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# BPA Energy Management Pilot Evaluation Results Cohort 1, Year 1

Brown Bag

April 8, 2013



# Agenda

- Energy Savings Validation Methodology
  - Monitoring, Targeting & Reporting (MT&R)
  - Cadmus Savings Estimation Approach
  - Example Site for Cadmus Methodology
- Program Results
- Cost-Effectiveness
- Recommendations

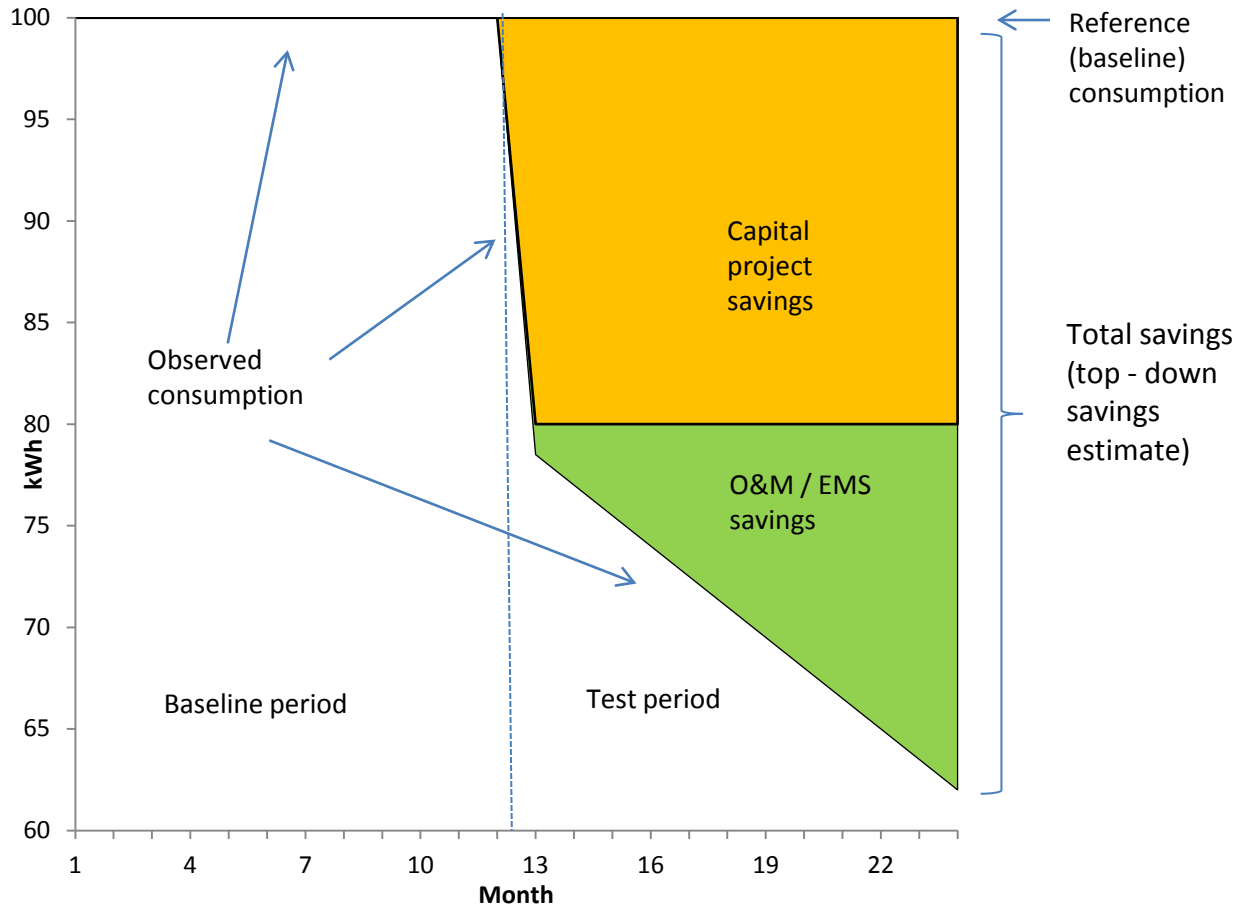
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# ENERGY SAVINGS VALIDATION METHODOLOGY



# Cadmus Savings Estimation Approach





# Comparison of MT&R and Cadmus Savings Estimation Approach

- MT&R (ESI program estimates)
  - Estimate of baseline consumption regression model for each site uses pre-intervention period data and predict consumption in the post- period
  - Savings equal cumulative sum of differences between predicted and actual consumption (CUSUM) net of capital project savings
  - Value: allows ongoing feedback to site and program on status
- Cadmus Savings Estimation Approach
  - Consumption regression model for each site uses pre- and post-intervention data
  - Model specification includes
    - Independent variables for site outputs and weather
    - Dummy (0-1) variable for HPEM or T&T implementation
    - Dummy (0-1) variables for capital measures without engineering savings estimates
  - Savings equal number of post periods x per period HPEM/T&T savings minus annual capital project savings
  - Value: uses all post data in model



# Cadmus Savings Estimation Steps

- Collect and prepare data
  - Billing/interval meter data
  - Program data
  - Facility production/operations data
  - Weather data
- Identify baseline and test periods
- Review facility operations and production data for correlations with energy use
- Develop a regression model
- Estimate model parameters and total energy savings
  - Conduct specification tests including Durbin-Watson and use FGLS if autocorrelation detected
- Conduct robustness and sensitivity checks of model
- Estimate HPEM/T&T savings and confidence intervals
- Compare to MT&R savings estimates



# Summary Statistics

- 17 sites
  - 2 Track & Tune, 15 HPEM (12 with capital measures)
  - HPEM 13 has two meters and was split into HPEM 13a and HPEM 13b
- Data Frequency
  - 5 daily, 3 weekly, 9 monthly or bi-monthly
- Performance period: July 1, 2010 – June 30, 2011
- 16 electricity and 2 therm consumption models
  - Not able to estimate O&M savings for HPEM 4 or HPEM 13a



## Example: HPEM 5

- Facility: Non-woven synthetic fabrics for diapers and other sanitary products
- Data frequency: weekly
- Baseline period: 7/2009-6/2010 (N=52)
- HPEM performance period: 7/2010-6/2011 (N=52)
- BPA model specification:
  - $kWh_t = \beta_0 + \beta_1 \text{Zero\_production}(1) + \beta_2 \sqrt{\text{KG\_production}} + \varepsilon_t$
- Cadmus model specification:
  - $kWh_t = \beta_0 + \beta_1 \text{HPEM}(1)_t + \beta_2 \text{OutputKG}_t + \beta_3 \text{OutputKG}_t^2 + \beta_4 \text{Zero\_Production}(1)_t + \beta_5 \text{CDD}_t + \varepsilon_t$
- Estimation method: FGLS (N=104)

MT&R HPEM/T&T Estimate (kWh)	Cadmus HPEM/T&T Savings (kWh)	Lower bound 80% CI	Upper bound 80% CI
963,226	992,767	598,649	1,386,885



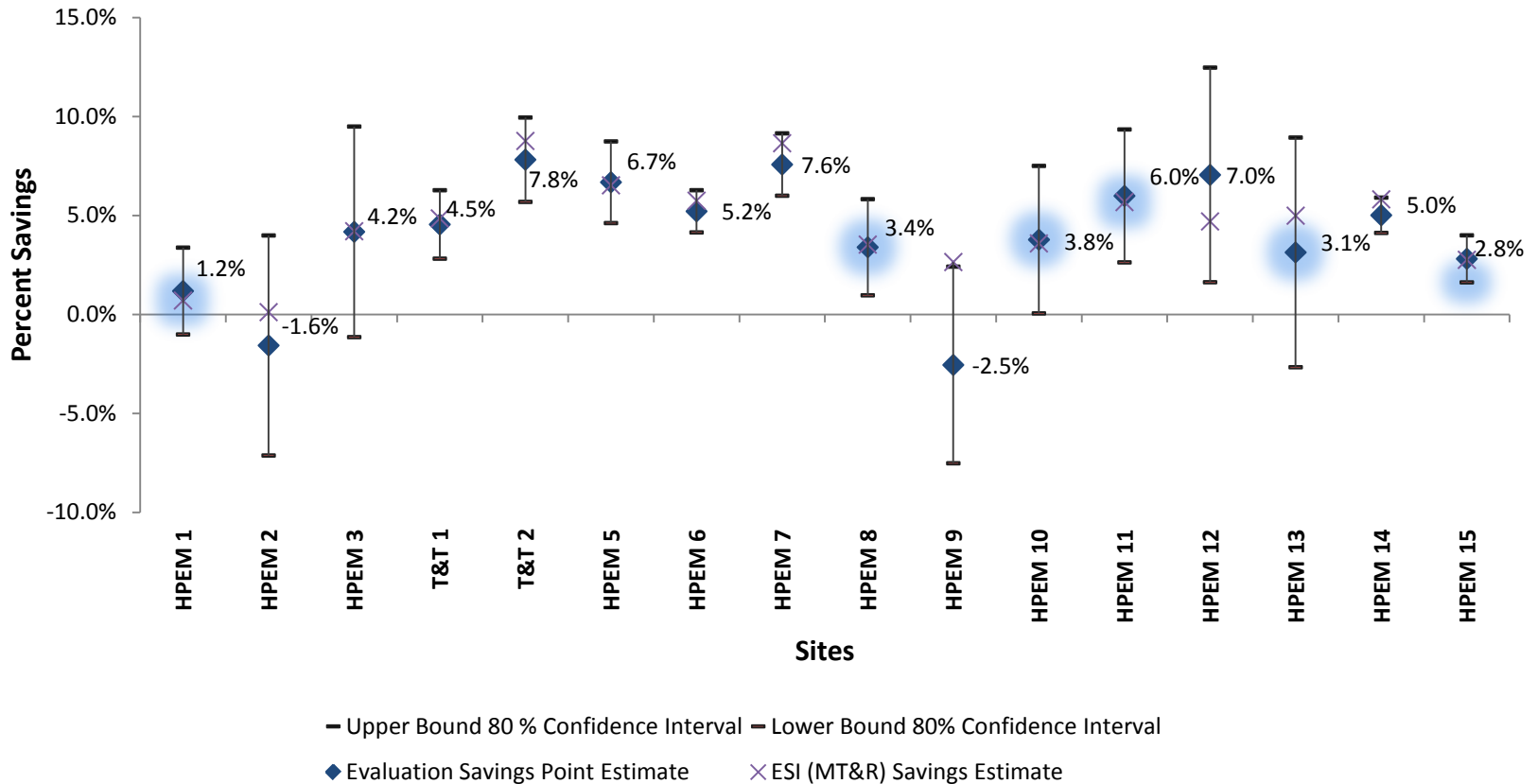
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# ENERGY SAVINGS RESULTS



# Capital and O&M Electric Savings as Percent of Consumption

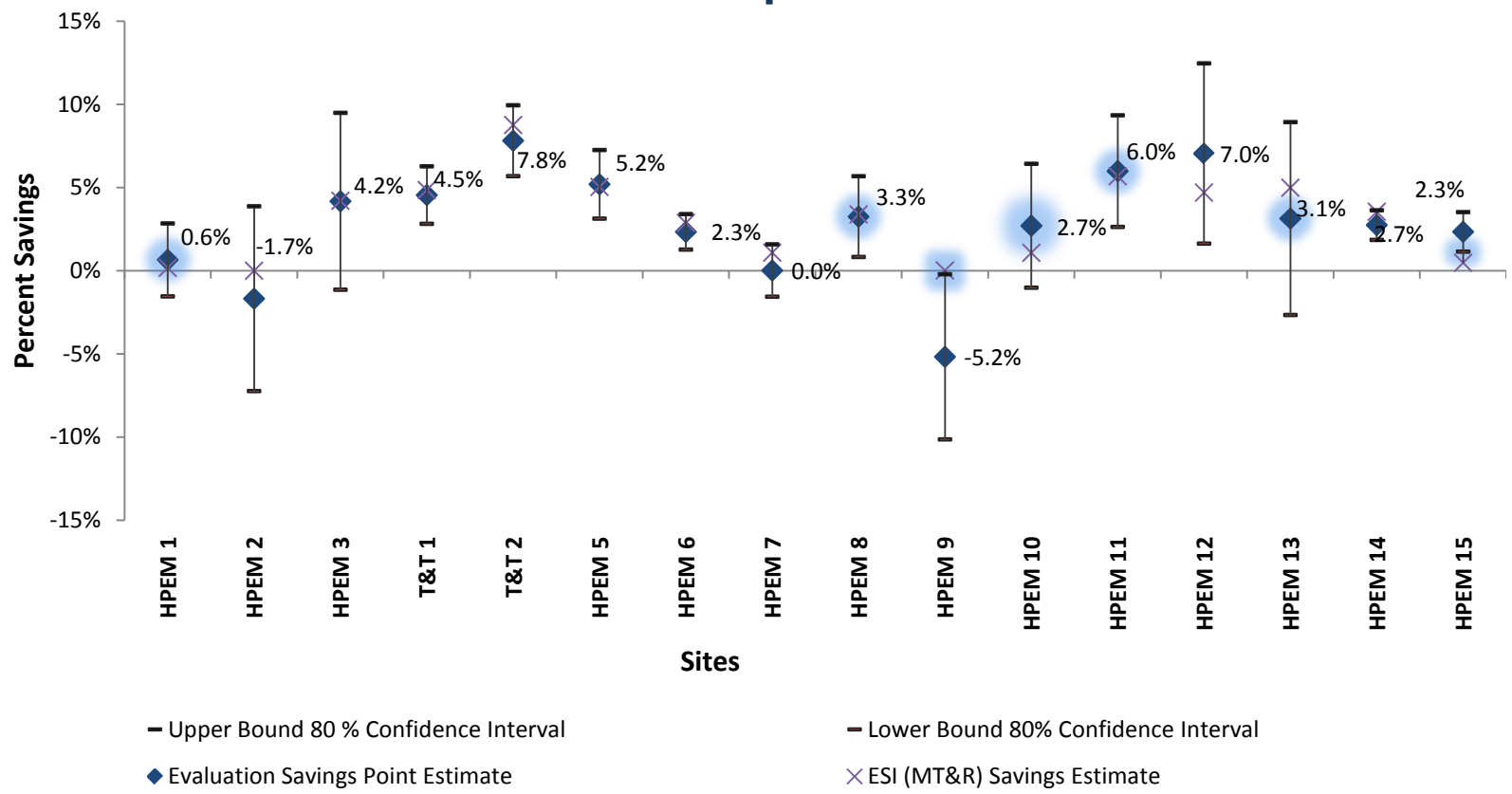


A shadowed diamond represents EPM sites.

HPEM 4 and HPEM 13a are excluded from the plot. HPEM 13 represents O&M savings from HPEM 13b.



# O&M Electric Savings as Percent of Consumption

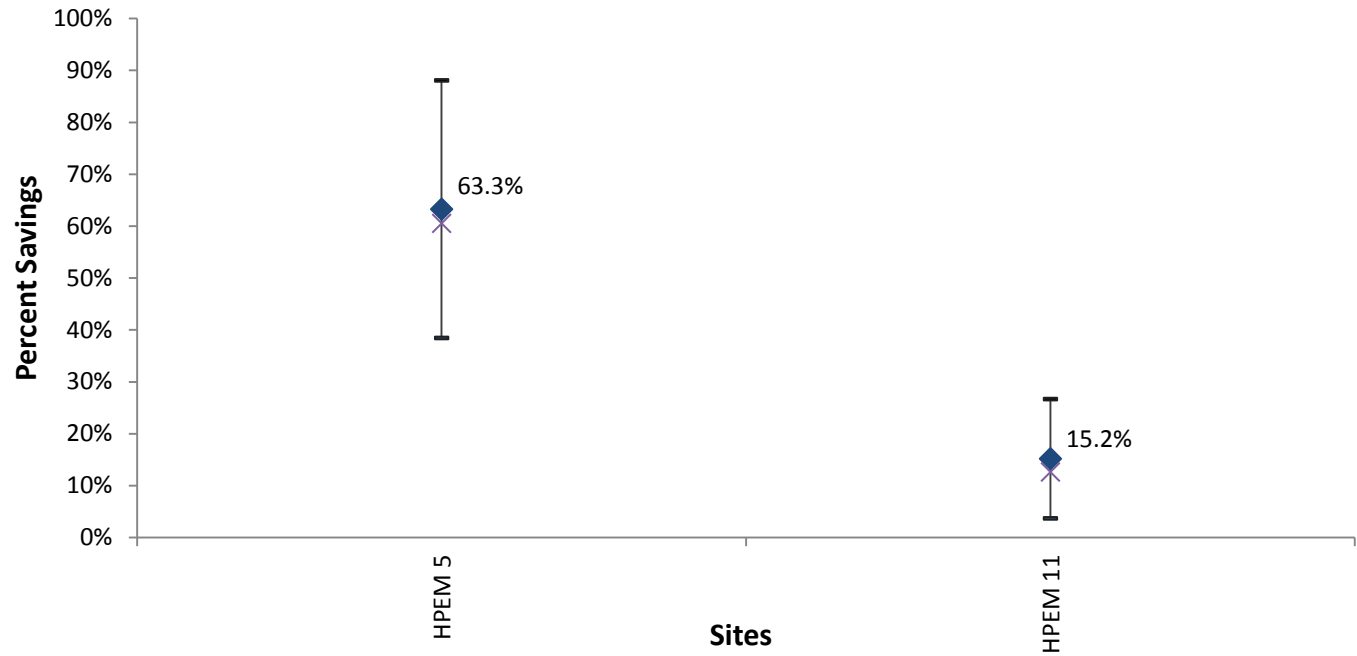


A shadowed diamond represents EPM sites.

HPEM 4 and HPEM 13a are excluded from the plot. HPEM 13 represents O&M savings from HPEM 13b.



# Gas Savings as Percent of Consumption



— Upper Bound 80 % Confidence Interval — Lower Bound 80% Confidence Interval  
◆ Evaluation Savings Point Estimate    × ESI (MT&R) Savings Estimate



# Capital + O&M Savings

Fuel	Measure Type	MT&R Reported Savings	Verified Savings	Verified Savings as a Percent of Consumption	Realization Rate
Electric (n=17)	Capital Measures	4,806,470 kWh	4,806,470 kWh	1.6%	100%
	O&M Measures	9,366,362 kWh	8,277,665 kWh	2.7%	88%
	Total	14,172,832 kWh	13,084,135 kWh	4.4%	92%
Gas (n=2)	Capital Measures	0 therms	0 therms	n/a	n/a
	O&M Measures	34,659 therms	38,736 therms	24.6%	112%
	Total	34,659 therms	38,736 therms	24.6%	112%



# O&M Electricity Savings Summary

	Sites (N)	O&M Savings (kWh)	O&M Savings as Percent of Load	Realization Rate	LB 80% CI	UB 80% CI
ESI Program Reports (MT&R): All Sites	16	9,366,362	3.1%	n/a	-	-
Evaluation results: All sites	16	8,277,665	2.7%	88%	62%	115%

Notes: HPEM 4 and HPEM 13a are not included because it was not possible to estimate the O&M savings. Realization rate is relative to MT&R savings estimates for the same 16 sites.



# Gas Savings Summary

Estimate	N (Sites)	O&M Savings	O&M Savings as Percent of Load	Realization Rate	LB 80% CI	UB 80% CI
ESI Program Reports (MT&R): All Sites	2	34,659	22.0%	n/a	-	-
Evaluation Results: All sites	2	38,736	24.6%	112%	64%	159%



# Overall Findings

- With few exceptions, the MT&R estimates are close to evaluated estimates for each site
- Positive HPEM/T&T savings at 14 sites (9 statistically significant at 20% level)
- Savings more likely to be detected at sites with higher frequency data
  - 7 of 8 sites with daily or weekly data had statistically significant savings
  - 2 of 9 sites with monthly or bi-monthly data had statistically significant savings
- At some sites, installation of capital measures before or after start of HPEM/T&T made it difficult or impossible to identify HPEM/T&T savings
  - We were not able to estimate savings for HPEM 4 and HPEM 13a because of the installation timing of capital measures



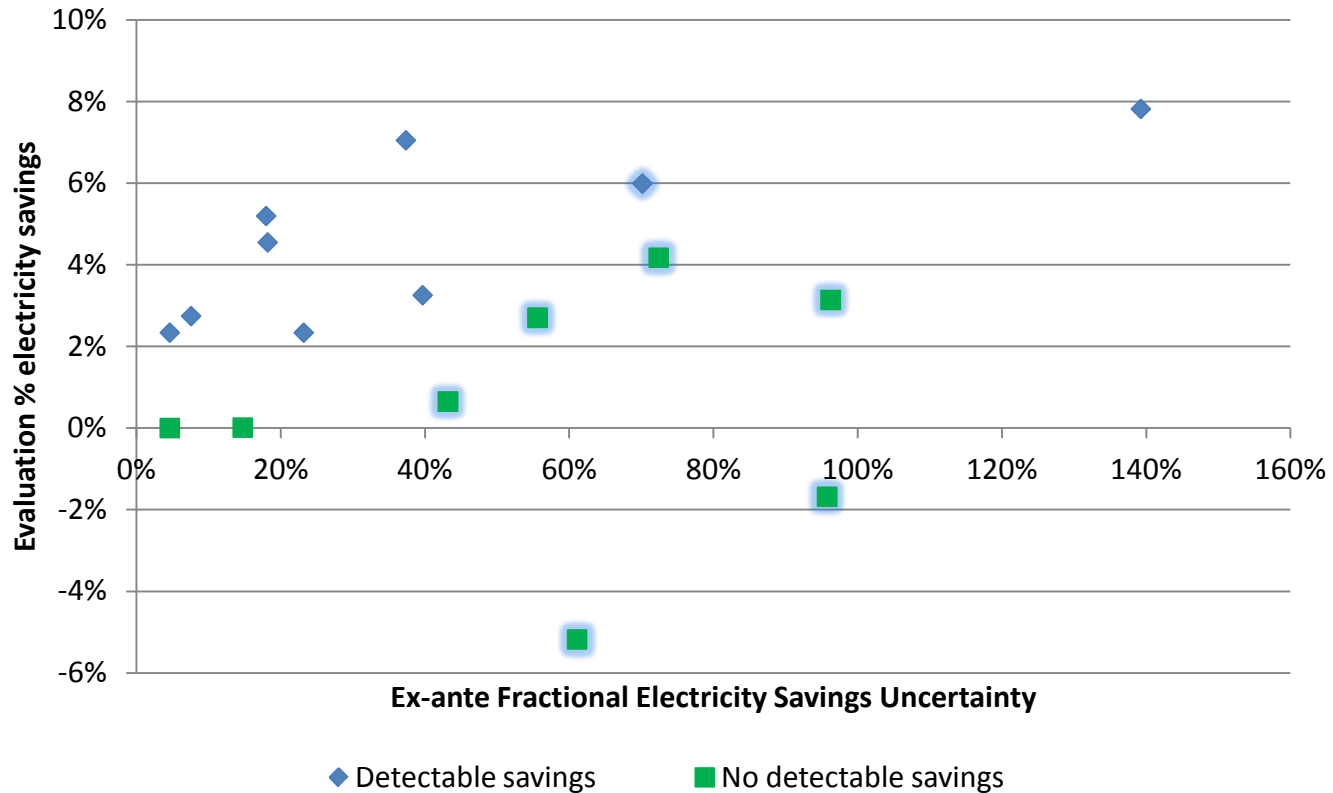


## Other Analyses

- FSU Analysis
  - Predicts whether savings can be detected statistically
- Pooled Model
  - To increase the probability of detecting savings at sites with monthly data, we pooled data from these sites and estimated a panel regression model



# FSU Results



Shaded markers denote sites with monthly or bi-monthly data



# Pooled Model Results

- This approach did not improve the precision of the savings estimates.
- If in future program years there are more participants which can be grouped into similar industries, then a panel approach might be used with more success and would be a less costly method than estimating the savings separately for each site.
  - For example, all food processors could be grouped together and an average savings rate for all food processing facilities in the program would be estimated by the model.

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# COST-EFFECTIVENESS



# Cost-Effectiveness Methodology

- Calculated TRC, UCT, and PCT for entire program
- Used evaluated kWh and therm savings
- Demand savings were determined by applying coincidence factors
- Measure costs
  - Capital measure costs were taken from the MT&R reports
  - O&M costs to site were assumed to be zero
- Ran scenarios for 3 years of program costs and 5 years of program cost to see how many years of life would be required to make  $TRC > 1$
- Measure life
  - O&M measures were assumed to have a 3-year or 5-year life based on the scenario
  - Capital measures have life corresponding to 6<sup>th</sup> Power Plan assumptions
- Other inputs came from the 6<sup>th</sup> Power Plan



# Cost-Effectiveness Results

	Test	B/C Ratio for 5 years	B/C Ratio for 3 years
All Facilities (n = 17)	Total Resource (TRC)	1.11	1.00
	Utility (UCT)	1.03	1.00
	Participant (PCT)	1.20	1.00

BPA and the EPT team have efficiently administered the pilot program in its first year, and the program can expect to improve its cost-effectiveness as the team streamlines processes in future years



# CONCLUSIONS & RECOMMENDATIONS



# Summary of Energy Savings

Fuel	Measure Type	MT&R Reported Savings	Verified Savings	Verified Savings as a Percent of Consumption	Realization Rate
Electric (n=17)	Capital Measures	4,806,470 kWh	4,806,470 kWh	1.6%	100%
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	O&M Measures	34,659 therms	38,736 therms	24.6%	112%
	Total	34,659 therms	38,736 therms	24.6%	112%





# Conclusions

- The first-year pilot electricity and gas savings estimates are statistically different from zero but imprecise
  - There is an 80% chance the realization rate for the O&M savings is between 62% and 115%
- The 80% confidence interval for electricity and gas savings include the MT&R savings estimate
- The program was cost-effective from the TRC, UCT, and PCT perspectives



# Challenges in Estimating Savings

- Billing and production data frequency
- Capital measures confounding analysis
- Implementation timing of measures



# Recommendations – Next Steps

- Perform a statistical power analysis
- Collect additional data
- Increase the frequency of data collected
- Re-estimate first-year pilot savings for sites with insignificant savings
- Account for autocorrelation
- Report confidence intervals and precision
- Consider the confounding effects of implementing simultaneous capital and O&M measures on impact evaluation

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**QUESTIONS?**



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