SAVING WASTE: ENERGY USE AND WASTE ANALYSIS BY END-USE

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Presentation Overview

- Statement of research objectives
- Review of traditional approach
- Overview of usage and waste analysis
- Application of results/implications for future research

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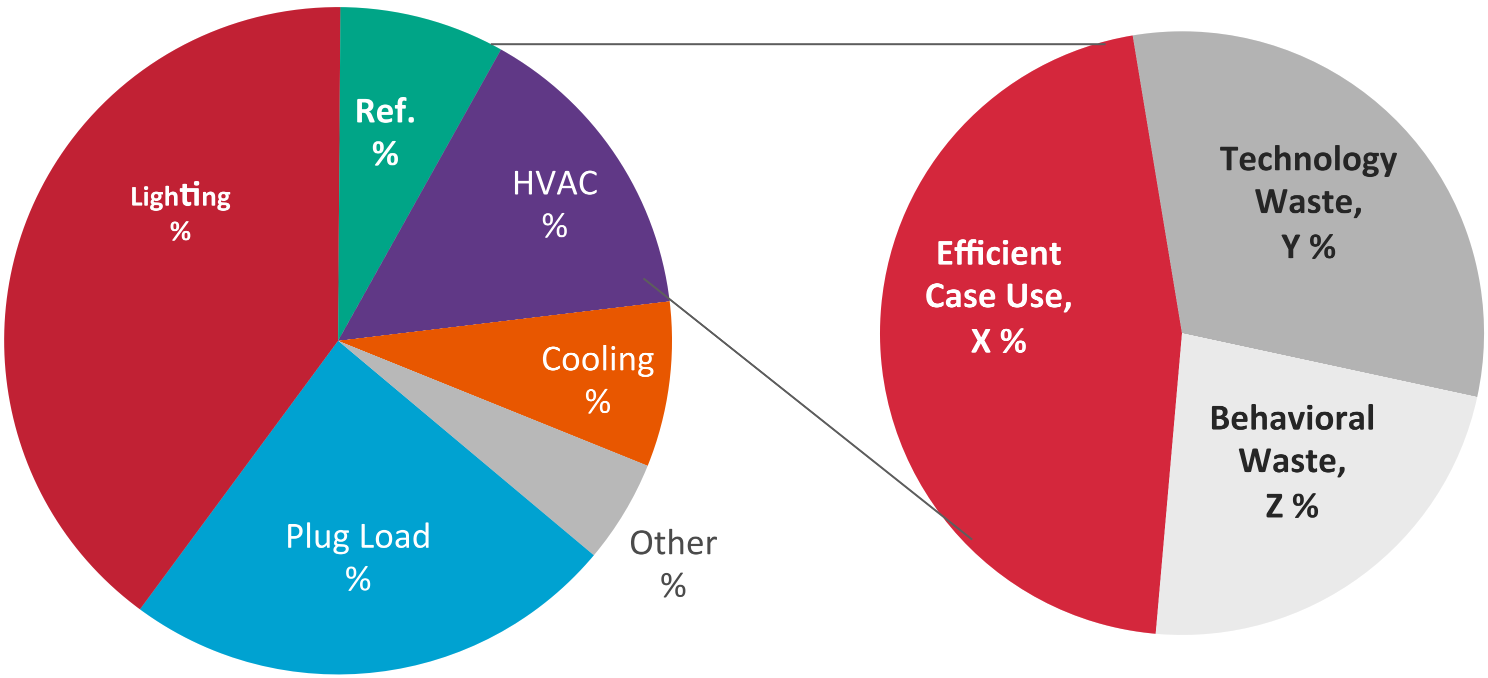
Research Objectives

- Identify gaps in program offerings by providing a more complete assessment of usage at the end-use level
- Disaggregate electricity usage by end-use and segment
- Develop energy use profiles by end-use and segment that quantify:
  - Base case usage
  - Excess energy use due to inefficient technologies
  - Energy “waste” due to customer behaviors
  - Efficient case usage

Research Objectives (cont.)

Segment Usage by End Use (% kWh)

HVAC End Use Energy Profile (%kWh)



- Disaggregation of segment usage by end use
- Disaggregation of end use specific usage into efficient case and waste components

Standard Approach

- A traditional potential study quantifies available energy savings from DSM by segments
- Forecasts are developed by:
  - Understanding baseline energy usage and market conditions
  - Modeling/forecasting market response to DSM programs

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Where Behavior Gets Lost

- Traditional potential study produces results too blunt for strategic program planning and program gap analysis:
  - Rely heavily on secondary data reflecting regional/national trends
  - Results do not adequately reflect potential associated with behavior change

- Behavior is addressed:
  - Embedded within engineering algorithms (e.g. Hours of Use)
  - Reflected in assumptions regarding efficient measure adoption

However…

- Baseline assumptions used - no adjustment for "efficient" behaviors
- Engineering assumptions fail to capture all behavioral influences

Behavioral Component

Energy use is defined by the interaction between end users and technology – accurately assessing behavioral component is critical to quantifying savings potential

EXAMPLE: ELECTRIC SAVINGS FOR HIGH SEER CAC

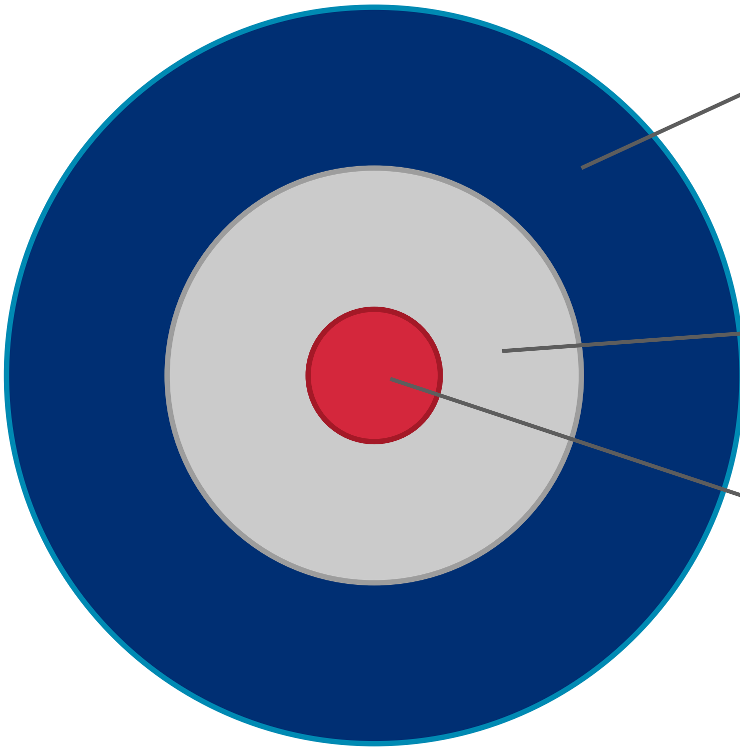
$\Delta kWH = (FLHcool * BtuH * (1/SEERbase - 1/SEERee))/1000$

End user behavior is embedded here and represents assumed set points at given outside air temps

A New Approach

- Enhanced primary data collection to inform understanding of:
  - Baseline equipment saturation and penetration
  - Baseline building and equipment characteristics
  - Customer equipment use and occupancy patterns
- Determination of efficient case behaviors for end uses
- Enhanced engineering assessment to more accurately reflect behavioral component of energy use and waste

Primary Data Collection: C&I



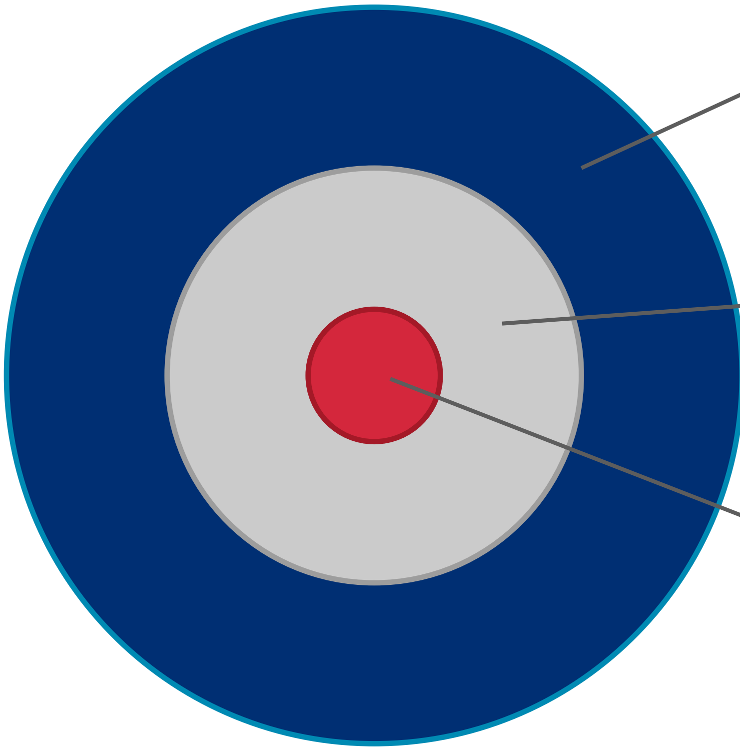
Telephone Survey: 1,600 completes
Penetration/saturation 3 end uses;
Behavioral/operational practices

Onsite Audits: 345 completed visits
Penetration/saturation all end uses;
Equipment technical specifications;
Behavioral/operational practices

Monitoring: 70 audited sites
Lighting, HVAC (limited ref);
Occupancy

- Nested sample design 311 onsite audits
- Audits completed at sites not nested in phone survey sample included collection of segment & operational information during recruitment calls

Primary Data Collection: Residential



Mail Survey: 4,414 completes; Penetration/saturation; Behavioral/ operational practices

On-Site Audits: 297 completes; Penetration/saturation all end uses; Equipment technical specifications; Behavioral/ operational practices

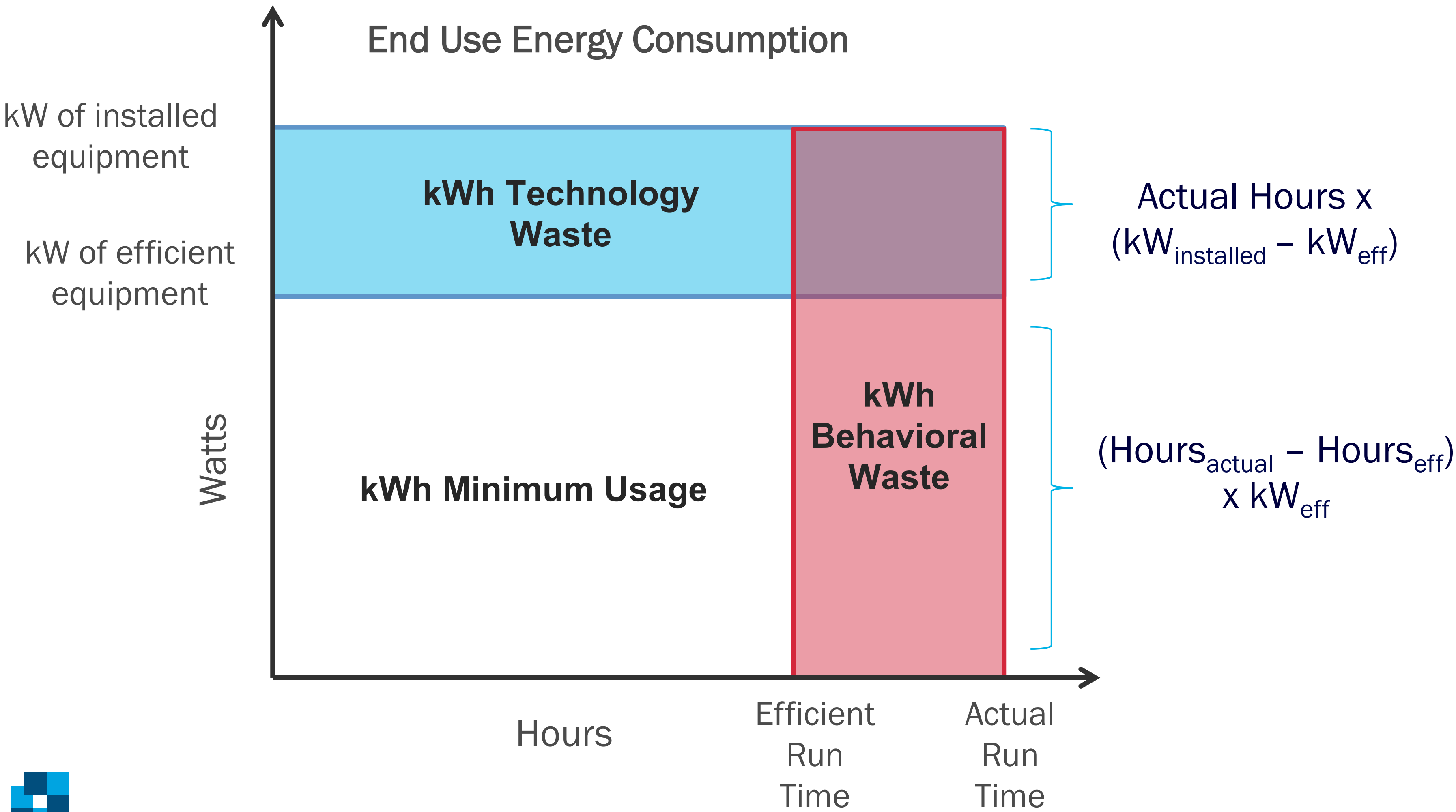
Monitoring: 140 completes; Current logging on all circuits; Lighting / occupancy logging; Temperature and humidity

- Originally designed as fully nested sample
- Audits completed at sites not nested in phone survey sample included collection of segment & operational information during recruitment calls

Waste Definitions

Waste Type	Examples
Technological	
Equipment Characteristics	Equipment type is not high efficiency
	- incandescent instead of CFL;
	- standard instead of Energy Star;
	- regular furnace fan (not ECM);
	- regular showerheads
	- no faucet aerators
Behavioral	
Hours of Use	Equipment is left on or in standby mode when not in use
	Programmable thermostat not aligned with occupancy hours
Performance/Temperature Settings	Water temperate too high
	Thermostat set points too low in summer
	Furnace fans always on, rather than auto
Maintenance	HVAC tuned up regularly

End Use Usage & Waste Definition



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Analytic Example: Residential CAC

- Determine actual usage based on primary data:

$$kWh_{actual} = kW/Ton_{type} \text{ X } Tons_{user} \text{ X } EFLH_{user}$$

$EFLH_{user}$ determined by CDD profile and equipment "design day". Model user CDD for different time of day periods and occupancy conditions based on customer behaviors (set points).

- *where*:

KW/Ton_{type} = Power draw per ton of cooling, a function of SEER

$Tons_{user}$ = User System capacity in tons

$EFLH_{user}$ = Equivalent full load hours

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Analytic Example: Residential CAC

Home A

Time	Set Point	Actual CDD
6am-9am	78.5	16.7
9am-12pm	82	41.2
12pm-4pm	82	117.6
4pm-7pm	76.5	135.8
7pm-10pm	76.5	59.1
10pm-6am	78.5	30.0
	Total	400.4

EFLH = 320.3

Home B

Time	Set Point	Actual CDD
6am-9am	67	85.3
9am-12pm	67	201.3
12pm-4pm	67	368.5
4pm-7pm	67	235.6
7pm-10pm	67	131.2
10pm-6am	67	154.9
	Total	1176.8

EFLH = 941.5

Analytic Example: Residential CAC

- Determine technology waste associated with three categories of potential efficiency upgrades that affect CAC usage:
  - CAC unit efficiency
  - Building shell
  - Duct sealing
- For each category waste calculated as:

$$kWh_{waste} = kWh_{actual} - kWh_{efficient}$$

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Analytic Example: Residential CAC

Setting	Time	Setpoint Temperature (Heat)	Setpoint Temperature (Cool)
Wake	6:00 a.m.	< 70° F	> 78° F
Day	8:00 a.m.	Setback at least 8° F	Setup at least 7° F
Evening	6:00 p.m.	< 70° F	> 78° F
Sleep	10:00 p.m.	Setback at least 8° F	Setup at least 4° F

ENERGY STAR

Home A

Time	Occu-pancy	Rec. Set Pt.	Opt. CDD
6am-9am	Home	78	19.2
9am-12pm	Home	78	87.2
12pm-4pm	Home	78	190.9
4pm-7pm	Home	78	115.3
7pm-10pm	Home	78	46.3
10pm-6am	Asleep	82	12.1
		Total	471.0

$EFLH_{opt\ behave} = 376.8$

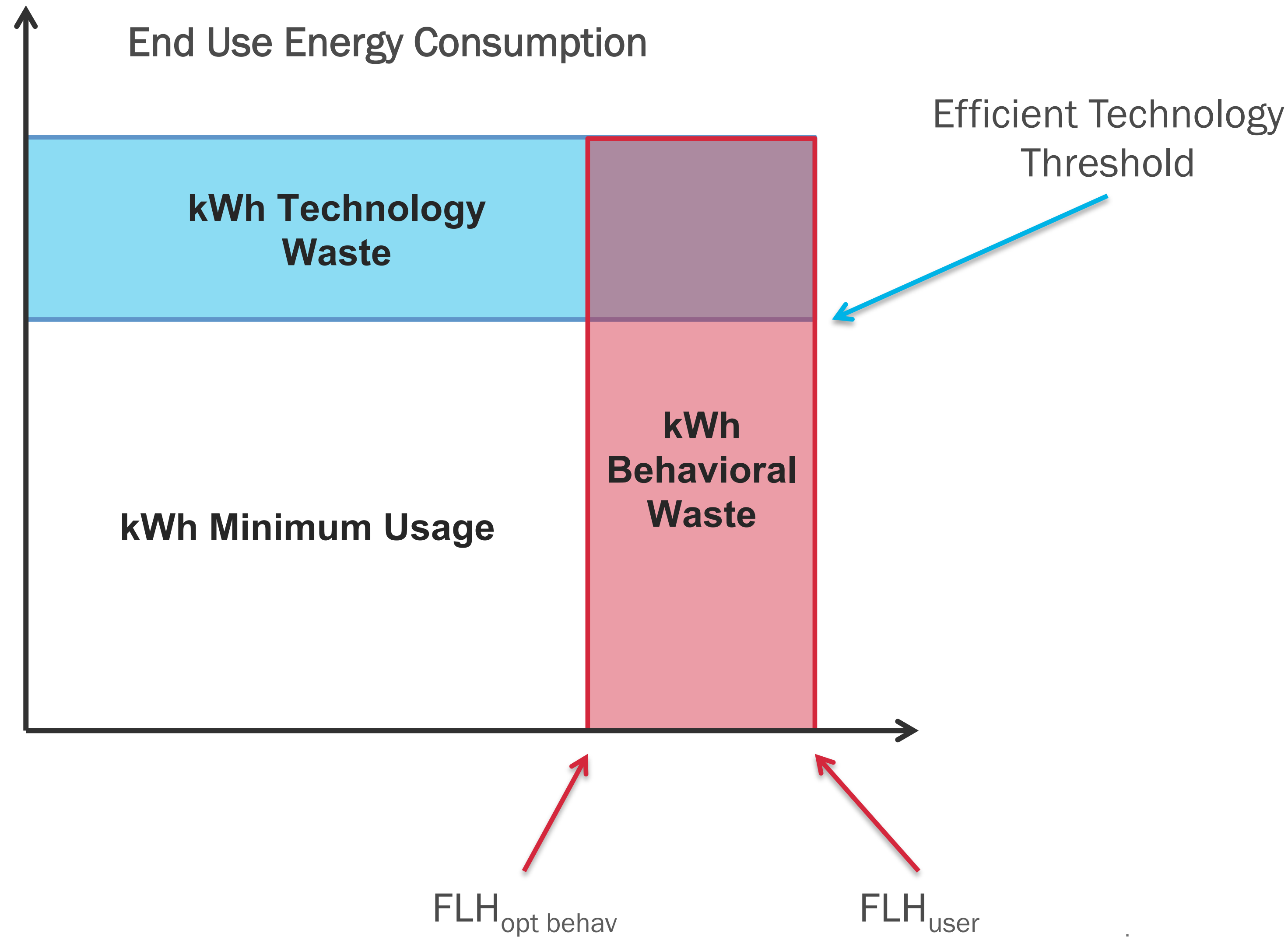
Home B

Time	Occu-pancy	Rec. Set Pt.	Opt. CDD
6am-9am	Home	78	19.2
9am-12pm	Away	85	23.4
12pm-4pm	Away	85	75.5
4pm-7pm	Home	78	115.3
7pm-10pm	Home	78	46.3
10pm-6am	Asleep	82	12.1
		Total	291.8

$EFLH_{opt\ \ behave} = 233.4$

http://www.energystar.gov/ia/partners/publications/pubdocs/HeatingCoolingGuide%20FINAL_9-4-09.pdf

Getting to Behavioral Waste



Why This Matters

- Benefits of the study:
  - Improved understanding of current end use energy consumption – particularly behavioral drivers
  - Measurement of the behavior savings potential by end-use and segment
  - Enhanced primary data provides basis for other analyses and ability to address other research questions - stimulate new research objectives

Implications for Program Planning

- Assess efficacy of technology and behavioral program options to optimize DSM investment
- Identify and prioritize among "opportunity pockets"
  - Customer segments or end uses where energy savings can be realized through behavioral program elements or messaging
- Assess benefits of replacing widgets or attempting to change how widgets are used, or both