Energy Usage and Waste Study Estimation Approach

Summary for DOE
Behavior Potential Workshop

June 13, 2016

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Traditional Potential Studies Provide a Forecast of DSM Savings

- Behavior, other than consumer purchase behavior, “gets lost”
- Produces results that are too blunt for strategic program planning and program gap analysis
  - Often rely heavily on secondary data and rules of thumb for important analytic assumptions
  - Results do not adequately reflect potential associated with behavior change or O&M measures

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Study Incorporates Behavior Into Energy Use and Waste Estimation

- Usage and Waste study had three goals:
  1. **Baseline study, first and foremost (equipment and behavioral)**
  2. Support utility program planning and gap analysis
  3. Provide a comprehensive assessment of energy usage and waste at the end-use level
- Method estimates energy “waste”, not a forecast of savings potential
- Estimates most closely align with **technical potential**, did not include estimates of economic or program achievable potential
- Characterized and quantified waste from both technological (equipment) and behavioral waste categories

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Characterized Waste for Residential and Commercial Sectors

- Selected measurable / quantifiable behaviors with potential for high impact
  - Quantified waste from 11 residential behaviors and 16 commercial behaviors
  - Looked at behaviors with interaction between end-users and end-use equipment

- Turn off lights in unoccupied spaces
- Decrease temperature set-point on electric water heating
- Adopt efficient CAC control strategies
- Reduce industrial ventilation when not needed based on facility operations

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Required Data Inputs & Estimation Method

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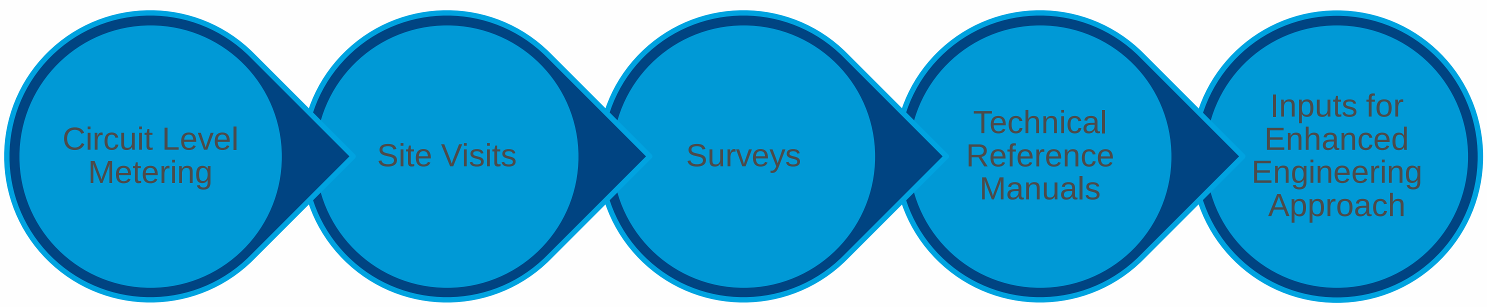
Study Incorporated Primary Data with Engineering Approach

- Effort included:
  - Extensive primary data collection and metering to define equipment and behavioral baseline
  - Building, circuit and equipment level metering to disaggregate load by end-use
  - Define efficient technologies and behaviors for each end-use
  - Enhanced engineering analysis to assess energy usage and waste



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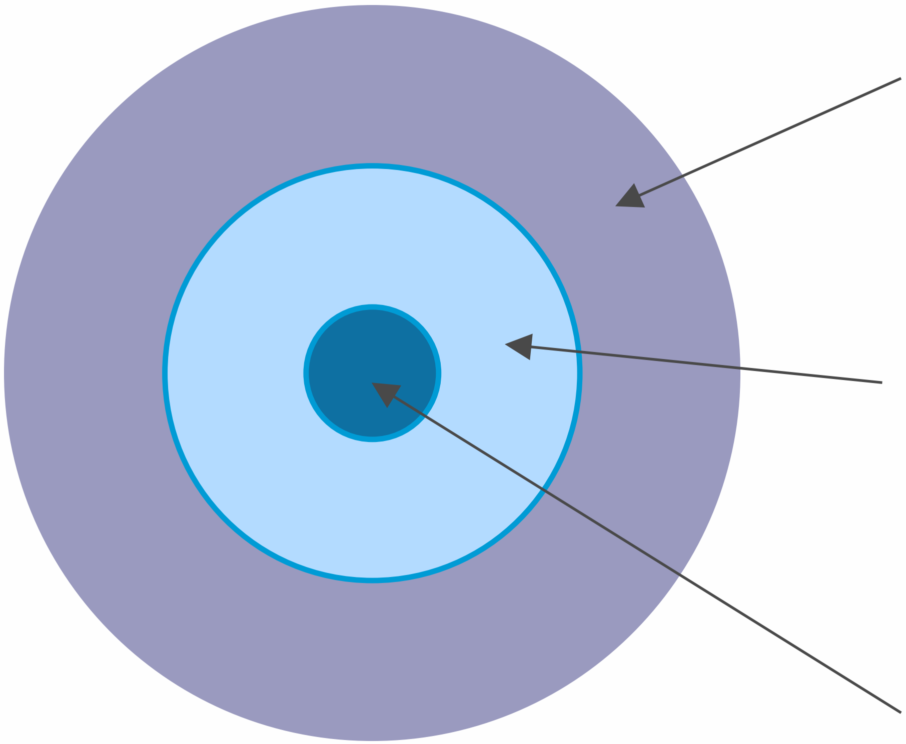
Data Sources

- Extensive primary data collection (nested design)

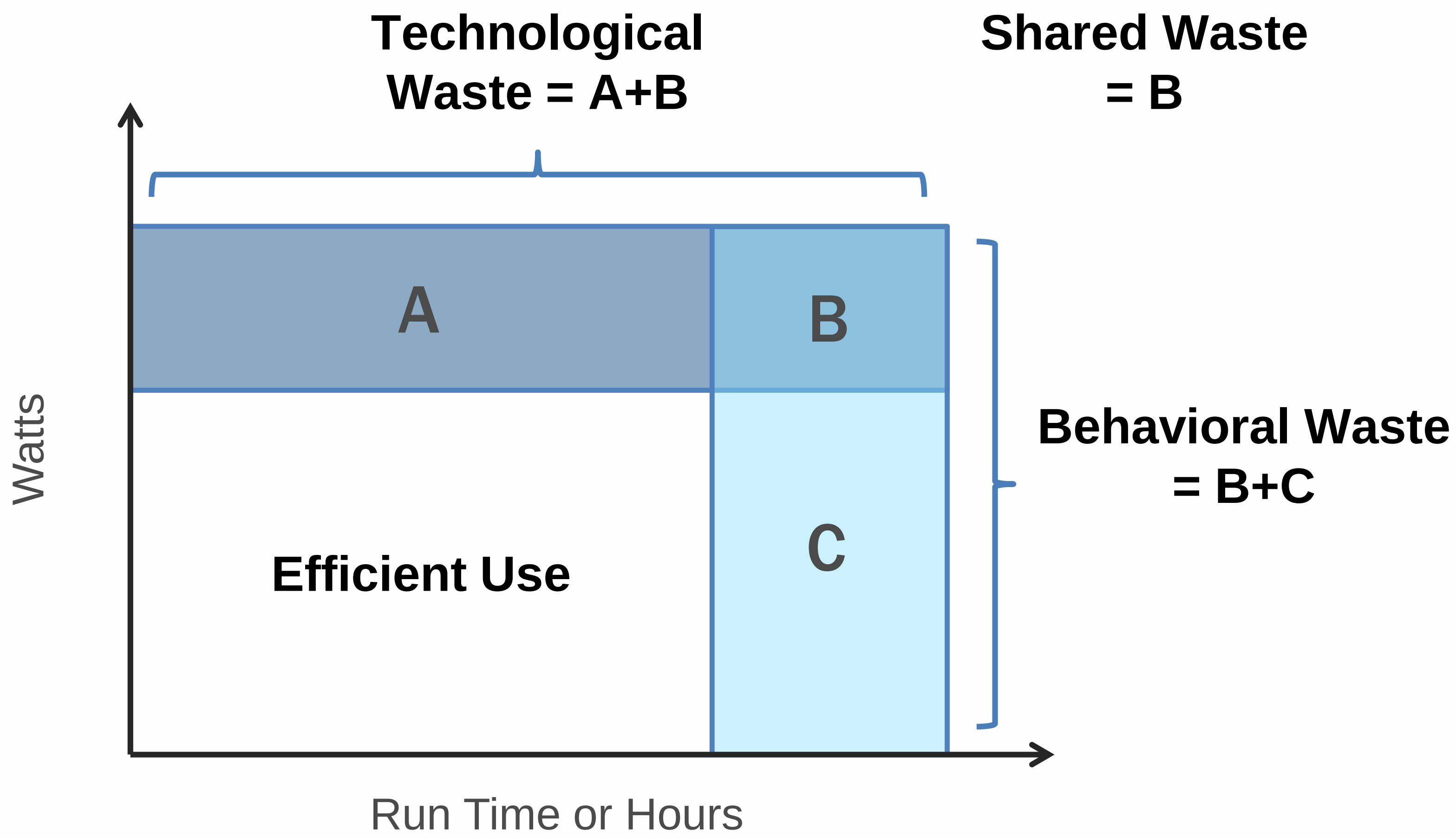


<u>Mail/Phone Survey</u>:
4,414 completes (Res)
1,519 completes (C&I)
• Penetration/saturation
• Behavioral/operational practices

<u>On-Site Audits:</u>
297 completes (Res)
347 completes (C&I)
• Penetration/saturation
• Equipment technical specifications

<u>Monitoring:</u>
140 completes (Res)
70 completes (C&I)
• Log current on all circuits (Res)
• Lighting/occupancy
• Temperature and humidity (Res)

Conceptualizing Usage and Waste



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Estimation Method Overview

- Enhanced, bottom up engineering approach
  - Began by estimating baseline annual energy usage by end use with TRM algorithms using heterogenous, site-specific data

Example: Electric Usage for Residential Central AC

$$\Delta kWh = \frac{EFLH_{cool} * \frac{Btu}{Hr} * SEER}{1000}$$

  - Traditional approach would be to use TRM default values, plus, in some cases, slightly more granular data (e.g., regionally-defined EFLH)
  - We used actual parameters measured from site visits
- Assessed waste by varying parameters to reflect efficient behavior/technology and calculating differential

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Estimation Method – Incorporating Site-Specific Data

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

Estimation Method – Quantifying Waste

Defined Current Usage Case

$$\Delta kWh_{actual} = \frac{EFLH_{actual} * \frac{Btu}{Hr} * SEER}{1000}$$

1000 kWh/year

Defined Efficient Usage Case

$$\Delta kWh = \frac{EFLH_{eff} * \frac{Btu}{Hr} * SEER}{1000}$$

700 kWh/year

Differential is Behavioral Waste:
Set-points Below Efficient Level

300 kWh/year
(30% of current usage)

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Select Results

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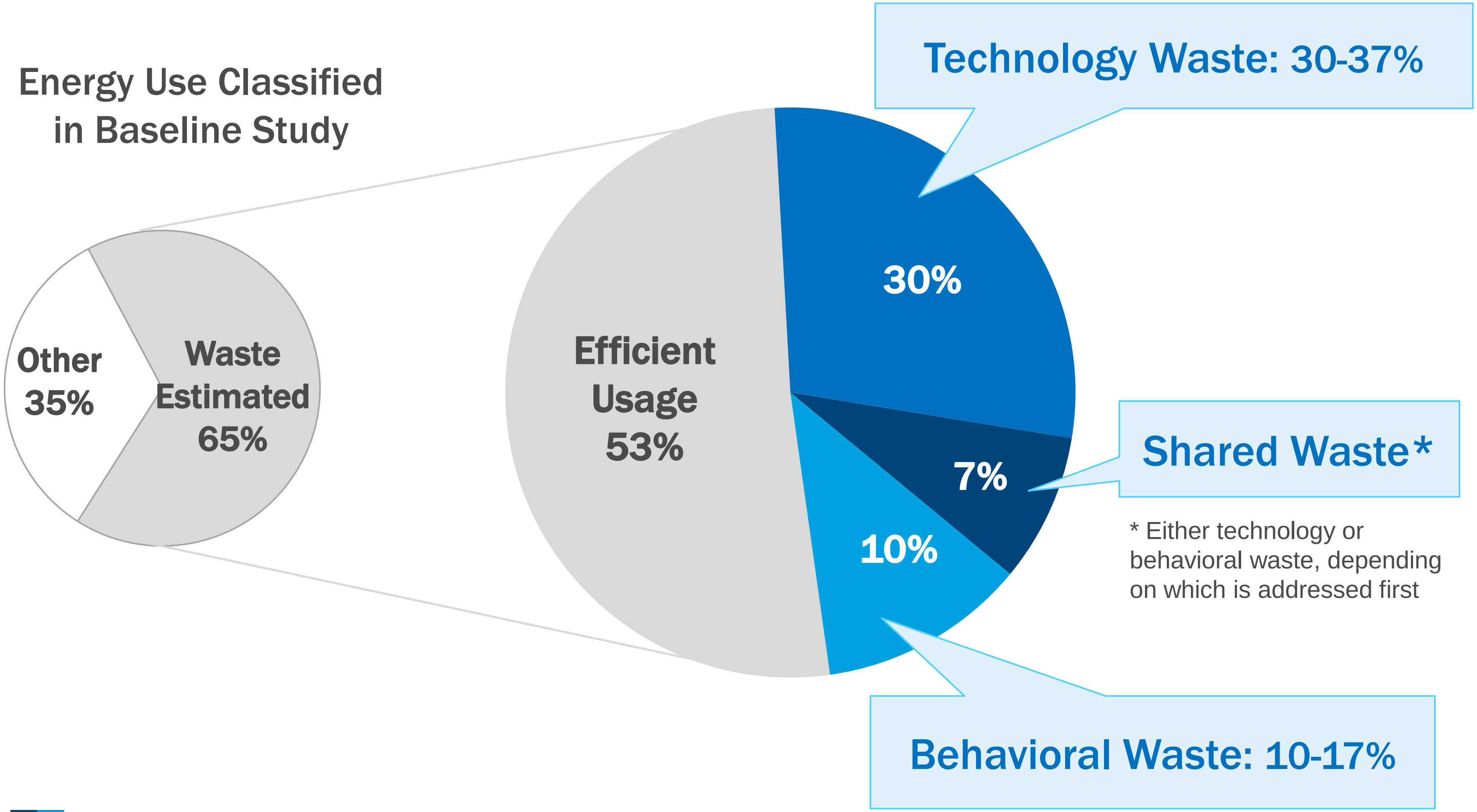
Example Results – Overall Residential Usage & Waste



* Either technology or behavioral waste, depending on which is addressed first

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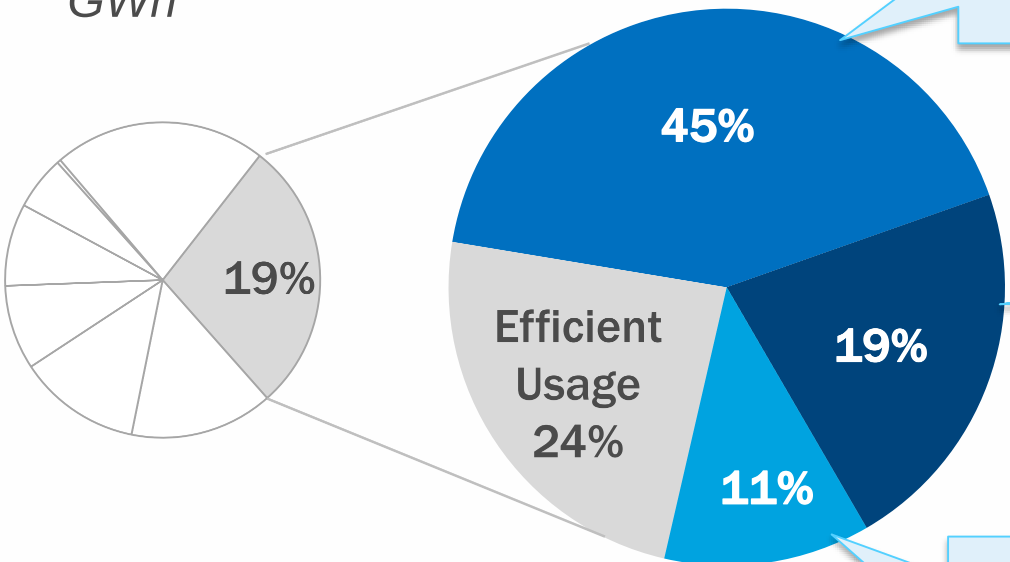
Example End-use Results – Residential Lighting

Penetration: 100%

Current Usage: 5,528 GWh

Current Waste: 4,208 GWh



Technology Waste: 42-65%

- Upgrade incandescent and halogen bulbs to CFLs

Shared Waste*

* Either technology or behavioral waste, depending on which is addressed first

Behavioral Waste: 11-30%

- Turn off lights when room not in use (15-minute time-out)

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Application of Approach

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Who Can Use This Method?

- No proprietary model required
- Relies on comprehensive, accurate primary data collection, TRM algorithms, and secondary sources
- Requires accurate definition of equipment and behavioral baseline
- Requires significant expertise in primary research design and engineering
- Method will need to be customized to each service territory/area it will be applied to

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Additional Inputs Required to Forecast Behavioral Potential

- Effort is a starting point, but does not provide a comprehensive forecast of savings over a specified time horizon
  - Doesn’t reflect all behaviors
  - Reflects behaviors for one year only (no estimated useful life/persistence of action)
  - Does not reflect market, economic, or program spending contraints
  - No program spending (cost-effectiveness)
- Could be incorporated into traditional potential model – would need to develop a comprehensive list of “behavioral” measures and fully define/characterize each measure (e.g. EUL, adoption rates, savings, etc)

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Behavioral Waste Quantified

Residential

- Turning off lights when room is not occupied (15 minute time-out period)
- Performing annual system maintenance on CAC
- CAC temperature setback
- Electric space heating temperature setback
- Electric water heating set-point decrease
- Unplug empty/nearly empty secondary fridge
- Unplug empty/nearly empty secondary freezer
- Eliminate excessive hot water usage for clothes washers
- Use “no heat dry” function for dishwashers
- Eliminate partial loads for dishwashers
- Turn off TV when not watching

Commercial & Industrial

- Turn off lights when not in use for given task
- Implement multiple methods of lighting controls
- Maintain split/packaged systems on a regular schedule
- Cooling temperature setback
- Reduce ventilation when not needed based on facility operations
- Perform regular maintenance of motors
- Decrease rewinding of motors
- Refrigeration temperature setbacks
- Office equipment power management
  - e.g. turn off computers, copiers, retail registers when not in use