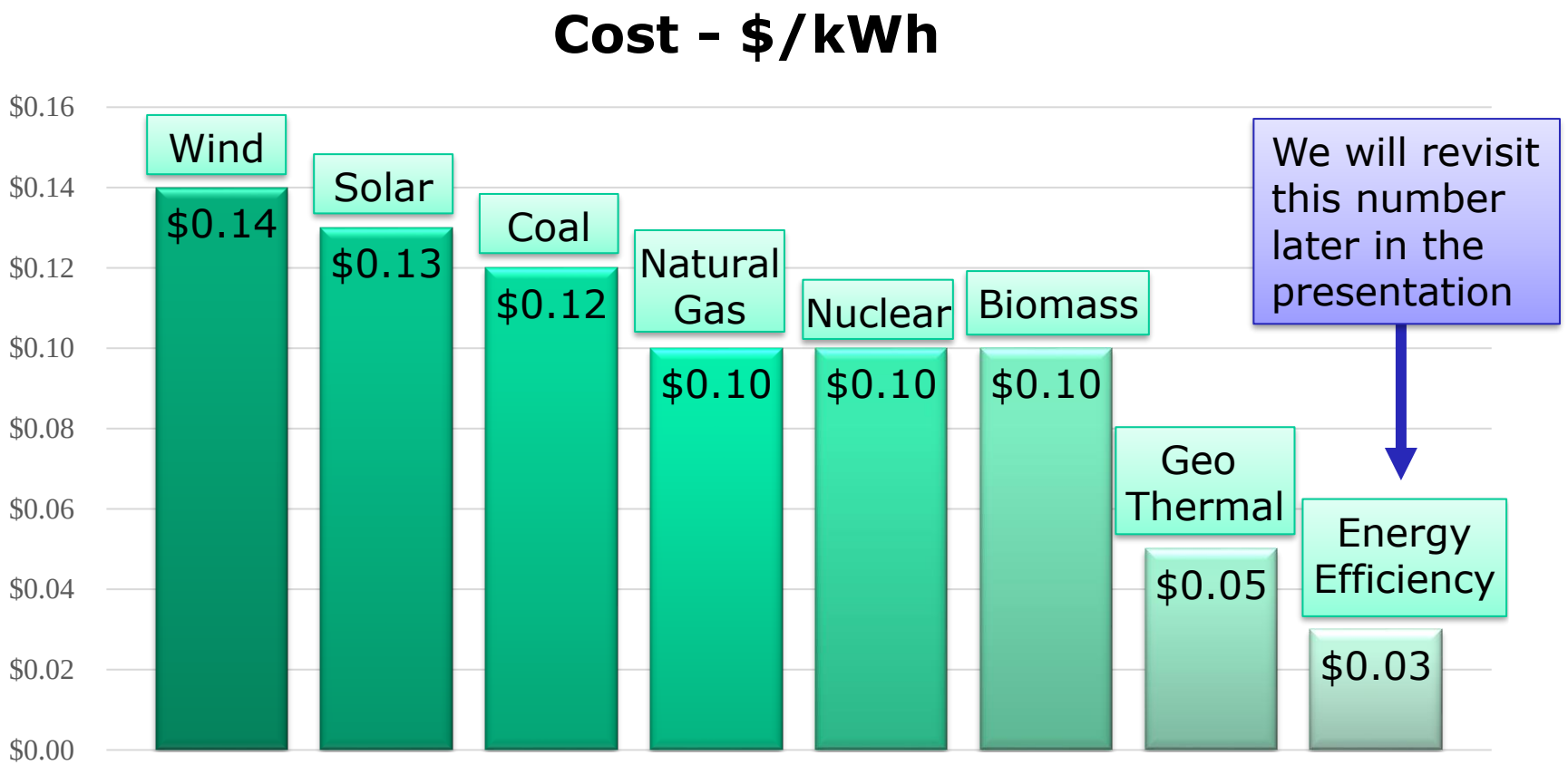

Source: ACEEE

Other Benefits

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Home Comfort

Drafts

Humidity

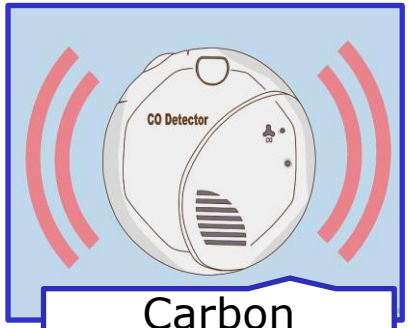
Cold/Hot Rooms

Noise

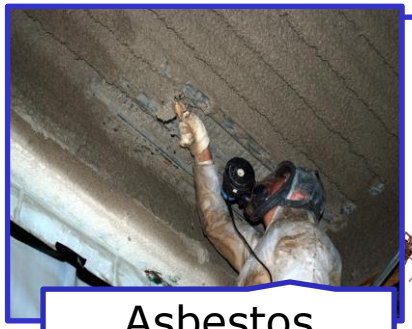
Health & Safety

Mold

Air Quality



Carbon Monoxide



Asbestos

Pests

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Evaluation

Why Evaluate?

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Measure Program Impacts	Assess Potential Improvements	Meet Regulatory Requirements
• Energy usage • Energy bill affordability • Economic impacts • Environmental impacts • Health, safety, and comfort • Delivery to vulnerable households • Cost benefit analysis	• Goals • Efficiency • Effectiveness • Equity • Targeting • Client satisfaction	• State • PUC • Other

"Measurement is the first step that leads to control and eventually to improvement. If you can't measure something, you can't understand it. If you can't understand it, you can't control it. If you can't control it, you can't improve it."
— H. James Harrington

Evaluation Activities

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Impact Evaluation Activities

- Program Data Analysis
- Usage Impact Analysis
- Payment Impact Analysis
- Economic Impact Analysis
- Environmental Impact Analysis
- Health & Safety Impact Analysis
- Participant Survey
- Cost-Benefit Analysis

Process Evaluation Activities

How is the program designed?	• Documentation review • Interviews with program design and management team
How is the program implemented?	• Interviews with program managers and implementers • On-site observation • Surveys with program participants
Why is it working or not working?	• Synthesis of all evaluation data

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Energy Usage Impact Analysis

Usage Impacts

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Research Questions

- Were expected energy savings results obtained?
- Are the treatments cost-effective?
- Should measure selection procedures be revised?
- Should installation procedures be reviewed?
- Should contractors be re-trained?

Approach

- Goal: Develop most accurate estimate of program savings
- Weigh costs and benefits of various approaches to measurement
- Consider possible causes of mis-measurement or bias

Options

1. Deemed Savings
2. Projections / Engineering Estimate / Technical Reference Manual
3. Energy Usage Billing Analysis

Analysis Approaches

Approach	Cost	Accuracy	Attrition	Reasons for Excluding Jobs from Analysis
Deemed Savings	$		****	None
Engineering Estimate with Retrofit Data	$$	*	***	Retrofit Data Missing
Billing Analysis	$$$	***	**	Usage Data Missing or Inadequate
Metering	$$$$	****	*	Cost

What Are You Measuring?

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Approach	Measures	Issues
Deemed Savings --- Engineering Estimate	Expected usage change based on measures alone	•Assumptions •Installation quality •Other usage changes
$Usage_2$ - $Usage_1$	Actual change in usage	•Weather •Other factors
Weather Norm $Usage_2$ - $Usage_1$	Change in usage if both periods had average weather	•Other factors
Weather Norm $Usage_2$ - $Usage_1$ w/Comp. Group	Other factors held constant (prices, economy, market information, etc.)	•Best estimate of program impact

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Projections

Bad Forecast?

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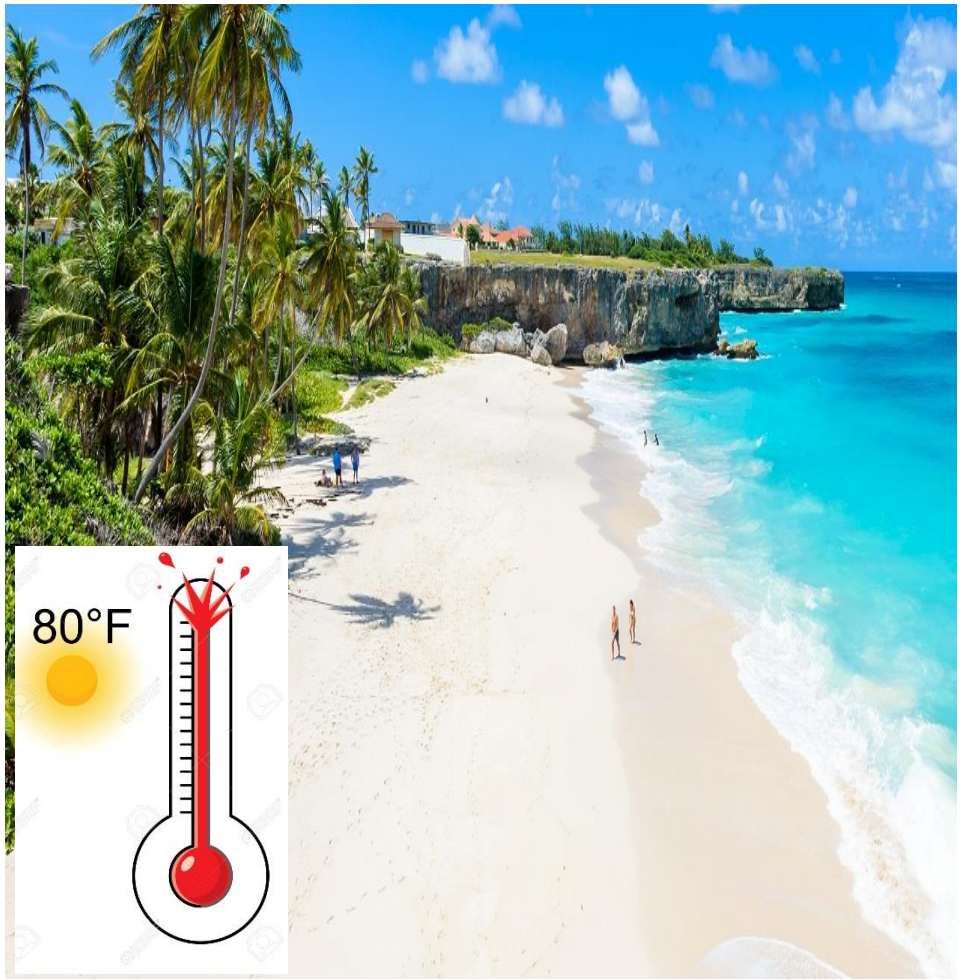

What are TRMs?

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TRM

- Technical Reference Manuals
- Engineering Estimates
- Projections

Equations

- Calculate savings that result from measure installation
- Use of newly installed measure compare to a baseline

What is the Baseline?

- Existing equipment
- Current code requirements or standard equipment

- Existing equipment for remaining life in existing equipment
- Standard equipment for rest of the life of the new measure

Low-income households may continue to use equipment past the expected life

TRM Calculations

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NJ 2018 TRM

- Lighting Savings (kWh/yr) = $\frac{(Watts*QTY)_{BL} - (Watts*QTY)_{P}}{1{,}000}$ * HRS * (1+$HVAC_E$)
- $HVAC_E$ accounts for interaction, reduces gas heating saved, increases cooling saved

Mid Atlantic 2016 TRM

- HE Gas Boiler Savings (MMBTU/yr)= $\frac{EFLHhet*Btuh*\frac{AFUEee}{AFUEbase}}{1{,}000{,}000}$
- $EFLH_{het}$=equivalent full load heating hours
- AFUE = efficiency

MN 2019 TRM

- LF SH Savings (kWh/yr) = $\frac{(GPM_{BASE} - GPM_{LOW})*\left(\frac{PH*SPD*SL}{SPH}\right)*365*Density*C_P*(T_{OUT}-T_{IN})}{ReEff*3{,}412}$
- Gallons per Minute, People in Home, Showers per Day, Shower Length, Showers per Home, Shower Temperature, Groundwater Temperature, Recovery Efficiency (98%)

TRM Advantages & Disadvantages

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Advantages (convenience)

Data Requirements

- No post usage data, weather data, or comparison group data

Lower Cost

- Less complicated data analysis

Timeliness

- No need to wait for post usage data

Planning & Reporting

Disadvantages (accuracy)

Measure Install Rates	Power strip not installed
Measure Retention Rates	Removed /broken LED
Pre-Treatment Usage/ Existing Conditions	Hours used for specific measure
Measure Effectiveness	Quality (air sealing comprehensiveness)
Incorrect TRM Application	Formula, Input values
Interactions	Shell & heating system Lighting & heat gain/loss
New Measures	Not included Or deemed savings
Variation in Savings	Measured differences may relate to TRM

How are TRMs Used?

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Regulatory Reporting — **Justify Program Investments**

- How are TRM values referred to?
- Does the audience understand what they mean?
- Is this measure an improvement over jobs completed or dollars invested?
- Overemphasis on TRM as a measure of program accomplishments

$.03 cost per kWh saved?
Significantly higher?

Non-Energy Impacts — **Economic, Environmental, and Other Impacts**

- Economic: Energy savings translate into increased spending on goods with greater multiplier than energy
- Environmental: Energy savings translate into reductions in greenhouse gas emissions

Cost-Effectiveness Calculations — **Measure Selection, Program Implementation or Continuation**

- Key input for program and measure-level cost-effectiveness

Program Comparisons — **Relative Investments and Savings**

- How does variation in TRMs impact relative savings?

Energy Efficiency Resource Standards (EERS) — **Performance Incentives & Penalties**

- Require utilities to reduce energy consumption by a certain amount over a specified time period
- 27 states had EERS in 2019 (ACEEE https://www.aceee.org/sites/default/files/state-eers-0519.pdf)

Decoupling — **Lost Revenue Calculations**

- Removes connection between utility revenue and sales volume
- Sometimes can only recover revenue related to energy efficiency program savings

TRM Examples

Example 1: Savings from One All Electric Program Based on Different State TRMs

Measure	2011-2015 Jobs	
	Source	Mean TRM Savings (kWh)
Insulation – Floor	CT (2016)	150
	IL (2016)	58
Room AC – Early Replacement	CT (2016)	59
	PA (2016)	39
Dehumidifier – Early Replacement	MN (2016)	136
	MA (2013-15)	329

Example 2: MN Low-Income Utility Wx

Basic TRM – no interactions, no pre-condition info

- Utilities can use alternative method
- Documentation not provided

Utility	Delivery Agencies	Mean Cost	Mean TRM Savings (Therms)	Notes
1	WAP	$3,482	186	Consistent with WAP Billing analysis. No data to assess Non-WAP.
2	Non-WAP	$3,122	159	
3	WAP	$3,354	318	Appears high
4	WAP	$6,689	546	Appears high. No info on usage.

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Billing Analysis

Billing Analysis

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Analysis Steps

1. Data Retrieval
2. Weather Normalization
3. Comparison Group Selection
4. Sub-Group Analysis

Challenges

Data Attrition

- Savings may not represent treated population

Sample Size

- If too few observations…
- Low precision for savings estimates
- Cannot perform sub-group analysis

Measure Savings

- Requires larger sample size,
- Variation in installed measures, and
- Significant installation of measures

Billing Analysis Data Requirements

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Core Data Required	
Energy billing data	• Read date • Real / estimated • Usage • Units
Service delivery date	Divides period into pre- and post-treatment
Weather data	• Local weather station • Daily temp • One year pre- and post-treatment • Longer normalization period

Supplemental Data	
Energy efficiency measures	Measure-specific impacts
Service delivery providers	Provider-specific impacts
Housing unit characteristics	Relation between housing /household characteristics and savings
Household characteristics	

Weather Normalize

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Household Level

PRISM

- Regression analysis for each household
- Weather-normalized pre-usage, post-usage, and change estimated for each household

Advantages

- Remove outliers
- Detailed attrition analysis
- Analysis of usage & savings
  - High & Low Savers
  - Pre-Treatment Usage
  - Contractor
  - Measures
  - Household characteristics
  - Home characteristics

Pooled

Fixed Effects Regression

- Usage analyzed for all households within one model
- Average energy savings estimated for all homes

Advantages

- Uses all data / all homes
- Does not require full year pre/post
- Direct estimate of impact
- Controls for exogenous factors

Weather Normalization

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Household Level Analysis

Regression Analysis on Each Individual Home

$$F_i = \alpha + \beta H_i(\tau) + \epsilon_i$$

F_i = average daily usage, time interval i

$H_i(\tau)$ = heating degree days to reference temp τ in interval i

ϵ_i = random error term

Normalized Annual Usage = $365\alpha + \beta H_o(\tau)$

$H_o(\tau)$ = long term mean heating degree days

Use House-by-House Analysis When

- Sufficient usage data for significant % of treatment and comparison
- Data to assess factors related to savings

Use Pooled Analysis When

- Limited usage data availability
- Concern for attrition bias
- Supplemental data not available

Pooled Analysis

$$F_{it} = \alpha_i + \beta 1 * H_{it} + \beta 2 * POST_t + \beta 3 * POST_t * H_{it} + \varepsilon_{it}$$

- F_{it} = average daily usage during the pre- and post-treatment periods
- H_{it} = average daily base 60 HDDs
- POSTt = a dummy variable that is 0 in pre-period and 1 in post-period
- ε_{it} = estimation error term
- **PRE USAGE**
  - α_i = average daily baseload usage in pre-treatment period
  - β1 = average daily usage per HDD in the pre-treatment period
- **POST USAGE**
  - $\alpha_i + \beta 2$= average daily baseload usage in post-treatment period
  - $\beta 1 + \beta 3$= average daily usage per HDD in post-treatment period
- **SAVINGS**
  - β2 = average daily baseload savings
  - β3 = heating usage savings per HDD

Comparison Groups

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Purpose

Control for Exogenous Factors

- Energy Prices
- Economic Conditions
- Pandemics

Random Assignment

"Gold Standard"

- Difficult to apply
- Challenge to find participants
- Programs not willing to withhold treatment
- Serve those most in need

Quasi-Experimental

Best Alternative

- Later Program Participants
- Low-Income Non-Participants
- Matched Sample

Quasi-Experimental
Later Participant Comparison

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Difference-in-Difference Analysis

	Pre	Post	Change	Measured
Treatment Group	Year Before Services	Year After Services	Before - After	Program Impact +Other Factors
Comparison Group	2 Years Before	1 Year Before	2 Years Before – 1 Year Before	Other Factors
Treatment - Comparison				**Program Impact**

Quasi-Experimental Design

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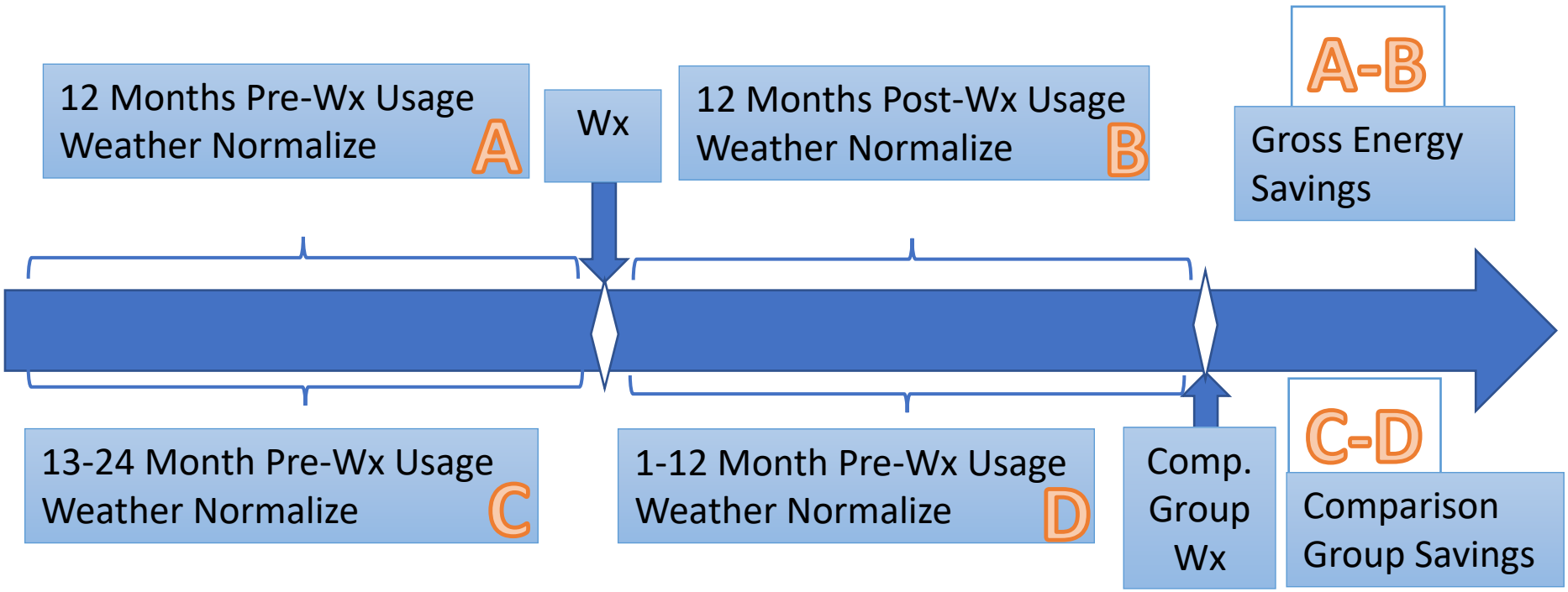

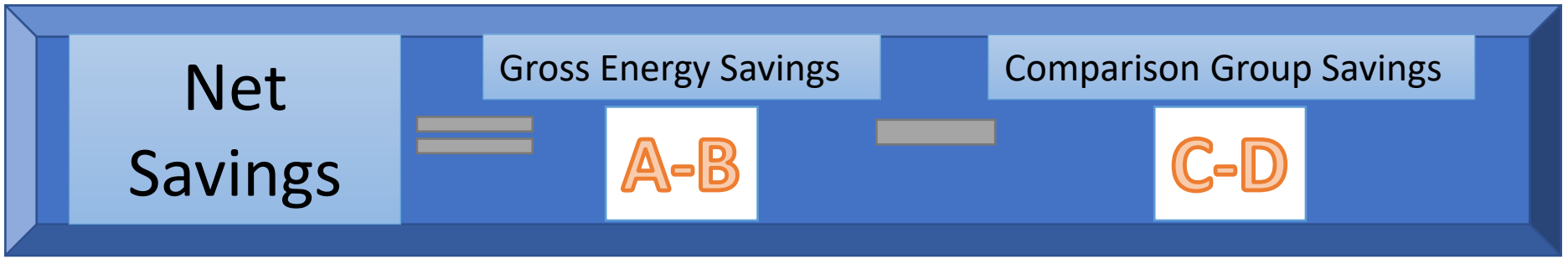

Billing Analysis Subgroups

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Research Questions

- Why are savings higher or lower than expected?
- Which measures are providing savings?
- Which contractors are most effective?
- How does savings relate to pre-treatment usage?
- Are certain types of homes providing higher savings?

Key Factors

- Measures Installed
- Measure Cost
- Pre-Treatment Usage
- Contractor
- Home Type

Major Measures

Electric

- Air Sealing
- Insulation
- Duct Sealing
- Heating System Replacement
- Air Conditioning Replacement
- Refrigerator Replacement

Natural Gas

- Air Sealing
- Insulation
  - Attic
  - Floor
  - Wall
  - Sidewall
- Duct Sealing
- Heating System Replacement

Rebate Impact
Gas Savings by Efficiency

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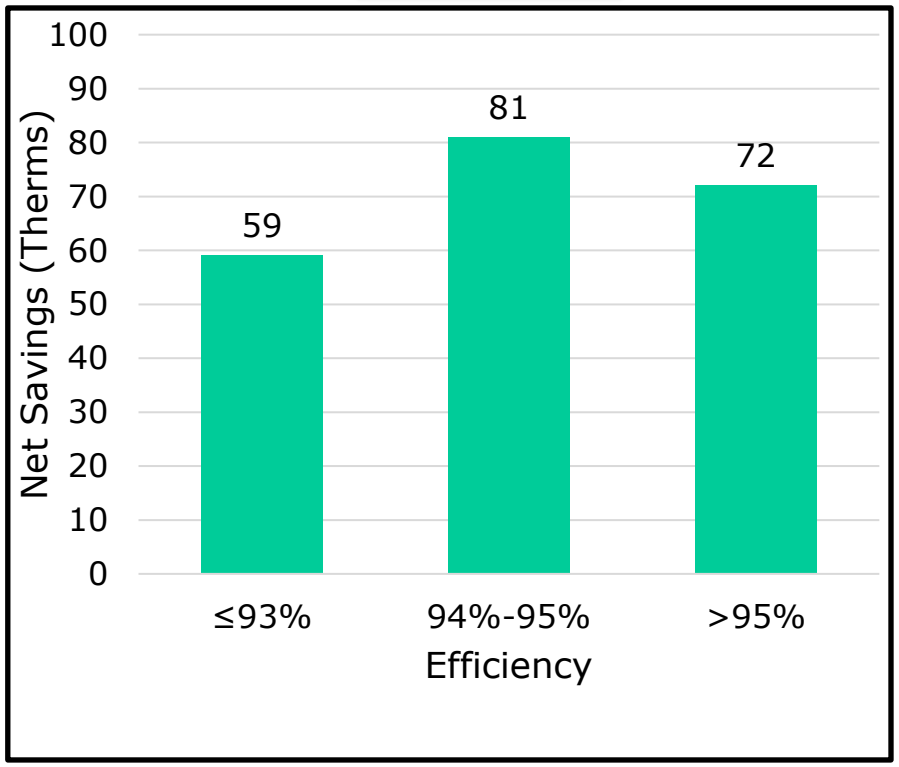
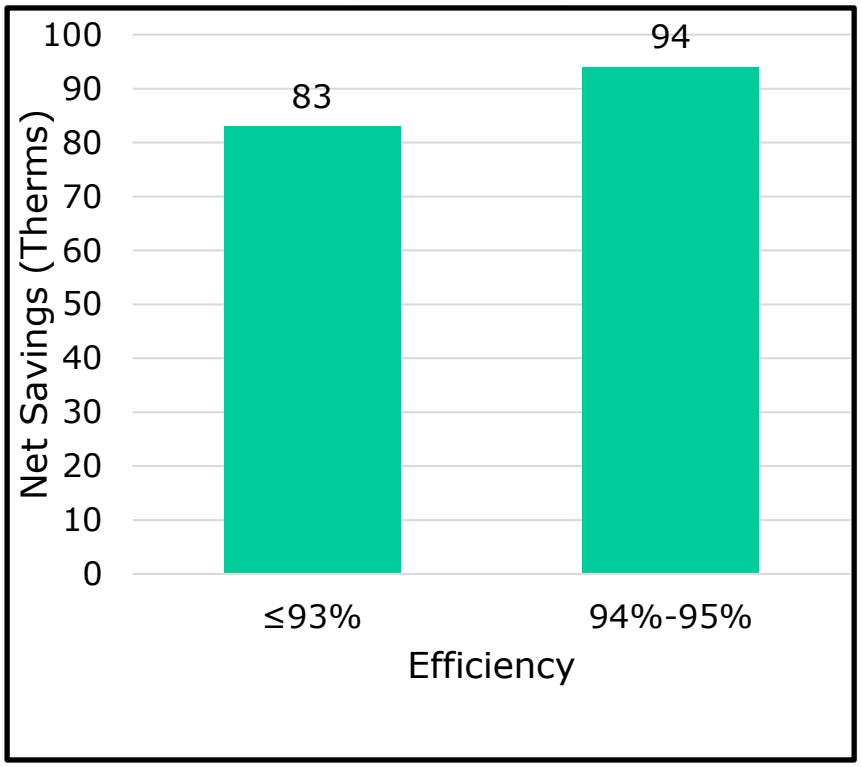
Furnaces



Boilers



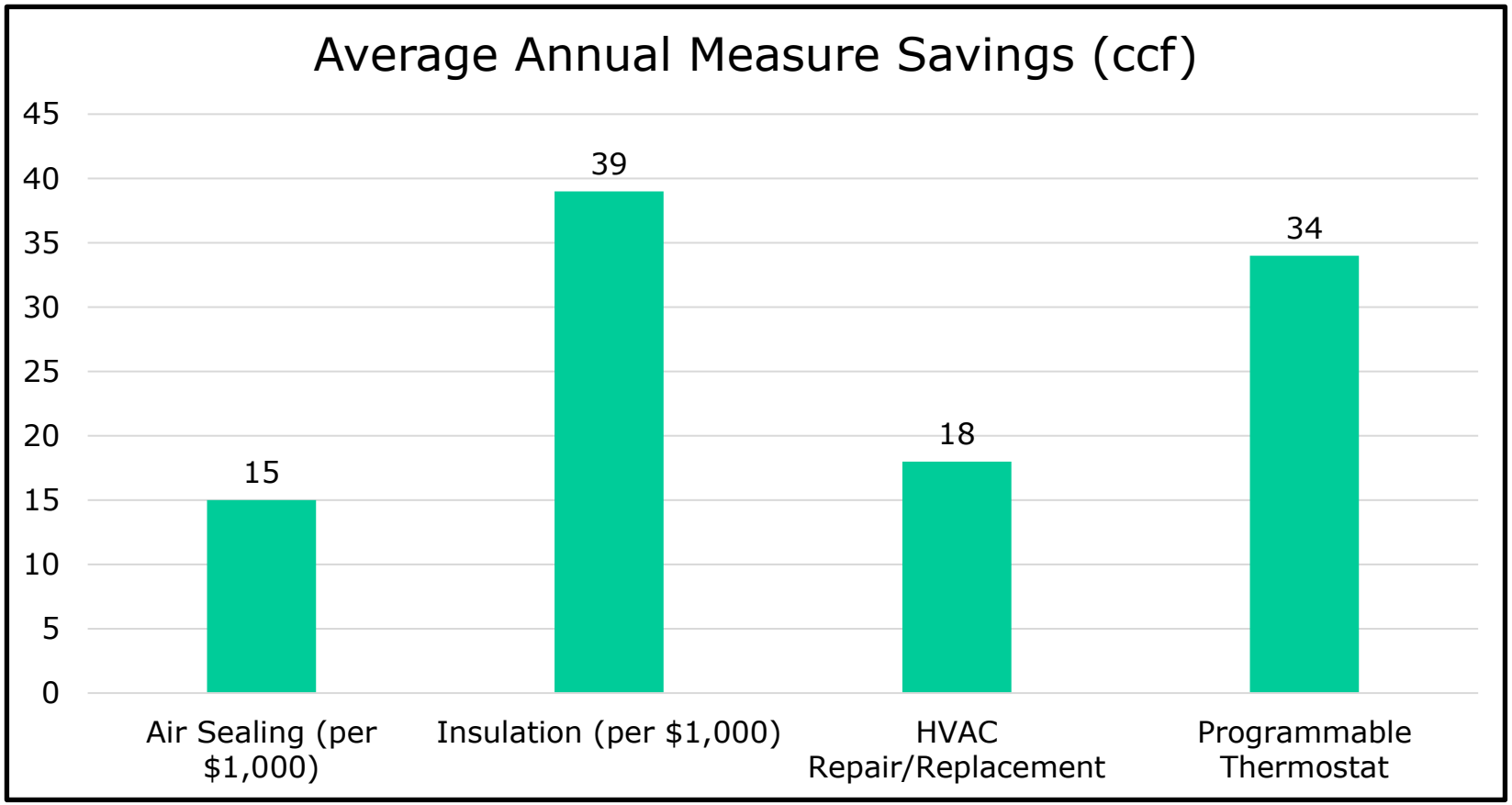
New Jersey Natural Gas SAVEGREEN 2013 participants.

Measure Impacts

- Run regression to determine measure specific impacts

$$\text{Usage change} = \alpha + \gamma^{1} * \text{measure}^{1} + \gamma^{2} * \text{measure}^{2} + \gamma^{3} * \text{measure}^{3} + \mu$$

Measure Impacts Low-Income EE Program



New Jersey Comfort Partners 2010-2011 participants.

Measure-Level Impacts

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2016 PGW Low-Income Usage Reduction Program
Measure-Level Savings

Measure	Obs.	Savings (ccf/yr)	Projected Savings (ccf/yr)	Realization Rate
Roof Insulation	364	87±33	133	65%
Heating System Replacement	523	284±25	409	69%
Air Sealing w/ Blower Door	718	40±24	112	36%
Air Sealing w/o Blower Door	482	24±26	76	32%
Programmable Thermostat	1,391	37±18	64	57%
Water Heater Replacement	60	71±66	38	184%

Cost Effectiveness

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Purpose	Description	Options

• Determine whether program is cost-effective
• Determine whether specific measures are cost-effective
	• Comparison of program benefits and program costs
	• Use of discount rate to determine total benefits over lifetime of the measures
		• Costs to include
		  • Program costs
		  • Participant costs
		  • Ratepayer costs
		• Benefits to include
		  • Utility avoided supply costs
		  • Participant savings
		  • Non-energy benefits

Cost Effectiveness

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2016 Low-Income Usage Reduction Program Evaluation

	#	Mean Savings	Mean Total Cost	Cost Per Unit Saved	Measure Life (years)		
					5	10	15
Electric Baseload							
Electric (kWh)	4,198	887	$444	$0.50	$0.12	$0.06	$0.05
Electric Heat							
Electric (kWh)	162	1,129	$1,969	$1.74	$0.40	$0.23	$0.17
Gas Heat							
Electric (kWh)	841	550	$203	$0.37	$0.09	$0.05	$0.04
Gas (ccf)	854	89	$1,936	$21.76	$5.02	$2.82	$2.10

Realization Rates

Purpose

How do estimated savings compare to projections?

- Are certain measures underperforming?
- How should the Technical Reference Manual (TRM) be adjusted?

Computation

Program Level or Customer Level

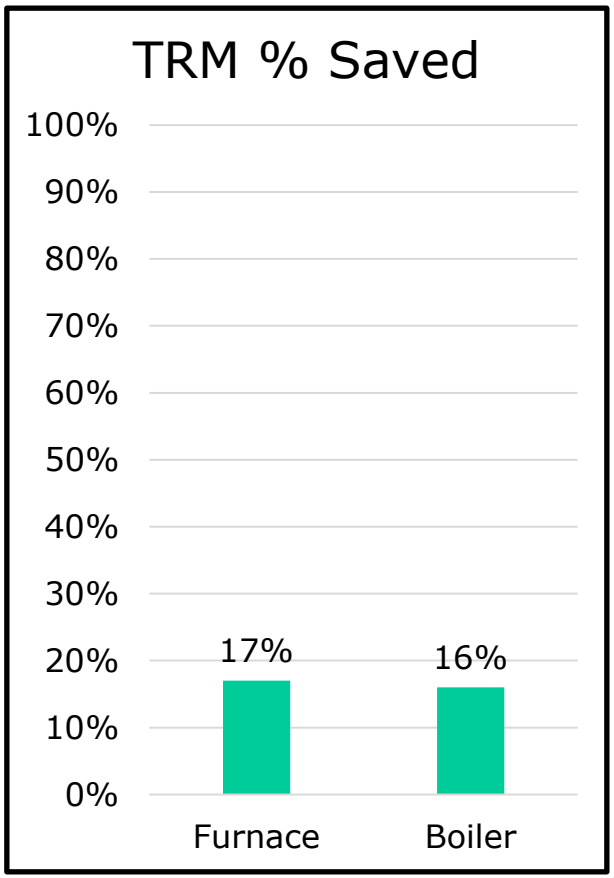
- Average Customer Realization = Mean $\left\{\frac{\text{Usage Impact Savings}}{\text{Projected Savings}}\right\}$
- Average Program Realization = $\frac{\text{Sum of Usage Impact Savings}}{\text{Sum of Projected Savings}}$

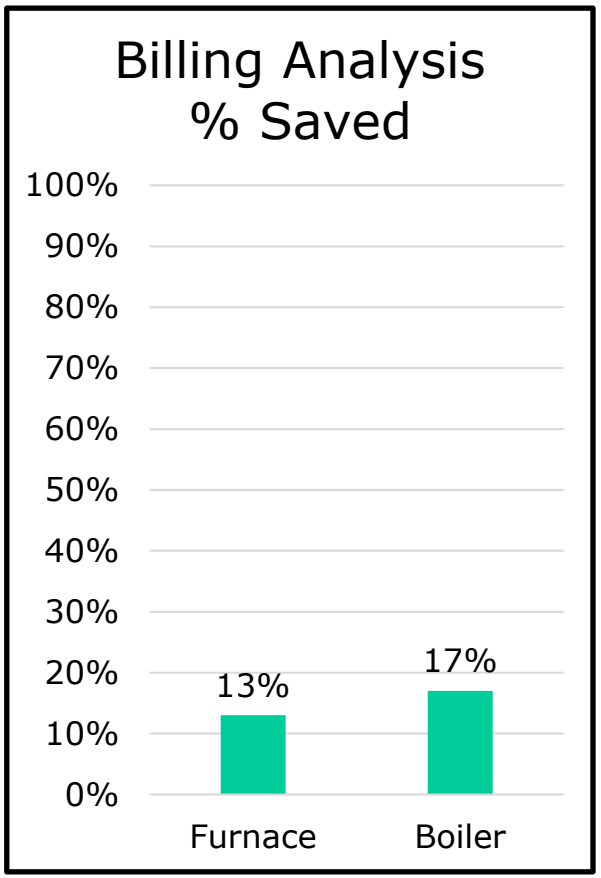
Adjustment

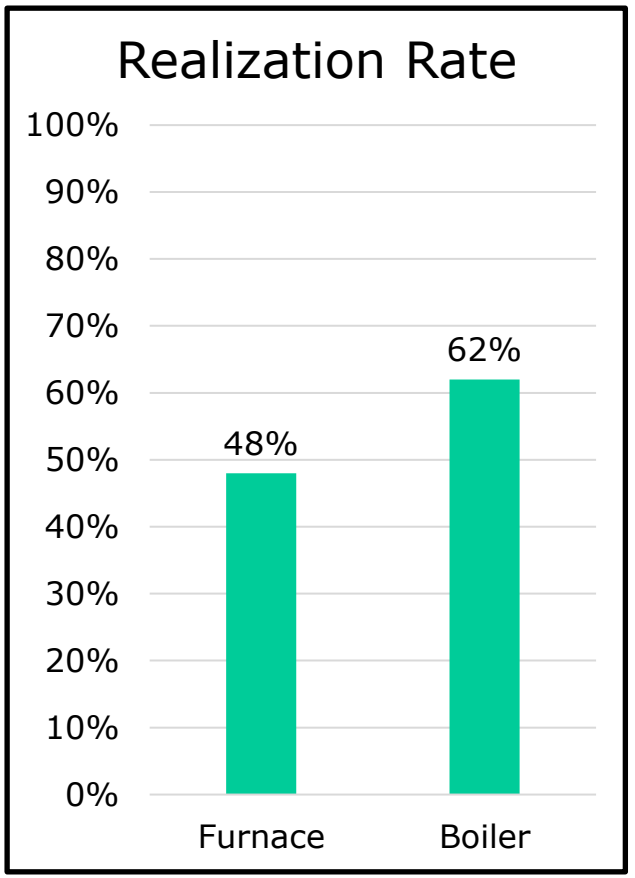
Parameters to Improve Realization Rates

Pre-Treatment Energy Usage	Use of Measures	Measure Interactions
Installation Rates	Installation Quality	

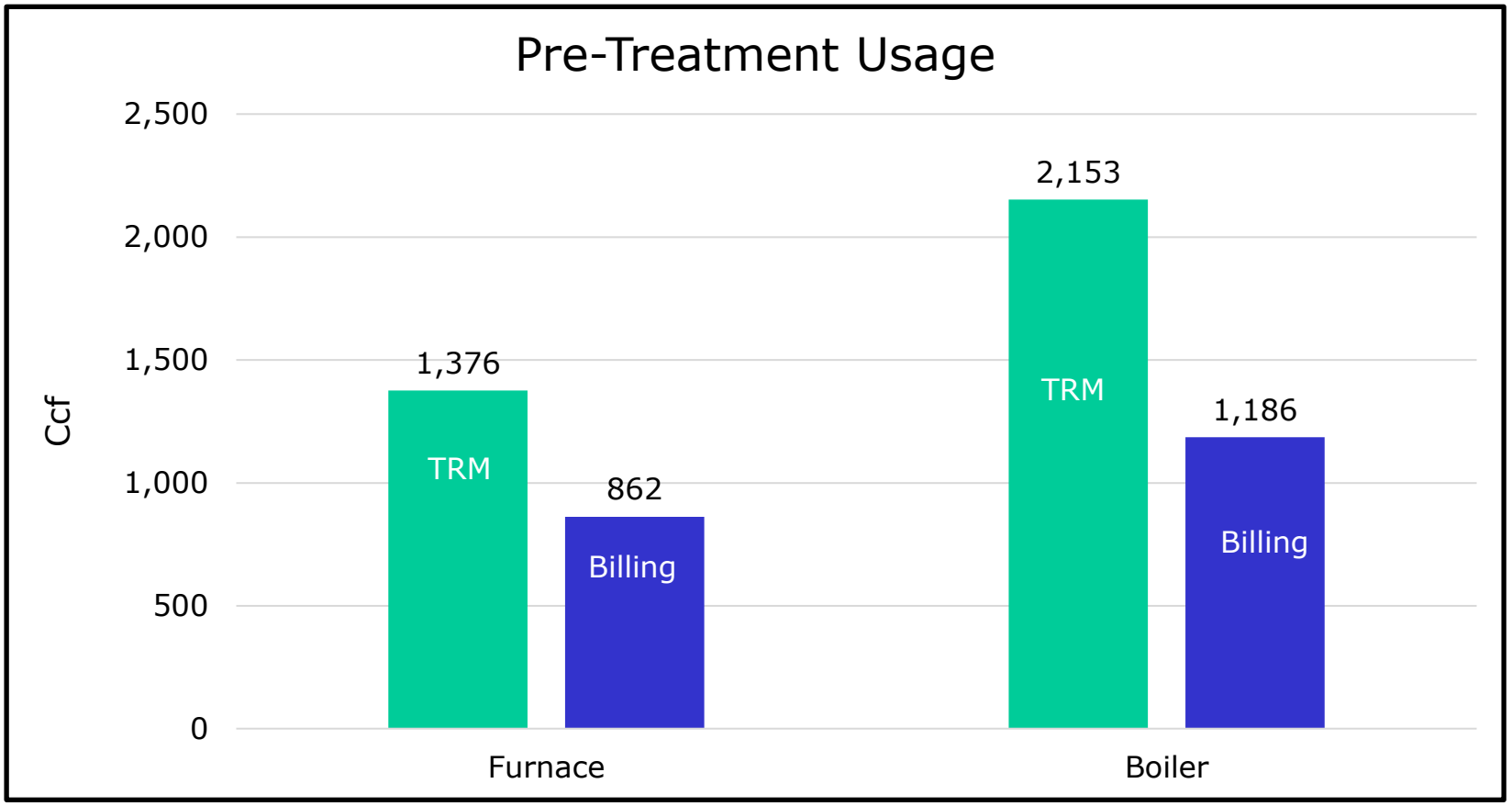
Res High-Efficiency Furnace Replacement







Res High-Efficiency Furnace Replacement



Res High-Efficiency Furnace Replacement

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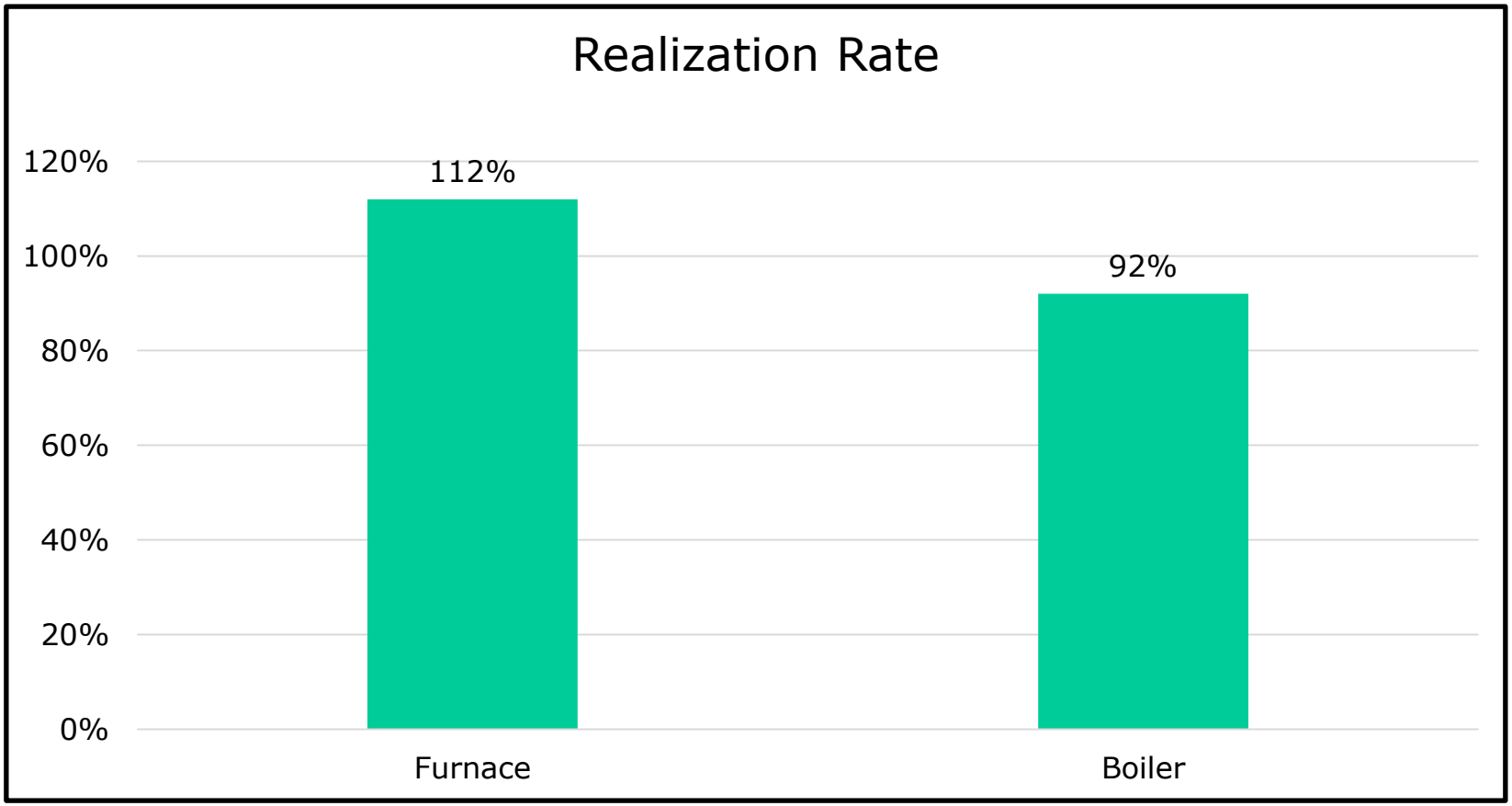
TRM updated based on first evaluation findings



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Participant Surveys

Participant Surveys

Can provide insights into…

- Motivation to participate
- Barriers to participation
- Changes in energy usage behavior
- Impacts on home comfort
- Impacts on health
- Program satisfaction

Participant Surveys

Methodology

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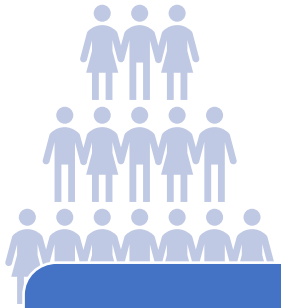

Select Survey Sample

- Understand who is represented – the sample frame
- Stratify to ensure sub-groups are represented

Send Advance Letters

- Explain purpose of survey
- Provide call-in option
- Incentive with letter increases response rates

Conduct Telephone Interviews

- Calls made day, evening, and weekends
- Leave message
- 12-call minimum
- 3-week survey period

Results & Reporting

- Weight for selection & response –to represent sample frame
- Report response rates
- Assess potential bias

Participant Surveys

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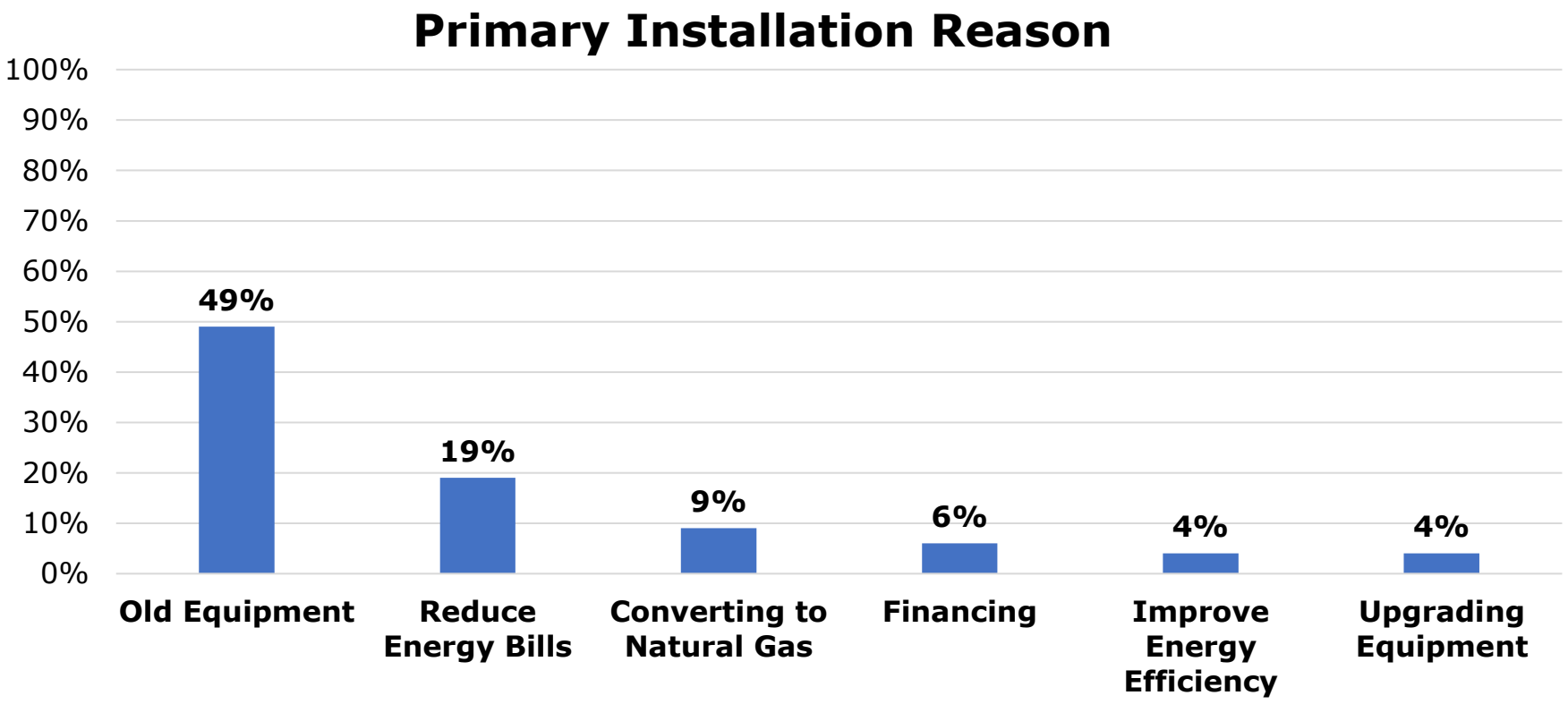
2016 South Jersey Gas Home Performance Program Evaluation



Participant Surveys

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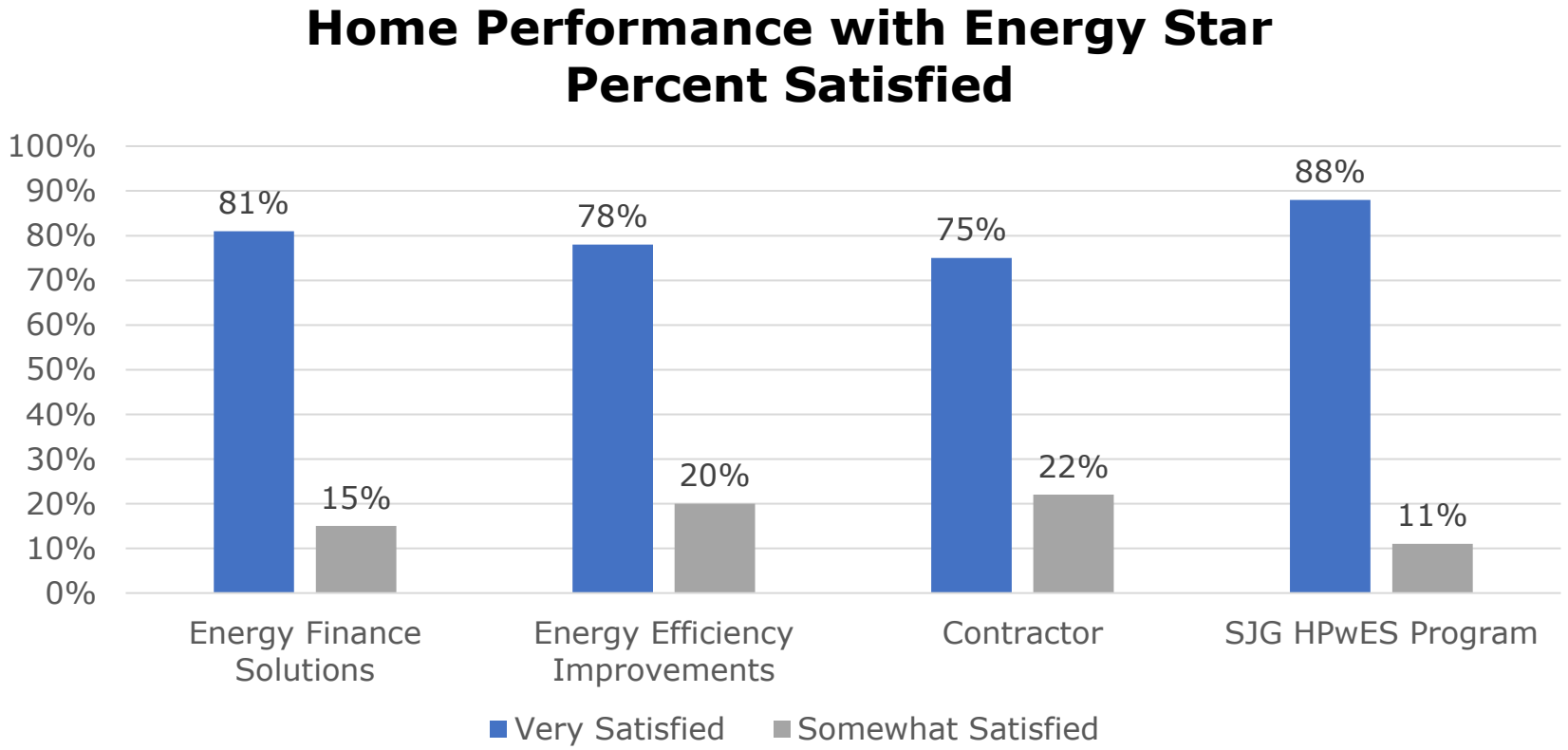
2016 South Jersey Gas Home Performance Program Evaluation



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On-Site Observations & Inspections

On-Site Observations and Inspections

Description

- Direct observation of service delivery
- Inspection of completed jobs

Purpose

- Implementation of program protocols
- Usability of program protocols
- Use of equipment
- Provider adaptability
- Comprehensiveness of service delivery
- Quality of work
- Client education
- Client interaction

On-Site Observations and Inspections

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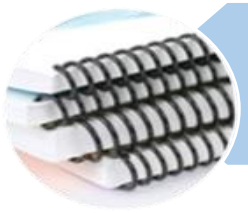
Develop check lists and rating scales

Train experts to implement consistently

Quantify findings across all observations and inspections

Enrich data with descriptive information



Make recommendations based on prevalent issues

On-Site Observations and Inspections

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National WAP Evaluation Check List Example

Audit Air Leakage and Insulation Diagnostics	Applicable Observations	Action Taken	
		#	%
Measured surfaces	100	94	94%
Inspected windows	100	96	96%
Inspected all accessible attics	78	69	88%
Measured insulation in all accessible attics	79	70	89%
Created access to inaccessible attics	33	3	10%
Measured insulation in exterior walls	95	47	49%
Measured insulation in basement/crawlspace	74	55	74%
Inspected for all typical bypasses	100	62	62%
Visual inspection for air sealing opportunities	100	83	83%
Used blower door while inspecting for leaks	96	64	67%

On-Site Observations and Inspections

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National WAP Evaluation Rating Example

	Quality of Attic Insulation
1	**All air sealing work completed first**
2	**Exhaust fans vented to exterior as needed**
3	**Heat producing devices or systems protected from insulation contact**
4	**Attic checked for knob and tube wiring**
5	**Workers wore respirators, safety glasses, gloves, and hard hats while insulating attic**
6	**Insulation installed in sufficient quantity (bags per ft^2) to meet R-value requirement**
7	Proper insulation material chosen for attic conditions
8	Open blow insulation is level and of consistent depth
9	Attic ventilation maintained
10	Confined areas blown to dense pack
11	Proper containment used to protect client and belongings

	Needs Improvement → **Excellent**						
Rating	**1**	**2**	**3**	**4**	**5**		
Total Points needed	0-5	6-7	8-9	10	11	**Mean Rating**	**# Rated**
Bold Points needed	0	0	0	6	6		
Attic Insulation Quality	4%	18%	42%	19%	18%	3.3	57

On-Site Observations and Inspections

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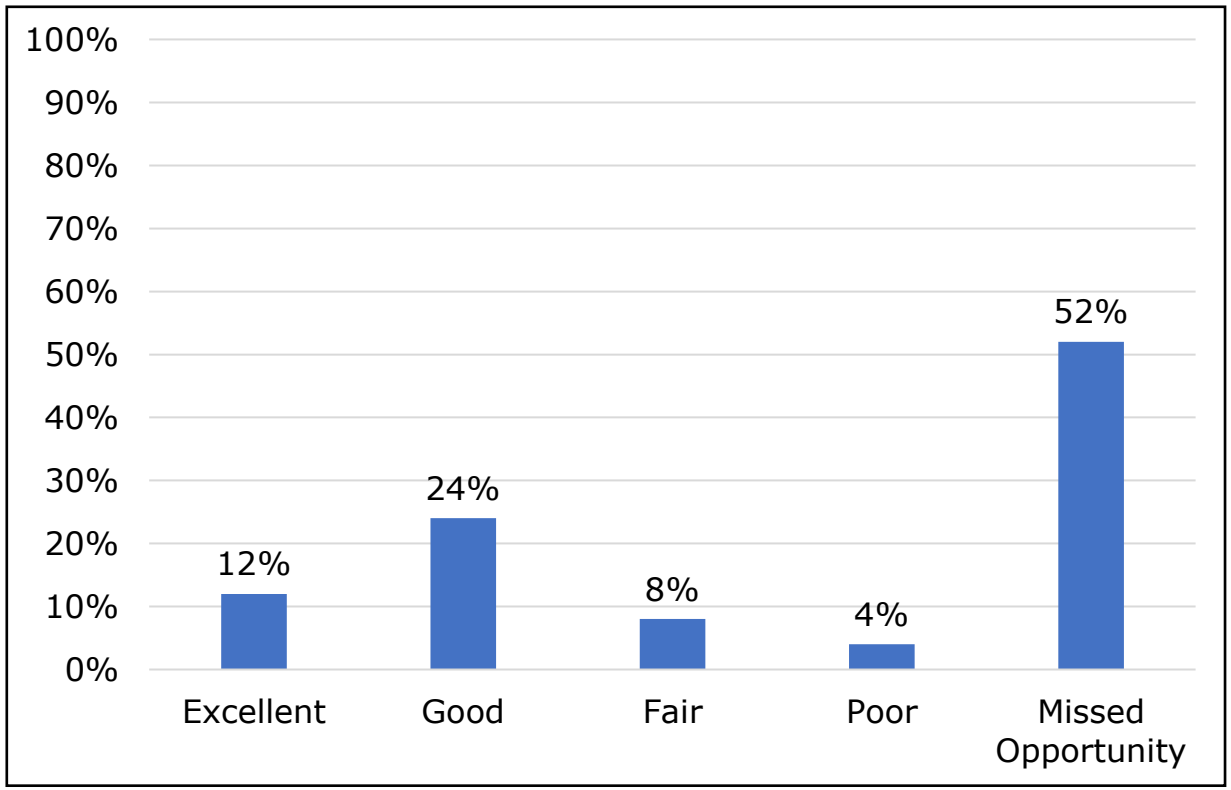
NJ Comfort Partners Inspection Example
Insulation Quality & Missed Opportunities



364 Measures Rated

Achieving High Savings

Achieving High Savings

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Policies

- Target homes with highest potential
- Prioritize measures with greatest impact
- Furnish providers with right incentives

SUCCESS

Practices

- Ensure staff have needed skills and tools
- Use best practices for measure selection
- Complete high-quality installation
- Identify problems, give feedback, resolve issues

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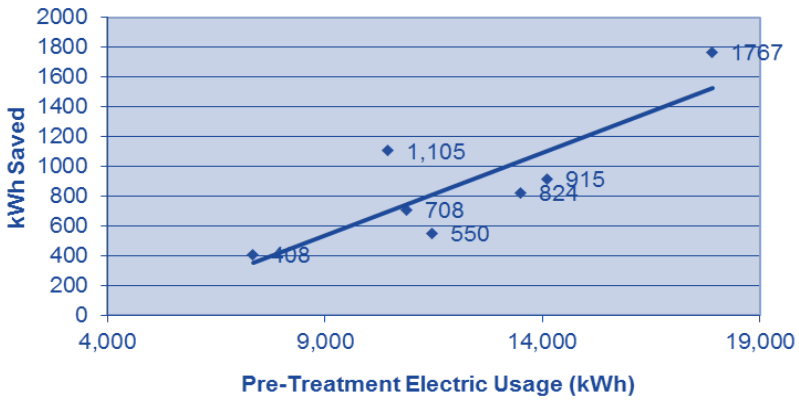
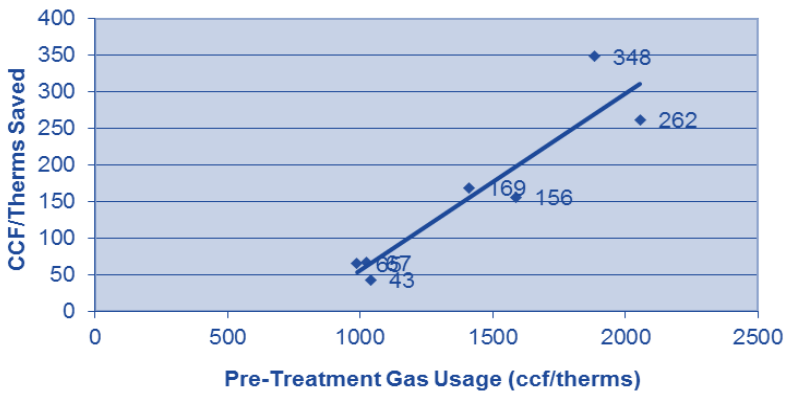
Target High Energy Users



Seven low-income electric efficiency program evaluations.

Seven low-income gas efficiency program evaluations.



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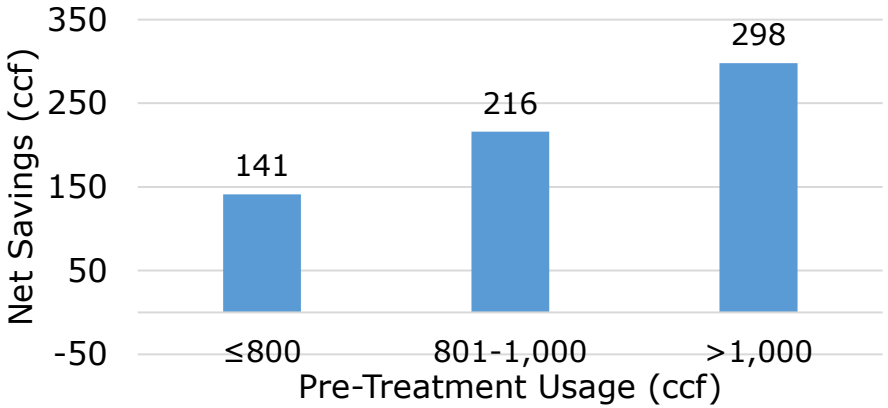
Target High Energy Users

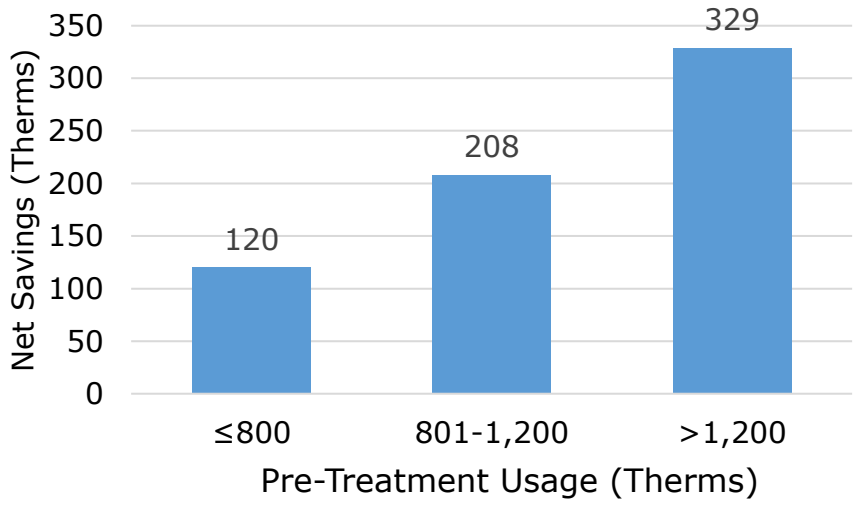
Savings by Pre-Treatment Usage



South Jersey Gas
Home Performance with Energy Star

New Jersey Natural Gas
Home Performance with Energy Star

Savings by Pre-Treatment Usage



Achieving High Savings

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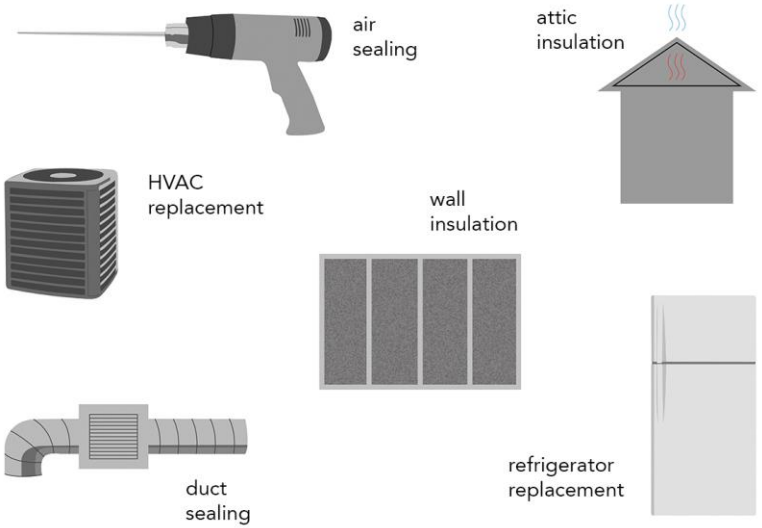
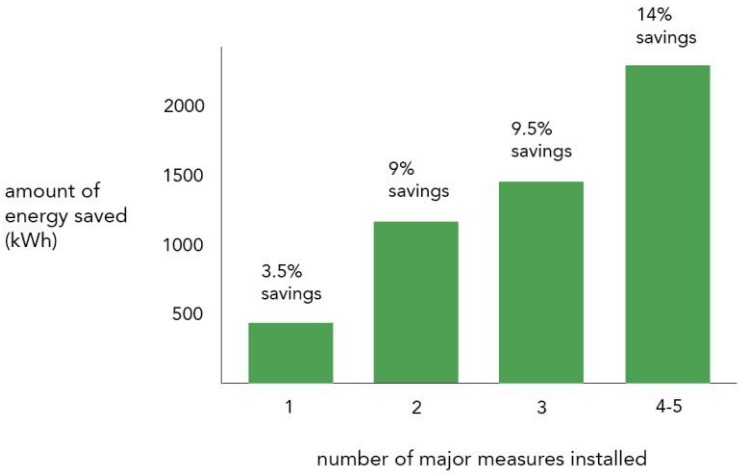
Install Major Measures

- Identify and prioritize cost-effective measures with the greatest impact to achieve usage reduction goals

Major Measures Include:



Impacts of Installing Major Measures
Electric Heating Jobs



Achieving High Savings

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Install Major Measures

NJ Comfort Partners

GAS HEATING SAVINGS				
Number of Major Measures	Air Seal, Attic Insulation, Floor Insulation, Sidewall Insulation, Wall/Perimeter Insulation, HVAC Replace, Duct Seal			
	Obs.	%	Net Savings	
			ccf	%
None	1,365	28%	11	1.1%
1 Measure	1,066	22%	35**	3.9%
2 Measures	1,284	27%	34**	3.5%
3 Measures	792	16%	97**	8.8%
4 Measures	260	5%	150**	12.4%
5-6 Measures	57	1%	218**	15.9%

**Statistically significant at 95% level.

Achieving High Savings

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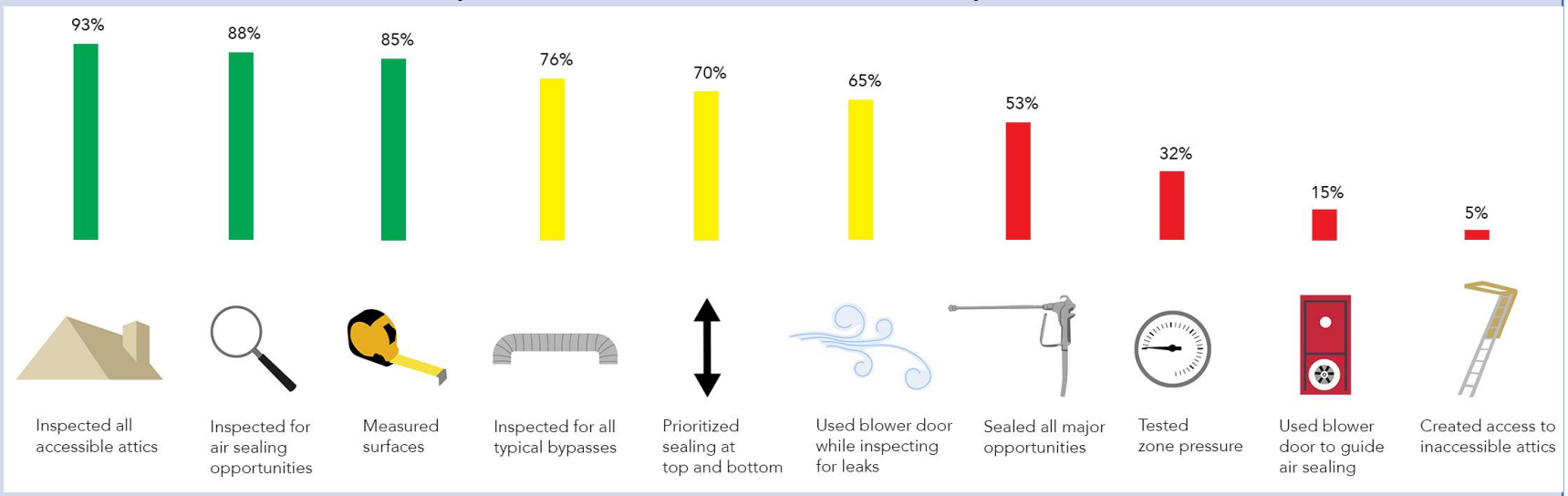
Ensure Quality Work

- On-site observation and inspections in addition to documentation of procedures, contractor training, and quality control can help increase the use of best practices



Achieving High Savings

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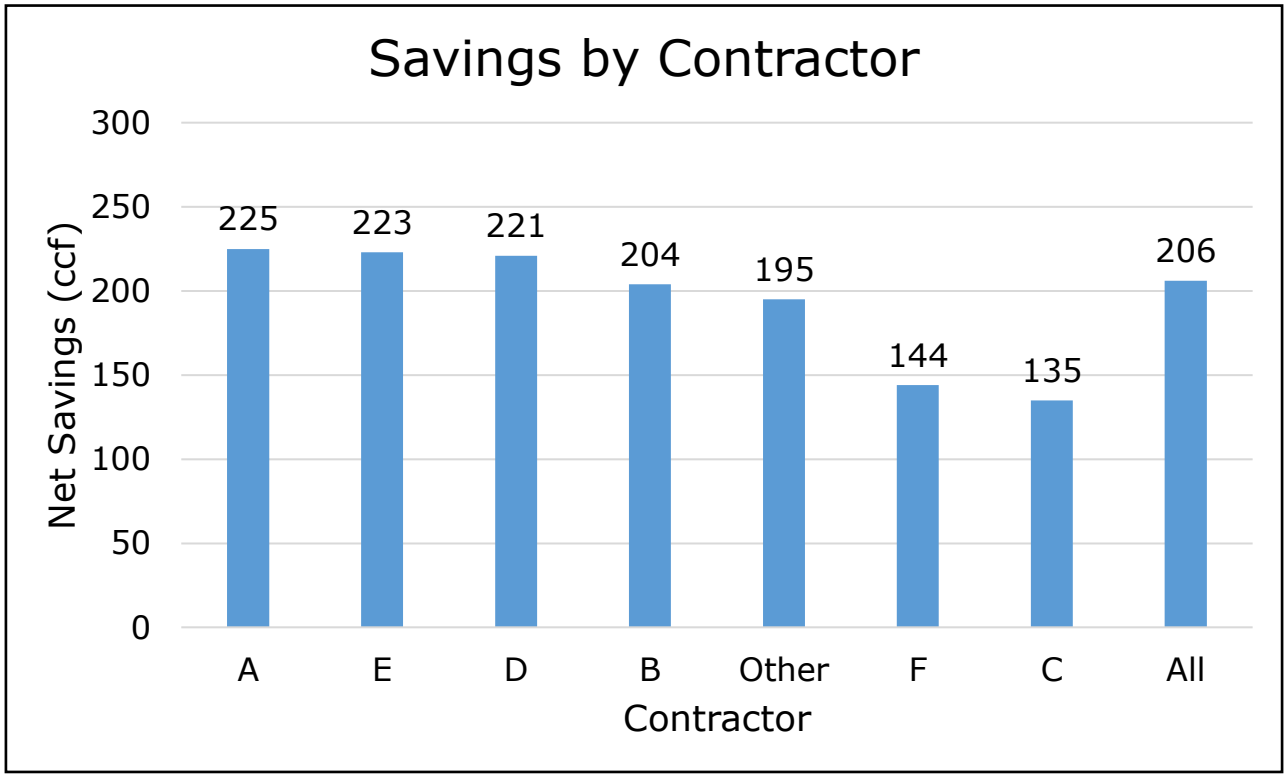
Ensure Quality Work

South Jersey Gas

Home Performance with Energy Star



Achieving High Savings

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Ensure Quality Work

South Jersey Gas

Home Performance with Energy Star

Contractor	Treatment					Matched Comparison Group					Net Savings		Average Project Cost
	Obs	Pre	Post	Savings		Obs	Pre	Post	Savings				
				ccf	%				ccf	%	ccf	%	
A	281	890	678	211***	23.7%	281	883	897	-14**	-1.6%	225***	25.3%	$14,756
B	98	834	637	198***	23.7%	98	806	812	-6	-0.7%	204***	24.4%	$17,697
C	50	746	615	131***	17.6%	50	742	745	-3	-0.4%	135***	18.0%	$14,839
D	47	901	696	205***	22.7%	47	882	898	-16	-1.9%	221***	24.5%	$15,743
E	34	872	694	178***	20.4%	34	875	920	-45*	-5.1%	223***	25.5%	$15,698
F	20	871	732	139***	16.0%	20	864	869	-5	-0.5%	144***	16.5%	$17,190
Other Contractors	116	887	702	184***	20.8%	116	879	890	-11	-1.2%	195***	22.0%	$15,595
All	646	859	675	194***	22.3%	646	859	871	-13***	-1.5%	206***	23.8%	$15,556

Performance Measurement

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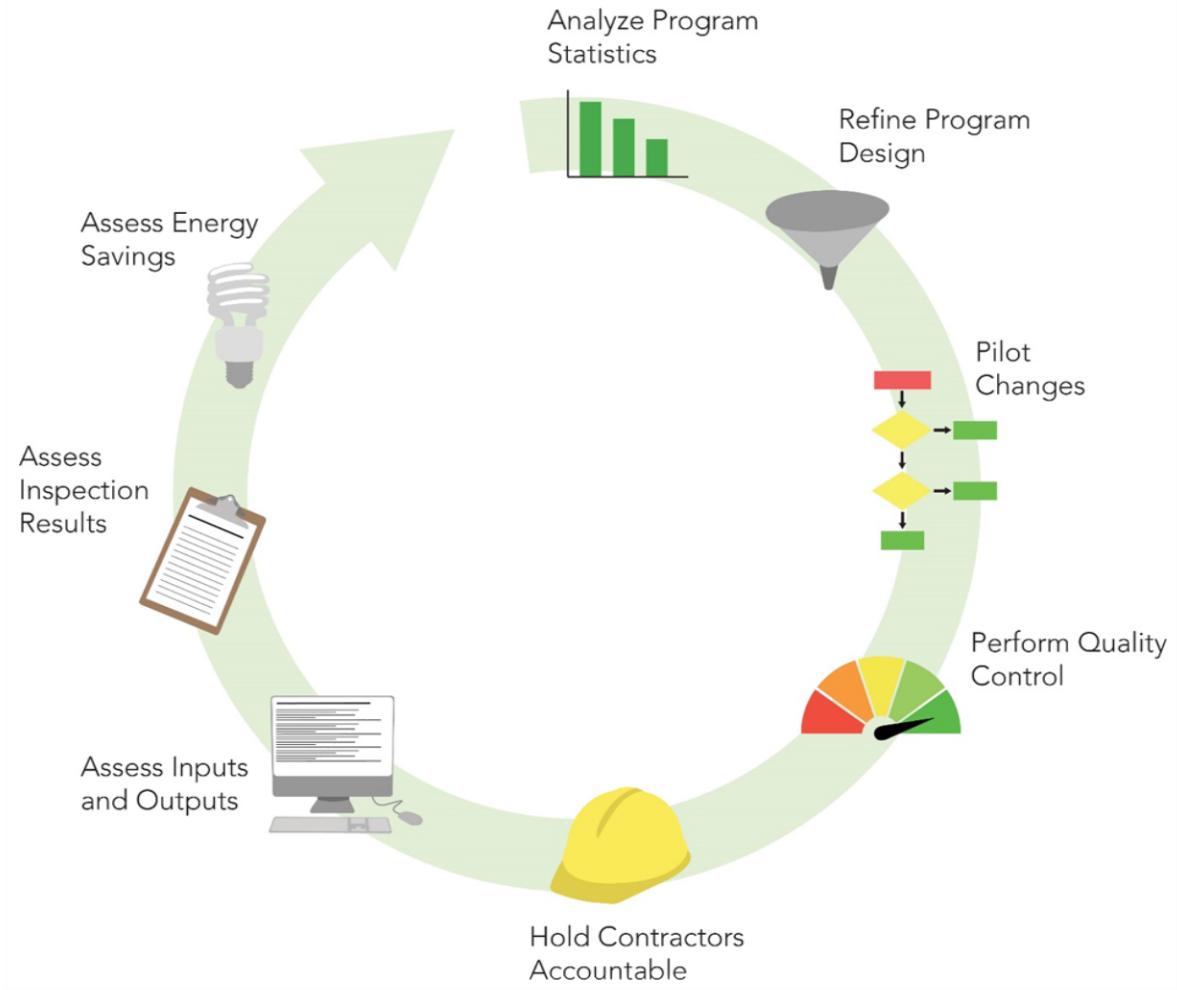

Performance Measurement

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Assessment Example
Analyze Program Statistics

	Baseline	Follow-up 1	Follow-up 2
Pre-Usage>1,200 ccf	25%	35%	40%
3 or 4 Major Measures	15%	25%	35%
Wall Insulation	10%	15%	25%
Attic Insulation	50%	55%	60%
Major Air Sealing	55%	55%	60%

Provides critical information about potential savings before post usage data are available.

Achieving High Savings Lessons Learned

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It is challenging to meet savings expectations

Target high usage customers

Ensure major measures are installed where opportunities exist

Maximize use of proven home performance techniques

Conduct performance measurement

Non-Energy Impacts

Non-Energy Impacts

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Background

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

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

Typical Approach to Estimation

Review Past Studies

Select Benefits for Inclusion

Take 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

Non-Energy Impacts

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Two NEI Estimates from the Same Survey

Benefit	Reduction Estimate		Per Job Monetization First Year Benefit	
	Estimate 1	Estimate 2	Estimate 1	Estimate 2
CO Poisoning	0%	No Report	$0	$31.43
Home Fires	0%	0%	$0	$84
Cold-Related Illness/Death	1%	1%	$0	$393.26
Heat-Related Illness/Death	0%	1%	$0	$87.45
Asthma Emergency Dept. Visits	1%	12%	$0	$202.00
Sleep Problems/Work Productivity	1%	21%	$0	$182.33
Sleep Problems/Housework Productivity	1%	21%	$0	$133.67
Missed Days of Work	.49	.52	$0	$20.25
Short-Term Loans	2%	9%	$0	$7.12
Prescriptions Affordability	10%***	10%	$43	$193.98
Food Affordability	4%	16%	$0	$19.92
Food Assistance	3%	6%	$0	$84
Total Benefit			$43	$1,439

Non-Energy Impacts

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Why Did the Results Differ?

	Estimate 1	Estimate 2
Longitudinal Framework	Same Participants in Pre and Post Periods	Unmatched Samples
Comparison	Net Change = (Pre-Treatment–Post-Treatment) – (Pre-Comparison–Post-Comparison)	Gross Change = Pre-Treatment – Post-Treatment Additional Measure = Pre-Treatment – Pre-Comparison
Statistical Significance	At Least 90 Percent Confidence Level	No Requirement
External Data	Only Data from Referenced Survey	External Data Used when Survey Found Small NEI

Non-Energy Impacts

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- Methodologies have been developed to measure NEIs
- Current literature on NEIs has many challenges
- Additional research is needed
- Difficult to apply findings from previous studies
- Factors specific to programs, jurisdictions, participants, and implementation can impact the NEIs
- Additional challenges relate to valuing benefits relating to health, comfort, and safety

Recommendations

- Review referenced studies
- Understand methodologies & limitations
- Assess applicability to evaluated program

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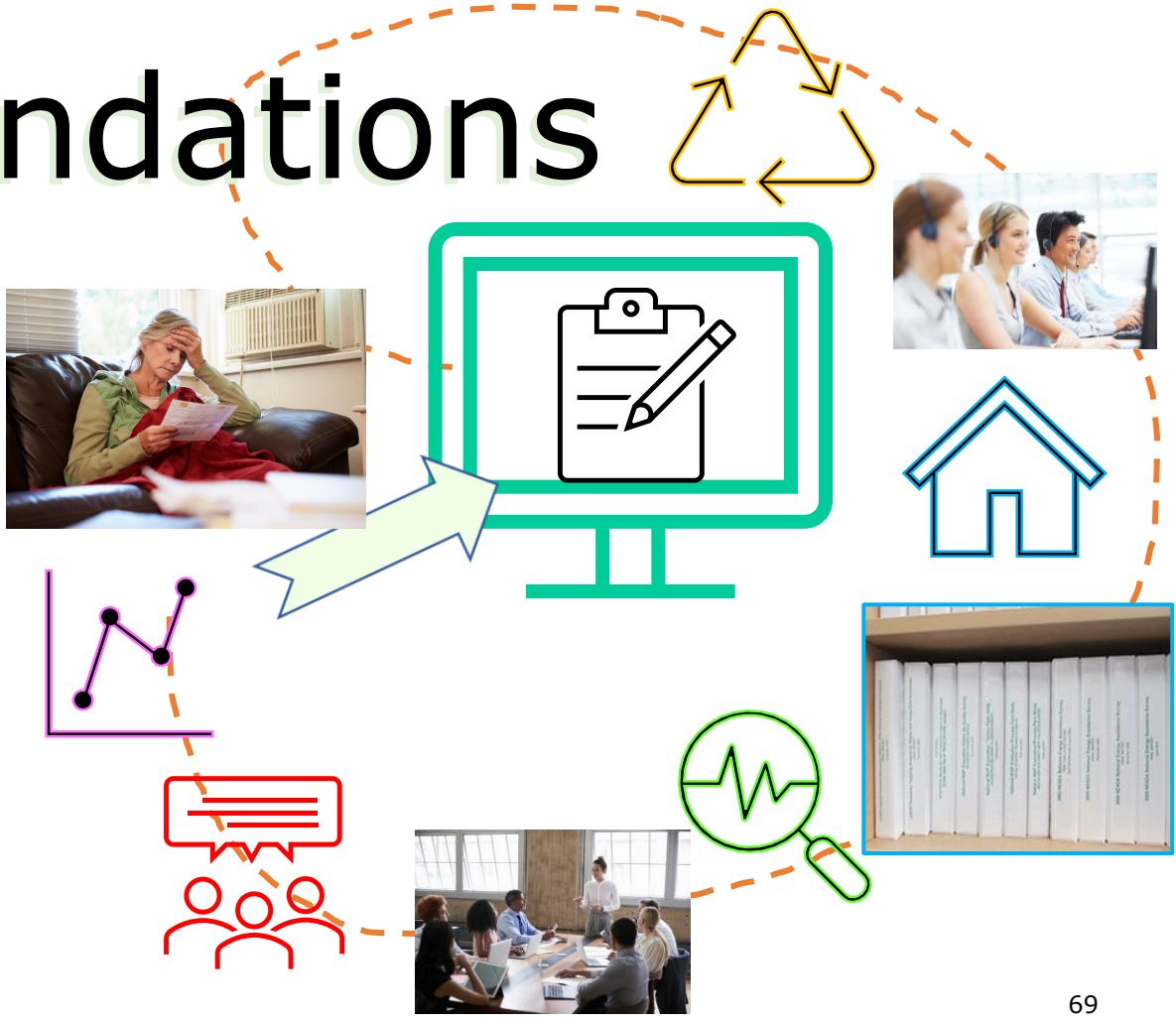
Recommendations



Recommendations

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Energy Efficiency

- Treat high users
- Install major measures where cost-effective opportunities exist
- Provide training and quality control to ensure high quality work

Evaluation

- Estimate savings using billing data
- Weather normalize energy usage
- Use comparison group
- Re-assess frequently

Study Review

- Sample
- Attrition/ Response Rate
- Methodology
- Separation between implementation, evaluation, and advocacy?
- Ask questions!

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