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2014 Energy Savings for the Commercial Real Estate Strategic Energy Management Cohorts

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Executive Summary

The Northwest Energy Efficiency Alliance (NEEA) engaged Cadmus to determine the 2014 energy savings for NEEA's Commercial Real Estate (CRE) Initiative.[1] Since 2007, NEEA has offered the initiative to encourage the Northwest's commercial real estate market to adopt Strategic Energy Management (SEM) practices to reduce energy use. SEM is a holistic approach to managing energy that involves efficient equipment and behavioral activities and requires engagement from building staff at all levels. NEEA provides technical advice and training to ensure that building managers have the knowledge and tools they need to track and measure energy consumption. For the CRE Initiative, NEEA defines SEM as:

1. Adoption of a management-approved energy performance improvement goal at the firm, portfolio, and/or building level;
2. Documented planned activities to achieve the goal;
3. Allocation of resources (staff and training, capital, or both) toward the goal;
4. Implementation of planned activities;
5. Regular management review of progress achieved toward energy performance goal and effectiveness of SEM practices.

NEEA's CRE SEM initiative offers two paths of participation: the Market Partners Program (MPP), which employs an organizational coaching process to integrate SEM into a company's business practices, and office energy efficiency competitions that engage the target market to adopt SEM practices.

Research Objectives

NEEA's objectives for this study were to determine the electricity and gas savings achieved by the MPP and OC cohorts during the 2014 program year, which ran from October 2013 through September 2014.

Key Findings

The OC cohort saved 0.772 aMW during 2014, equivalent to 4.09% of building consumption. The MPP cohort saved 0.611 aMW during 2014 equivalent to 5.54% of building consumption. Both results were significant at the 90% level with 10% precision. The cohorts had higher electricity savings in 2014 than in 2013 (Cadmus, 2014) and similar savings to 2012 (Itron, 2014).

The 2013 electric savings for both cohorts could be lower due to the absence of data for October, November, and December 2013 at the time of analysis. These months have high energy use for heating, and therefore have high savings potential for buildings with electric heating that implemented HVAC measures or actions. Beginning with the 2014 program year, NEEA adjusted the savings validation period to run from October through September so that an entire

[1] The geographic footprint encompassed by the NEEA region includes the States of Idaho, Montana, Oregon, and Washington.

year of post-program data can be included in the model to more accurately reflect savings for weather-sensitive activities.

Additionally, in 2013 NEEA invested more time up front than it had in previous program years in an effort to help cohort building managers establish an implementation plan. Consequently, cohort buildings did not implement energy-efficiency projects until later in the year, so there may not have been enough months of data to capture energy savings from these projects. NEEA's documentation showed that building managers planned to implement more energy-saving activities during the 2013 program than in previous years; however, the majority of these activities did not begin until late 2013 or were planned for 2014. Therefore, the 2014 program year savings likely capture the savings from the activities planned in 2013, but implemented during late 2013 and 2014.

Neither cohort achieved any gas savings. Cadmus reviewed the measure list for the MPP and OC cohorts and found that the MPP cohort only implemented two gas measures in 2014 and the OC cohort only implemented six gas measures in 2014.

Conclusions and Recommendations

Cadmus offers the following conclusions based on the energy savings findings.

- **NEEA's CRE SEM Initiative achieved electricity savings in three consecutive years.** The CRE SEM cohorts have achieved between 2% to 6% annual savings in 2012 through 2014.

- **NEEA's CRE SEM Initiative achieved gas savings in 2013, but not in 2014.** The CRE SEM cohorts achieved 7% to 8% annual savings in 2013, however, did not achieve measurable savings in 2014. Cadmus reviewed the measure list for the MPP and OC cohorts and found that the MPP cohort only implemented two gas measures in 2014 and the OC cohort only implemented six gas measures in 2014.

Cadmus continues to recommend that NEEA collect occupancy data from participants and billing and occupancy data from a representative control group for these types of programs in the future.[2] These data could explain any changes in energy consumption that currently available data cannot explain, and they may support an in-depth analysis of savings trends.

[2] NEEA and Cadmus are currently working with utilities in the region to collect billing data from a representative control group. In addition, NEEA is working with participants to collect occupancy data more frequently.

1 Introduction

Through the CRE Initiative, offered since 2007, NEEA encourages the Northwest's commercial real estate market to adopt SEM practices to reduce energy use in this sector. SEM is a holistic approach to managing energy use that includes both efficient equipment and behavioral activities and requires engagement from building staff at all levels, from the executives to the building managers and building tenants. NEEA provides technical advice and training to CRE cohorts to ensure that building managers have the knowledge and tools needed to track and measure energy consumption. For the CRE Initiative, NEEA defines SEM as:

1. Adoption of a management-approved energy performance improvement goal at the firm, portfolio, and/or building level;
2. Documented planned activities to achieve the goal;
3. Allocation of resources (staff and training, capital, or both) toward the goal;
4. Implementation of planned activities;
5. Regular management review of progress achieved toward energy performance goal and effectiveness of SEM practices.

The NEEA CRE Initiative uses a variety of formats to promote SEM practices. These include:

- **The Market Partners Program (MPP).** NEEA engages leading Northwest commercial real estate firms to adopt SEM practices through an organizational coaching process, with the goal of making SEM an integral part of how this target market does business. Firms engage with the MPP for several years. NEEA describes this group as the MPP cohort.

- **Commercial office efficiency competitions.** Office competitions engage firms, managers, and operators of buildings in the target market to adopt components of SEM. These practices include operations and maintenance best practices, benchmarking, goal setting, energy management action planning, and reporting on results. Competitions, delivered in partnership with market allies such as Building Owners and Managers Association (BOMA), result in significant energy savings for the region. Past competitions included Portland's Office Energy Showdown, Carbon4Square and Seattle's Kilowatt Crackdown. The 2014 competitions were Kilowatt Crackdown in Boise, Portland, and Seattle. NEEA describes this group as the Office Competition (OC) cohort.

- **Industry education and training.** The initiative builds analytic skills and operating knowledge of the competitive advantage of energy efficiency through professional seminars and workshops delivered by market allies.

- **Additional marketing communications.** NEEA provides case studies, analytic tools, and templates that equip building owners and managers with the tools to achieve increased market value through energy efficiency.

Note that the MPP is primarily an organizational (firm) level adoption and the office competitions engage (with staff) at the individual office building level. Some MPP firms manage buildings that participated in the office competitions, so there is some overlap between the two

cohorts. In these cases, Cadmus included these buildings as part of the MPP cohort because the MPP engages with firms for a longer time; therefore, these buildings may better reflect savings and SEM adoption levels for the MPP cohort than the OC cohort.

1.1 Study Objectives

NEEA's objective for this study was to determine the 2014 electricity and gas savings for the MPP and OC cohorts. To quantify the electricity and gas savings, Cadmus collected billing data and weather data and incorporated these into regression models.

2 Methodology

Cadmus estimated the overall electricity and gas savings achieved by the cohorts during 2014 using a billing analysis. This methodology is appropriate because the CRE Initiative affects a variety of end uses. Cadmus first prepared the data for analysis, then conducted a regression analysis of energy use intensity (EUI) to estimate energy savings per square foot of floor space. Finally, Cadmus used the coefficient estimates from the regression analysis results to calculate 2014 savings.

2.1 Preparing Data

NEEA provided Cadmus with billing data for 40 MPP buildings and 70 OC buildings. Ten buildings were in both programs, and Cadmus included them in the MPP energy-savings analysis, reducing the number of buildings in the OC analysis to 60.

To prepare the data, Cadmus first assessed the completeness of data available during the October 2012 to September 2014 baseline and evaluation periods for each electric and gas meter for each building. The team determined that billing data was missing for some months in the evaluation period, and it worked with NEEA and its implementer to obtain the missing data.

Cadmus reviewed the billing meter types to determine which meters to include in the analysis. Some buildings had separately metered photovoltaic (PV) systems that were not installed as part of the building's participation in NEEA's program, so Cadmus calculated the total building electricity use by adding the electricity produced by the PV system to the electric billing data. Some buildings separately metered the energy consumed for hot water or geothermal heating systems. Cadmus converted these data to therms, and then added them to the gas billing data to calculate total gas consumption and capture any energy savings from these systems.

Next, Cadmus reviewed each building's energy consumption data for outliers or other suspect readings. The team then adjusted the billing periods to calendar months to have comparable data across buildings and for different meters of the same building.

Cadmus downloaded weather data corresponding to the location of each building. The team calculated base 65 heating degree days (HDDs) and cooling degree days (CDDs) for each calendar month, then merged the weather data with the electric and gas consumption data.

2.2 Estimating Program Year 2014 Energy Savings

The regression analysis for the 2014 program year energy savings used the same approach as for the 2013 program year energy savings. The analysis included billing data from October 2012 through September 2014.[3] The baseline period was October 2012 through September 2013; the program period was October 2013 through September 2014.

Cadmus specified an EUI fixed-effects model to estimate MPP and OC savings. In a fixed-effects model, each building in each month is taken to have specific characteristics unique to that building, which are estimated separately from the other explanatory variables. In this way, any characteristics of a particular building (size, occupancy, insulation, etc.) are controlled for. The model is specified as follows:

$$kWh_{it} = \beta_1 HDD_{it} + \beta_2 CDD_{it} + \gamma Post(1)_{it} + \mu_{im} + \varepsilon_{it}$$

where:

kWh_{it}	=	Electricity use per square foot of floor space in building 'i' in month 't'
HDD_{it}	=	Heating degree days for building 'i' in month 't'
CDD_{it}	=	Cooling degree days for building 'i' in month 't'
γ	=	Electricity savings per square foot of floor space per month
$Post(1)_{it}$	=	An indicator for building 'i' that month 't' is in the program period
μ_{im}	=	Building month fixed effect, where m=1, 2, …, 11,12. This is the energy use for building 'i' specific to a particular month after controlling for HDDs and CDDs. These unobservable effects are analogous to building fixed effects, except they are specific to a building and month instead of just to a building
ε_{it}	=	Random error term for building 'i' in month 't'

Note that for estimating gas savings, Cadmus used the same model specification but with the exclusion of CDDs because gas is not used for cooling and therefore not dependent on CDD. To estimate this model, Cadmus formed a 12-month difference by subtracting kWh per square foot from a month in 2013 from the kWh per square foot in that same month in 2014.[4]

[3] Due to NEEA's need to report energy savings in April of each year, the energy savings in previous program years have relied on data from January through September. Starting with the 2014 program year, the savings validation period runs from October through September so that an entire year of test period data can be included in the model to more accurately reflect savings for weather-sensitive activities.

[4] We excluded months in the baseline period that did not have a preceding month in the evaluation year, or vice versa.

The current EUI is:

$$kWh_{it} = \beta_1 HDD_{it} + \beta_2 CDD_{it} + \gamma Post(1)_{it} + \mu_{im} + \varepsilon_{it}$$

The EUI 12 months ago is:

$$kWh_{i(t-12)} = \beta_1 HDD_{i(t-12)} + \beta_2 CDD_{i(t-12)} + \gamma Post(1)_{i(t-12)} + \mu_{im} + \varepsilon_{i(t-12)}$$

The difference between the current energy use and that from 12 months ago is:

$$kWh_{it} - kWh_{i(t-12)} = (\beta_1 HDD_{it} + \beta_2 CDD_{it} + \gamma Post(1)_{it} + \mu_{im} + \varepsilon_{it}) - (\beta_1 HDD_{i(t-12)} + \beta_2 CDD_{i(t-12)} + \gamma Post(1)_{i(t-12)} + \mu_{im} + \varepsilon_{i(t-12)})$$

Expressing the differences using deltas (Δ) results in the following equation:

$$\Delta kWh_{it,t-12} = \beta_1 \Delta HDD_{it,t-12} + \beta_2 \Delta CDD_{it,t-12} + \gamma \Delta Post(1)_{it,t-12} + \Delta\varepsilon_{it,t-12}$$

Note that in the difference model, the building-month specific effects drop out. If the analysis sample is limited to the 2014 evaluation period and 12 months of post period, the $\Delta Post(1)_{it,t-12} = 1$ for all periods in the evaluation year and becomes the model intercept. The coefficient γ is the average savings per square foot per month.

Cadmus estimated the model by Ordinary Least Squares, and the standard errors are Huber-White robust standard errors clustered on buildings.

The advantage of estimating a difference model is that it controls for unobservable effects specific to a building and month (e.g., July consumption of building A is large every year for reasons that we cannot observe). The approach used in the 2012 evaluation controlled for building-specific effects (e.g., building B has a small average monthly consumption) separately from month-specific effects (e.g., all buildings tend to use more energy in December), but it did not control for monthly effects specific to buildings. The difference model should result in a more precise estimate of savings than a levels model with reduced bias.[5]

The regression model does not include occupancy data because such data are not available at monthly intervals. The fixed-effects model captures variation specific to each building and estimates a fixed (time independent) effect specific to the building. Including occupancy for a single point in time would be redundant, as the fixed-effects coefficient estimate captures the relative difference in occupancy between buildings. Data on occupancy that varied over time would be useful in the model if NEEA is able to collect that data in the future.

[5] Bias in the estimate of γ would arise in the levels (but not difference) model if $Post(1)_{it}$ and μ_{im} were correlated. The unavailability of energy use data for a building during certain months of the program period could generate such correlation and thus bias. For example, if energy use during months with the highest consumption was missing, the missing data would confound the savings estimate (the low average consumption during the program would reflect the unavailability of data for certain months, instead of reflecting savings) and would result in an estimate of γ that was biased downward (reflecting higher estimated savings than the true savings).

Cadmus used the model to estimate average monthly energy savings per square foot using October 2013 through September 2014 data. The team calculated the annual energy savings per square foot by multiplying the average monthly savings by 12 months. The team then calculated the total 2014 savings for the buildings included in the analysis by multiplying the annual energy savings per square foot by the total square feet corresponding to those buildings.

3 Findings

Cadmus estimated the overall electricity and gas savings achieved by the cohorts during program year 2014.

3.1 2014 Electricity Savings Results

Cadmus included 60 buildings in the OC analysis and 40 buildings in the MPP analysis. The OC buildings saved an average 0.055 kWh per square foot per month, resulting in 0.772 aMW of savings during 2014. This was equivalent to 4.1% of building consumption. The MPP buildings saved an average 0.081 kWh per square foot per month, resulting in 0.611 aMW of savings during 2014. This was equivalent to 5.5% of building consumption. The OC results were significant at the 90% confidence level with 10% precision; the MPP results were significant at the 80% confidence level with 20% precision. Table 1 shows the 2014 electric savings by cohort.

Table 1. Electric Savings in the 2014 Program Year

Cohort	Number and Square Feet of Buildings	Avg. Monthly Savings (kWh per square foot)	Total Savings (aMW)*	90% Confidence Interval Bounds (aMW)		Percentage Savings
				Lower	Upper	
Office Competition	60 10,318,655	0.055	0.772	0.393	1.151	4.1%
Market Partners Program	40 5,494,993	0.081	0.611	-0.103	1.325	5.5%

* The total reported savings are *incremental* to 2014 (energy savings that may have occurred in previous years are not included).

Table 2 shows both cohorts achieved higher savings in 2014 than in 2013 (Cadmus, 2015), and achieved similar savings to 2012 (Itron, 2014).

Table 2. Electric Savings for the CRE Cohorts from 2012 through 2014

Cohort	2012 Electric Savings (% of Consumption)	2013 Electric Savings (% of Consumption)	2014 Electric Savings (% of Consumption)
Office Competition	5.9%	1.8%	4.1%
Market Partners Program	5.2%	3.8%	5.5%

The 2013 savings for both cohorts could be lower due to the absence of data for October, November, and December 2013 at the time of analysis. These months have high energy use for heating, and therefore have high savings potential for buildings with electric heating that implemented HVAC measures or actions. Beginning with the 2014 program year, NEEA adjusted the savings validation period to run from October through September so that an entire year of post-program data can be included in the model to more accurately reflect savings for weather-sensitive activities.

Additionally, in 2013 NEEA invested more time up front than it had in previous program years in an effort to help cohort building managers establish an implementation plan. Consequently, cohort buildings did not implement energy-efficiency projects until later in the year, so there may not have been enough months of data to capture energy savings from these projects. NEEA's documentation showed that building managers planned to implement more energy-

saving activities during the 2013 program than in previous years; however, the majority of these activities did not begin until late 2013 or were planned for 2014. Therefore, the 2014 program year savings likely capture the savings from the activities planned in 2013, but implemented during late 2013 and 2014.

Cadmus also analyzed 2014 electricity savings separately for OC buildings in Seattle, Boise, and Portland/Vancouver. Table 3 shows the electric savings for the three cities. Seattle buildings achieved 4.3% savings, Portland/Vancouver buildings achieved 4.2% savings, and Boise buildings achieved 4.7% savings. All results were significant at 90% confidence and 10% precision.

Table 3. Office Competition Electricity Savings in 2014 by City

City	Number of Buildings	Avg. Monthly Savings (kWh per sq. ft.)	Total Size (sq. ft.)	Total Savings (aMW)*	90% CI Lower Bound	90% CI Upper Bound	Percentage Savings
Seattle	6	0.0691	2,586,724	0.24	0.05	0.44	4.3%
Portland/ Vancouver	22	0.0565	5,178,265	0.40	0.04	0.76	4.2%
Boise	32	0.0492	2,553,666	0.17	0.05	0.29	4.7%

* The total reported savings are *incremental* to 2014 (energy savings that may have occurred in previous years are not included).

3.2 2014 Gas Savings Results

Cadmus included 37 buildings in the OC analysis and 31 buildings in the MPP analysis. Neither cohort achieved gas savings in 2014. Cadmus tried many different model specifications to determine gas savings, but no models showed gas savings. Cadmus also analyzed 2014 gas savings separately for OC buildings in Seattle, Boise, and Portland/Vancouver and those models also showed there were no gas savings.

This could be because very few gas measures were implemented in 2014. Cadmus reviewed the measure list for the MPP and OC cohorts and found that the MPP cohort only implemented two gas measures in 2014 and the OC cohort only implemented six gas measures in 2014. In 2013, the MPP cohort implemented four gas measures and the OC cohort implemented 10 gas measures (before October).

The cohorts achieved gas savings in 2013, shown in Table 4. The evaluation of 2012 savings did not include natural gas, and the 2014 analysis did not find savings.

Table 4. Gas Savings for the CRE Cohorts in 2013

Cohort	2013 Gas Savings (% of Consumption)*
Office Competition	7.5%
Market Partners Program	7.9%
*Savings are significant at 80% confidence and 20% precision.	

4 Conclusions and Recommendations

Cadmus offers the following conclusions based on the energy savings findings.

- **NEEA's CRE SEM Initiative achieved electricity savings in three consecutive years.** The CRE SEM cohorts have achieved between 2% to 6% annual savings in 2012 through 2014.

- **NEEA's CRE SEM Initiative achieved gas savings in 2013, but not in 2014.** The CRE SEM cohorts achieved 7% to 8% annual savings in 2013, however, did not achieve measurable savings in 2014. Cadmus reviewed the measure list for the MPP and OC cohorts and found that the MPP cohort only implemented two gas measures in 2014 and the OC cohort only implemented six gas measures in 2014.

Cadmus continues to recommend that NEEA collect occupancy data from participants and billing and occupancy data from a representative control group for these types of programs in the future.[6] These data could explain any changes in energy consumption that currently available data cannot explain, and they may support an in-depth analysis of savings trends.

[6] NEEA and Cadmus are currently working with utilities in the region to collect billing data from a representative control group. In addition, NEEA is working with participants to collect occupancy data more frequently.

5 References

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