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Review of Persistence in Customer Behavior Program

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Key Takeaway

- Households receiving Home Energy Reports (HERs) still saved energy three years after treatment stopped
 - Savings decline about 25% for each year after treatment.
 - Persistence savings reduces total program savings to one cent per kWh saved.
 - Four years of continued treatment is estimated to cost nearly three cents per kWh saved.
 - Cycling households in on/off treatment years could result in greatest savings at lowest cost (\$0.02 per kWh saved)

Major Objectives

- Determine whether savings still persisted after more than two-years after treatment had stopped (Persistence)
- Examine how persistent savings impacted cost-effectiveness (Cost-effectiveness)
- Explore the connection between behavioral program participation and outside program participation
- Analyze whether deeper measure adoption (Adoption)

Program Design (study groups and sub-groups)

| Program Component | Year 1 | Year 2 |
|---|-----------------------------|---|
| Treatment Period | January 2011 to April 2012 | July 2012 to June 2013 |
| Study Group Size | 48,000 | 68,500 |
| Control Group Size | 24,000 | 34,500 |
| Active Treatment Group Size | 24,000 | 18,000 |
| Discontinued Treatment Group Size | 0 | 16,000 |
| Pre-program usage type | High users only (1,600 kWh) | High-use (1,600 kWh) Average-use (700 kWh) |
| Monthly Sub-treatment Group (received reports for 16 months) | 10,000 | 18,000 in total 8,000 continued high-users [Extension] 10,000 new average users [Expansion] |
| Quarterly Sub-treatment Group (received reports every three months for a year) | 10,000 | No |
| Persistence Sub-treatment Group (received monthly reports, but only for eight months) | 4,000 | No |

Prior Savings Results

| Treatment and Sub-treatment Groups | | | Average daily savings (kWh) | % savings | Average Savings / HH | Average expenditure / kWh saved |
|------------------------------------|-------------|---------------------------|-----------------------------|-----------|----------------------|---------------------------------|
| High-use | Monthly | First Year | 1.07 | 2.17% | 415 kWh | \$0.03 |
| | | Second Year Treatment | 1.19 | 2.31% | 433 kWh | \$0.03 |
| | | First Year Post-Treatment | 1.49 | 3.70% | 292 kWh | \$0.02 |
| | Quarterly | First Year Treatment | 0.72 | 1.45% | 429 kWh | \$0.03 |
| | | First Year Post-Treatment | 0.83 | 2.06% | 303 kWh | \$0.02 |
| | | First 8 Months Treatment | 0.8 | 1.58% | 427 kWh | \$0.03 |
| | Persistence | 7 Months Post-Treatment | 0.52 | 1.06% | 273 kWh | \$0.02 |
| | | 23 Months Post-Treatment | 0.75 | 1.86% | | |
| | Average use | Monthly | First Year Treatment | 0.26 | 1.17% | 96 kWh |



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Evaluation Design

| Evaluation Activity | High-use Discontinued | High-use Extension | Average-use Expansion |
|---|-----------------------|--------------------|-----------------------|
| Persistence Analysis | Yes | No | No |
| CEEF Program Participation | Yes | Yes | Yes |
| Deeper Measure Uptake | Yes | Yes | Yes |
| Average Monthly Pre-program Usage (kWh) | 1,663 | 1,650 | 708 |



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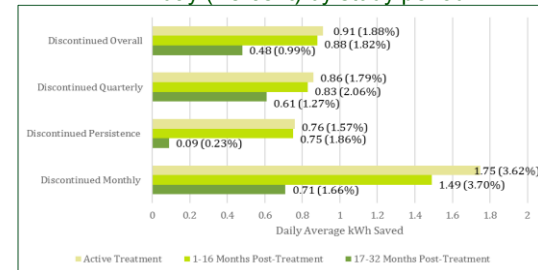
Savings Persistence: Discontinued High-use Groups Billing Analysis

- Examined savings persistence for discontinued high-use households that received reports during the first year of the program using OLS regression
- Examined overall and for three subgroups
 - Monthly - received monthly reports for 16 months
 - January 2011 through April 2012
 - Persistence - received monthly reports for 8 months
 - January 2011 through August 2012
 - Quarterly - received reports every three months for 16 months
 - January 2011 through April 2012 (received only four HERs)



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Billing Analysis Measured Program Savings for High-use Discontinued Households kWh / day (Percent) by study period



High-use Discontinued Monthly group saw much higher savings in every study period than the other two high-use discontinued groups.



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Developed Persistence Factors as Proxy for Effective Useful Life

- Technical degradation factor (TDF) refers to the rate at which savings decrease over time due to mechanical or behavior degradation
 - Very little literature on TDF so usually incorporated into effective useful life (EUL)
- Persistence factor
 - Years of Post-treatment savings x Average Savings Retention
 - Average savings retention limited to year with significant post-treatment savings
- Total savings per treatment group
 - Treatment savings + [Treatment savings x Persistence factor]



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Total Measured Billing Analysis Savings per High-use Household Discontinued Treatment Sub-groups

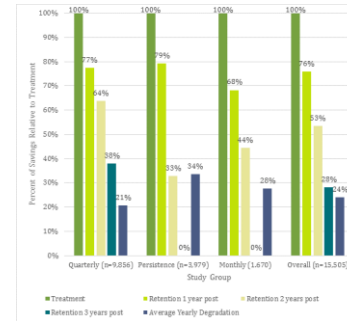
- All Discontinued Sub-group program induced savings have been measured 4 times
- Discontinued Quarterly = 1,093 kWh (treatment + three years significant savings post)
- Discontinued Persistence = 733 kWh (treatment + two years significant savings post)
- Discontinued Monthly = 1,694 kWh (treatment + two years significant savings post)
 - Treatment savings unusually high (3% compared to 1.5% to 2.2% for other high-use groups including discontinued and extension)



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Savings Degradation

Annualized Savings by High-use Discontinued Groups



Technical Degradation Factors High-use Discontinued Groups

- Quarterly = 21%
- Persistence = 34%
- Monthly = 28%
- Overall = 24%



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Measured Persistence informs Cost Effectiveness: Savings to Expenditure Ratio

- Applied measured persistence findings to explore program design options that maximize savings to cost ratio
- Created a simple calculation of savings over program budget
- Compare hypothetical “cycling” treatment design to continual treatment



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Cost per Savings: Discontinued High-use Sub-groups: based on measured savings

| Savings Period | Quarterly Group | Persistence Group | Monthly Group |
|---|-----------------|-------------------|---------------|
| Cost / savings Treatment plus two years post | \$0.01 | \$0.02 | \$0.007 |
| Program savings treatment plus two years post | 9,301,501 | 2,916,289 | 2,829,665 |
| Cost / savings Treatment plus three years post | \$0.01 | -- | -- |
| Program savings Treatment plus three years post | 10,768,468 | | |
| Program Expenditure | \$113,527 | \$45,833 | \$19,926 |
| Sample Size | 9,856 | 3,979 | 1,670 |



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- Each Sub-group has been evaluated three times
 - Quarterly Group treatment plus post period covers a four year period
 - Persistence and Monthly treatment plus post period covers a three year period
 - The fourth year program impact measurement for the Persistence and Monthly Groups did not show any significant savings.



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Extended Treatment and Continuous Treatment Design: High-use Sub-groups

| | Savings presented at the Household level | | |
|--|--|------------------|----------------------|
| | Quarterly-High-use | Monthly High-use | Persistence High-use |
| Cumulative Savings: Treatment and Post, based on billing analysis | 1,093 | 1,694 | 733 |
| Cumulative: Cost per kWh saved | \$0.011 | \$0.007 | \$0.016 |
| Cumulative: Years Post Savings | 3 | 2 | 2 |
| Hypothetical Savings: Two Years Treatment, Two Years Post | 1,335 | 2,491 | 1,079 |
| Hypothetical Cost per kWh saved: Two Years Treatment, Two Years Post | \$0.018 | \$0.010 | \$0.022 |
| Hypothetical Savings: Four Years Continual Treatment | 1,565 | 3,185 | 1,383 |
| Hypothetical Cost per kWh saved: Four Years Continual Treatment | \$0.031 | \$0.015 | \$0.035 |



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Cycling Design: All High-use Households

| | Group A | Group B | Group C | Continued |
|---------------------------------|-------------|-------------|-------------|-----------|
| Year 1 | Treatment | n/a | n/a | Treatment |
| Year 2 | Persistence | Treatment | n/a | Treatment |
| Year 3 | Persistence | Persistence | Treatment | Treatment |
| Year 4 | Treatment | Persistence | Persistence | Treatment |
| Accumulated Savings (kWh) | 1,298 | 882 | 699 | 1715 |
| Accumulated Cost | \$24.00 | \$12.00 | \$12.00 | \$48.00 |
| Accumulated Cost/Savings | \$0.018 | \$0.014 | \$0.017 | \$0.028 |
| Total Accumulated Savings (kWh) | 2,879 | | | 1,715 |
| Total Accumulated Cost | \$48.00 | | | \$48.00 |
| Total Accumulated Cost/Savings | \$0.017 | | | \$0.028 |

Achieve 68% greater savings from this Cycling scenario at 61% of the cost/savings



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Participation in Other CEEF Programs

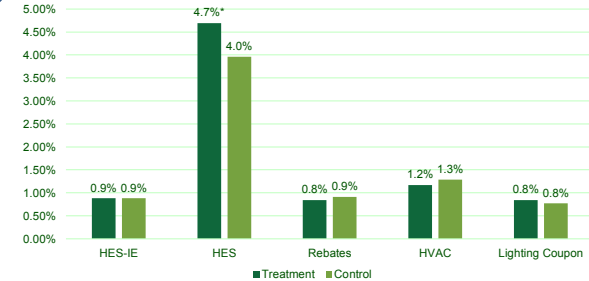
- Matched all HERs program study groups to HES, HES-IE, and Rebate Program databases from 2011 through April 2015
 - Discontinued High-use Groups
 - High-use Extension Group
 - Average-use Expansion Group
 - All Control Households
- Compared participation rates
 - Simple comparison
 - Statistical comparison using *Chi Square* tests



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Participation in other CEEF Programs

NOTE THE SCALE
↓



Home Energy Reports boosted participation in Home Energy Solution only – 0.7% higher for treatment group over control group



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Deeper Measure Adoption

- Did HERs treatment households adopt deeper measures at a greater rate?
- Is double counting an issue?
- Measures included
 - Insulation (attic & wall)
 - Furnaces & Boilers
 - Other HVAC
 - Refrigerators & Freezers
 - Heat Pump Water Heater
 - Windows



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Deeper Measure Adoption Results

- High-use Extension installed insulation at a greater rate than the control group
 - 8.9% for treatment vs. 7.1% for control
 - Received reports for more than two years
 - No statistically significant differences for any other measure or study group
- Deeper measure update very small impact on savings – less than 0.03%



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Recommendation 1: Update the PSD to Reflect Study Findings

| | High-use Discontinued Quarterly | High-use Discontinued Persistence | High-use Discontinued Monthly |
|---|---------------------------------|-----------------------------------|-------------------------------|
| Treatment Savings in kWh ¹ | 391 | 346 | 796 |
| Persistent Factor (Use in place of EUL) | 1.79 | 1.12 | 1.13 |
| Years of Post-treatment Savings | 3 | 2 | 2 |

Year 2 findings suggest that you NOT apply these to High-use Extension or Average-use Expansion

Recommendation 2: Continue to Assume Realization Rate of 100% for the Treatment Period

- Study did not have access to Eversource's savings estimates
- Lacking contrary evidence, should keep current estimate of 100%

Recommendation 3: Eversource should consider most appropriate length and duration of treatment

- Cycling could achieve greater savings for same cost as continual treatment
- Other designs that could take advantage of both treatment and persistence savings
- Must also consider issues of equity, feasibility, savings from long-term treatment

Recommendation 4: Do NOT adjust HERs savings estimates to avoid double counting

- Findings suggest that HERs savings do not need to be adjusted for double counting
- Eversource should closely monitor savings rates in HERs, adoption rates of deeper measures
 - Especially insulation, whole-house treatment with HPwES program
 - If rates increase, then may need to make adjustments (to be determined)
- Some jurisdictions do adjust for double counting, considered "best practice"
 - Greater rates of deeper measure adoption and/or savings from deeper measures

Link to Report

Final report will be posted on CTEEB website within the next few days.

