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Long-Term Monitoring and Tracking Report on 2011 Activities

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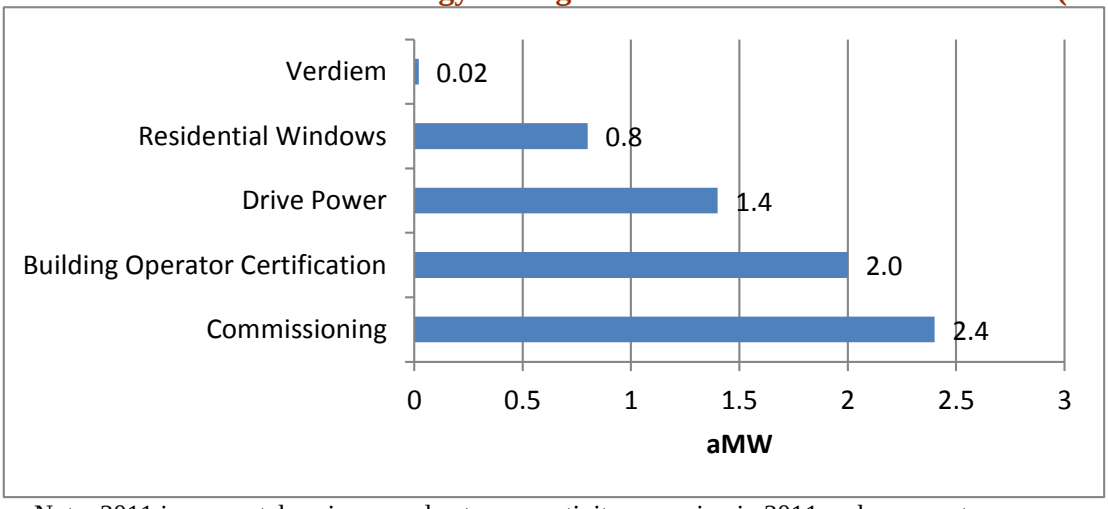
Executive Summary

Market transformation initiatives, by their nature, create change over the long term. An S-shaped diffusion curve can represent the developing and launching of new products and services, which have relatively little market impact in the initial years, and the major market effects occurring several years after the initiative's launch. The Northwest Energy Efficiency Alliance (NEEA) tracks the progress of its market transformation initiatives during their implementation phase through periodic Market Progress Assessment Reports (MPERs). However, because market diffusion often occurs after NEEA funding has ceased, NEEA also needs a mechanism for tracking ongoing market progress in the post-funding period so that it can verify key assumptions in its cost-effectiveness models.

Results by Initiative

Of the five initiatives assessed in the 2011 long-term monitoring and tracking (LTMT), Commissioning represents the greatest incremental savings at 2.4 average megawatts (aMW) in 2011. Building Operator Certification is next at 2.0 aMW, followed by Drive Power (1.4 aMW) and Residential Windows (0.8 aMW). Savings from Verdiem were negligible in 2011, although the initiative generated roughly 0.1 aMW of savings in 2010, which previous LTMT reports had not documented. The five initiatives resulted in 2011 incremental savings (due to new activity occurring in 2011) of approximately 6.6 aMW (Figure ES 1).

Figure ES 1: 2011 Incremental Energy Savings from the 2011 LTMT Assessment (aMW)



Note: 2011 incremental savings are due to new activity occurring in 2011 and represent estimated savings from market activity less estimated savings from baseline activity. NEEA's reported values might not match those presented here because NEEA may adjust for the effect of utility incentives and other factors not taken into account in this LTMT analysis.
Source: Navigant analysis

Building Operator Certification

Building Operator Certification (BOC) accounted for 2.0 aMW of incremental energy savings in 2011. This savings estimate represents participation in BOC through both the Northwest Energy Efficiency Council (NEEC) and the International Building Operators Association (IBOA). The number of active certifications increased to 1,196 in 2011, a 3 percent increase over 2010.

New for 2011, the LTMT team conducted in-depth interviews with 20 BOC participants and 17 non-participants to inform the estimates for baseline market activity and per-unit energy savings. Less than a quarter of non-participants reported receiving or pursuing other building certifications in the absence of BOC; furthermore, the other certifications provided by non-participant respondents do *not* appear to be equivalent to BOC in terms of a focus on energy efficiency. Therefore, Navigant recommends retaining the zero estimate for baseline market activity. The 2011 LTMT analysis captures any potential increase in the "baseline" level of building maintenance practices via the estimation of per-unit savings.

To assess per-unit energy savings, Navigant used its 2011 primary survey data and two different calculation approaches. One of the methods resulted in 0.85 kWh/ft^2 (i.e., higher than the 2010 estimate of roughly 0.42 kWh/ft^2), while the other one resulted in 0.30 kWh/ft^2 (i.e., lower than the 2010 estimate). For this reason, Navigant recommends retaining the 2010 estimate of 0.42 kWh/ ft^2, or 119 MWh per certified operator per year (based on an average of 286,000 ft^2 managed per certified operator).

Commissioning and Commissioning in Public Buildings

Commissioned floor space in commercial buildings was approximately 25 million square feet in 2011, with more than two-thirds from retro-commissioning of existing buildings. Commissioning of new buildings continues to increase as a share of new floor space (estimated at 35 percent in 2011); however, the dramatic decline in new construction activity over the past two years has reduced the market size to roughly one-third of its 2009 value. Annual incremental savings for the initiative were approximately 2.4 aMW in 2011, with nearly 90 percent of the savings attributable to retro-commissioning.

Drive Power

The Drive Power Initiative achieved an estimated energy savings of 1.4 aMW in 2011, with sales of NEMA Premium™ motors representing a little more than half of the savings, and efficient rewinds representing slightly less than half of the savings. NEMA Premium™ market penetration grew from 39 percent in 2008 to 64 percent in 2009 (the last year for which data are available). Market penetration nationally, which is used as a proxy for baseline activity, remained roughly steady at 24 percent in 2009. The number of efficient rewinds in the region grew by roughly 16 percent between 2009 and 2011, with total horsepower rewound increasing by 37 percent.

ENERGY STAR Residential Windows

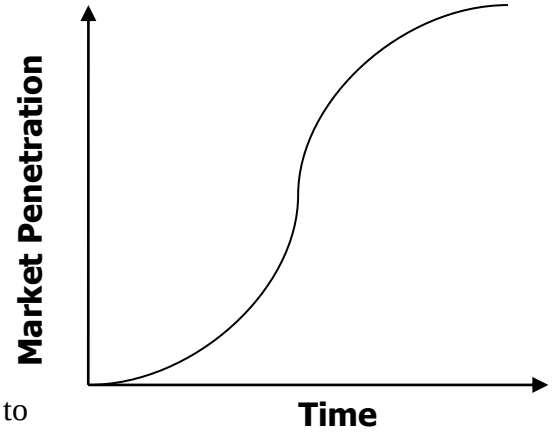
NEEA's ENERGY STAR Windows market transformation initiative continued to achieve significant incremental energy savings in 2011 (0.8 aMW). The total area of ENERGY STAR windows shipped in the Northwest was just over 35 million square feet, an increase of over 1 million square feet from 2010. The baseline activity is 59 percent. Per-unit energy savings remained at 0.5 aMW/ft^2 in 2011. Although ENERGY STAR has revised the qualification for windows from a U-Factor of 0.35 Btu/h./ft^2 ºF to a U-Factor of 0.30 Btu/h. ft^2 ºF, NEEA will not take credit for the modification and plans to discontinue claiming savings due to lack of recent involvement in the efficient window market.

Verdiem Network Energy Management Software

Over the past two years, competitors have increasingly offered their network energy management software as a part of a broader suite of end-point management solutions and/or such solutions have come pre-installed on new computers. This has resulted in an increase in the baseline activity, which the LTMT assessment recommends at 70 percent for 2011, increasing 10 percent per year going forward. Per-unit savings are lower than in previous years due to an RTF recommendation of 115 kWh per unit per year. The combined effect of increasing baseline share and reduced per-unit savings contributes to a 2011 savings estimate of only 0.02 aMW.

1 Introduction

Market transformation initiatives, by their nature, create change over the long term. An S-shaped diffusion curve can represent the developing and launching of new products and services, which have relatively little market impact in the initial years, and the major market effects occur several years after the initiative's launch. The Northwest Energy Efficiency Alliance (NEEA) tracks the progress of its market transformation initiatives during their implementation phase through periodic Market Progress Evaluation Reports (MPERs). However, because market diffusion often occurs after NEEA funding has ceased, NEEA also needs a mechanism for tracking ongoing market progress in the post-funding period so that it can verify key assumptions in its cost-effectiveness models.



In 2004, NEEA developed a process for tracking and monitoring the market progress of initiatives that it no longer funds. The goal of this long-term monitoring and tracking (LTMT) is to measure and track critical market progress indicators and Alliance Cost-Effectiveness (ACE) model assumptions that NEEA uses to estimate long-term electricity savings. LTMT uses methods that provide estimates with a reasonable and sufficient level of confidence in a timely and cost-effective manner. During the data gathering and analysis process, the review team seeks to leverage existing data sources and to identify areas where additional data collection would enhance the precision of the market effects estimates. NEEA does not intend for long-term monitoring and tracking to be an exhaustive evaluation of initiative impacts but rather a relatively brief and conservative assessment of the market effects of these initiatives.

The 2011 LTMT effort applied a market-wide, top-down approach where feasible and appropriate. Using this approach, the project team estimates market penetration rates for the product or activity that NEEA promoted, rather than counting individual sales or actions. For example, the early stages of many NEEA market transformation initiatives include tracking the adoption of a vendor's energy efficiency product or documenting a finite number of demonstration projects. However, once the promoted product/activity has begun to transform the market, its impact cannot easily be "counted." For this reason, the LTMT assessments generally use a market-wide view of adoption rates, with baseline estimation, to estimate impacts. In some cases, such as certification of building operators, the evaluation team performed a "bottom-up" accounting of market activity, because NEEA believes that this approach directly quantifies all relevant market activity.

1.1 Monitoring and Tracking Methodology

The LTMT process used the following approach:

1. **Review of the NEEA ACE model, or other documentation, for each initiative.** This included a review of the critical assumptions, inputs to energy savings calculations, and progress indicators.

2. **Assessment of data collection options and identification of variables to track.** Assessing the options entailed a brief review of the feasibility and cost of collecting the data to track market transformation and energy savings. Based on this review, the project team identified specific data inputs and initiative indicators for tracking.

3. **Refinement of a data collection/analysis work plan for each initiative.** Reviews of the LTMT approach recommended by MPERs or by past LTMT assessments informed development of a work scope for each initiative.

4. **Execution of the work scope and reporting of findings and recommendations.** Individual LTMT assessment reports include findings on market activity, baselines, and energy savings as well as recommendations for changes in the assumptions/inputs and for approaches to future LTMT efforts.

After NEEA and the project team finalize the LTMT report, NEEA staff will present the findings and recommended changes to the NEEA Cost-Effectiveness Committee. Once the changes receive approval, NEEA will incorporate them into the ACE models. Some initiatives will require greater data collection efforts than others as NEEA initiates monitoring and tracking procedures for each NEEA initiative after its active funding cycle. LTMT efforts will continue to focus on developing reliable estimates of real market transformation at the state and regional levels and the energy savings resulting from these initiatives. High uncertainty surrounding energy savings for a particular initiative with significant savings may warrant additional data collection. For those with limited impacts, or with good tracking data, existing sources may provide sufficient data. Each initiative assessment in the following chapters contains recommendations for ongoing data collection activities.

1.2 LTMT Review for 2011

The 2011 LTMT effort reviewed the following five NEEA initiatives, all of which updated previous LTMT assessments:

1. Building Operator Certification (BOC)
2. Commissioning and Commissioning in Public Buildings
3. Drive Power Initiative
4. ENERGY STAR Residential Windows
5. PC Power Management Solutions (Verdiem)

For each initiative, the LTMT project team focused on tracking activities in the market, examining NEEA's baseline assumptions (to varying degrees, depending on the initiative and past LTMT efforts), and assessing energy savings. Sections 2 through 6 of this report present background, methodologies, findings, and recommendations for each NEEA initiative in the order listed above.

1.3 LTMT for 2012 and Beyond

Future long-term monitoring and tracking efforts may include updates to some of the initiatives assessed in this 2011 LTMT report, as well as updates to previous LTMT assessments and additional NEEA initiatives that no longer receive funding. Table 1-1 includes a tentative schedule for each of the initiative tracking efforts proposed for 2012 along with the LTMT assessments from the past five years.

Table 1-1: Timeline for Conducting/Updating Long-Term Monitoring and Tracking

Initiative	2007	2008	2009	2010	2011	2012*
Building Operator Certification	U	U	U	U	U	U
Commissioning in Public Buildings	U		U		U	
Drive Power	C	U	U	U	U	U
ENERGY STAR Residential Windows	U		U	U	U	
Verdiem	U		U		U	
SIS/AM400		U	Recommended to discontinue			
SAV-AIR				U		
Just Enough Air	LTMT discontinued					
Evaporator Fan VFDs	U		U			
Siemens (Shell Solar)	U		Assess need annually			
BacGen		U		U		
Small Comm. HVAC (AirCare Plus)	LTMT discontinued					
ENERGY STAR Home Products	C		U			
MagnaDrive		U	U			
Dendritic PolySi (ASiMi) Production	C			Assess need annually		
Optichill (Microelectronics)	C		Recommended to discontinue			
Compact Fluorescent Lamps (CFLs)[#]			C	U	U	U
80 PLUS						C

Notes: C = Conduct initial analysis; U = Update to initial analysis
* = Tentative schedule for 2012 LTMT
[#] = LTMT for CFLs completed by KEMA

2 Building Operator Certification

The Northwest Energy Efficiency Alliance (NEEA) initially funded the Building Operator Certification (BOC) initiative from 1997 through 2003. NEEA offered a professional development program to teach facility managers, building operators, maintenance personnel, and others who monitor commercial building systems how to reduce energy and resource consumption in the facilities that they operate. With the BOC initiative, NEEA intended to achieve lasting improvement in the energy-efficient operation and maintenance (O&M) of commercial buildings by developing a market for educated and certified building operators.

After the establishment of the BOC curriculum and delivery mechanism several years ago, the Northwest Energy Efficiency Council (NEEC) and the International Building Operators Association (IBOA) have continued to offer BOC as self-supporting ventures since 2000. The program offerings include an initial set of courses that constitute the Level 1 curriculum, while Level 2 is comprised of a second set of somewhat more advanced courses. Six prominent organizations accredit the BOC as an approved means of continuing education, including the U.S. Green Building Council, which approved the Level 1 BOC courses as continuing education for Leadership in Energy and Environmental Design (LEED) certification in 2010.[1]

Starting in 2009 and continuing in 2010, NEEA's commercial sector began promoting BOC to various market sectors through the BetterBricks initiative, supplying marketing support to the Oregon BOC provider, Northwest Energy Education Institute (NEEI), and scholarships and tuition assistance for attendees across the region working in healthcare and property management. In 2010, the U.S. Department of Energy (DOE) awarded a grant to NEEC to enhance and expand the BOC curriculum. NEEA provided matching funding for this project, which will continue through 2011 while being piloted in the Northwest. In 2009 and 2010, NEEA's Commercial sector also sponsored the BOC Webinar Series. Through the combination of these investments and efforts, the number of classes, certifications, and renewals for BOC has increased.

This seventh LTMT report for BOC updates 1) market activity by utilizing current NEEC and IBOA data, 2) baseline activity through a survey of non-participants in BOC training, and 3) per-unit energy savings through surveys of participants in BOC training as well as non-participating operators.

2.1 Assumptions and Indicators for Review

As established in recent LTMT analyses, the energy savings impact of the BOC venture depends on the number of operators receiving certification and a series of assumptions regarding the size of the facilities and the percentage reduction in energy consumption. Specifically, Navigant calculates energy savings for a given calendar year as follows:

[1] Northwest Energy Efficiency Council, "Building Operator Certification: Recognition and Accreditation," 2011. http://www.theboc.info/w-recognition.html

Annual Energy Savings (kWh/year or therms/year) =

(1) Number of operators certified or renewed within the past five years

x (2) Square footage per operator

x (3) Electricity or gas consumption per square foot of participating facilities

x (4) Savings from certification (as a percentage of electricity or gas consumption).

where:

1. **Number of operators certified within the past five years originates** from NEEC and IBOA records.[2]

2. **Square footage per operator** is the average number of square feet of building space uniquely managed by operators receiving certification.

3. **Electricity or gas consumption per square foot of participating facilities** depends on a weighted average of building types operated by those receiving BOC training.

4. **Savings from certification (as a percentage of electricity or gas consumption)** is a measure of the reduction in facility energy consumption resulting from operator certification.

The assumed measure life is five years, meaning that the methodology assigns savings for five years beginning in the year of certification for each operator. If a student receives a Level 2 certification or a certification renewal, then the measure life extends for five years from the most recent date of certification. For the remainder of this report, the term "active building operators" refers to building operators who have obtained a new certification or renewed a previous certification within the past five years.

2.2 Methodology

Previous LTMT work has established methods for collecting and analyzing data on certifications. Navigant used the 2010 methodology to evaluate the BOC initiative in 2011 and repeated and refined these methods as described in this report. Appendix A includes a detailed methodology for estimating energy savings from BOC participants.

Navigant conducted the following data collection activities:

1. **Contacted NEEC and IBOA staff to obtain current database of certification activity.** NEEC provided an Excel file containing the names, contact information, company name, company type, and certification and recertification dates for BOC

[2] NEEC provided an Excel file containing the names, contact information, company name, company type, and certification and recertification dates for BOC participants through the end of 2011. IBOA provided its database of 2010-2011 Idaho certifications, and Northwestern Energy provided a list of IBOA certifications from Montana in 2010-2011.

participants through the end of 2011. IBOA provided its database of 2010-2011 Idaho certifications, and Northwestern Energy provided a list of IBOA certifications from Montana in 2010-2011.

2. **Surveyed NEEC-certified BOC participants.** Navigant staff designed a sample of 20 certified building operators that was (1) representative of the population of building types and locations and (2) placed more weight on participants with recent certification years. Navigant completed interviews with seven private sector and 13 public sector BOC participants. Neither NEEA nor Navigant intended for this sample to produce statistically significant results, but rather intended this as an initial test group for the methodology to provide a starting point on which future research and analyses can build.

3. **Surveyed non-participating building operators (i.e., those without BOC certification) to assess baseline activity.** Navigant staff interviewed 17 building operators, seven from the private sector and ten from the public sector, that have not yet participated in NEEC or IBOA BOC training. The non-participants' contact information was obtained from a NEEC marketing list. The survey updated both components of baseline activity, including (1) participation in energy efficiency-focused building operator training other than that offered by NEEC and IBOA and (2) energy savings generated by non-participants' existing O&M and equipment retrofit behavior.

4. **Reviewed ACE Model**. Navigant reviewed the most recent ACE model to assess key inputs, assumptions, and outputs used in reporting annual savings.

Table 2-1 summarizes the primary data collection activities conducted for the 2011 BOC LTMT.

Table 2-1: Primary Data Collection Activities for 2010 BOC LTMT

Telephone Interviewee Group	No. of Completed Interviews	No. of Attempted Completes	Topics/Issues
NEEC BOC Training Participants	20	20	• Facility and demographic information • O&M practices • BOC training's influence on O&M activities • Equipment upgrade activities • BOC training's influence on equipment upgrade activities • Additional impacts (e.g., new skills, techniques) • BOC training's influence on additional impacts
Non-participant Building Operators	17	20	• Facility and demographic information • O&M practices • Equipment upgrade activities

Source: Navigant analysis, 2011.

2.3 Findings

This section presents findings of the 2011-2012 LTMT efforts for the BOC initiative. Section 2.3.1 Market Activity discusses related market activity for BOC. Section 2.3.2 outlines the results of the baseline activity research. Section 2.3.3 discusses the results of the interviews with participants and non-participants, in addition to the implications for the per-unit energy savings.

2.3.1 Market Activity

Navigant used data from the NEEC certification database to update the number of Level 1 and Level 2 certifications and the number of operators having received their last certification or renewal in the past five years (i.e., within the period of the assumed measure life). NEEC provided certification data for all four states in NEEA territory through 2011 for this report. Navigant included certification data for IBOA's activities in the Northwest through 2009 based on previous LTMT efforts. IBOA provided its database of 2010-2011 Idaho certifications, and Northwestern Energy provided a list of IBOA certifications from Montana in 2010-2011.

As shown in Table 2-2, NEEC certified 126 new building operators in the Northwest during 2011.[3] This brought the total number of NEEC-certified operators since 1997 to 1,458. IBOA certified 389 building operators through the end of 2009. In 2010 and 2011, IBOA certified an additional 90 individuals in Idaho and Montana. This brings IBOA's total number of certifications in the Northwest since 1997 to 479.

Of the cumulative 1,458 operators certified by NEEC from 1997 to 2011, 901 are currently active at the end of 2011, which requires that they received certification or recertification within the last five years. Based on the data available for IBOA, IBOA had 295 active operators at the end of 2011, bringing the combined total from NEEC and IBOA to 1,196 active operators at the end of 2011.

Table 2-2: Market Status of Active Certified Building Operators

	NEEC			IBOA			Combined Total		
Year	**Annual New**	**Annual Retired***	**Total Active****	**Annual New**	**Annual Retired***	**Total Active****	**Annual New**	**Annual Retired***	**Total Active****
1997	1	0	1	2		2	3	0	3
1998	45	0	46	12	0	14	57	0	60
1999	120	0	166	22	0	36	142	0	202
2000	124	0	289	21	0	57	145	0	346
2001	96	0	383	9	0	66	105	0	449
2002	155	1	537	42	1	107	197	2	644
2003	109	22	624	60	3	164	169	25	788
2004	58	54	627	35	9	190	93	63	817
2005	120	63	684	30	11	209	150	74	893
2006	77	62	697	53	13	249	130	75	946
2007	88	93	691	23	22	250	111	115	941
2008	143	70	758	28	32	246	171	102	1,004
2009	84	51	788	52	23	275	136	74	1,063
2010	112	24	876	66	37	304	178	61	1,180
2011	126	101	901	24	33	295	150	134	1,196
Total	**1,458**	**541**	**901**	**479**	**184**	**295**	**1,937**	**725**	**1,196**

* Annual Retired refers to certified building operators whose measure lives have expired because they did not receive a new certification or renewal within five years of the year (table row) in which the data is presented.
** Total Active is the number of certified building operators who have received a new certification or renewal within five years of the year (table row) in which the data is presented. Total active (present year) = Total active (previous year) + Annual new – Annual net retired.
Source: Navigant analysis of 2011 NEEC certification database, 2009 IBOA certification database, and 2010/2011 IBOA data from Idaho and Montana.

An analysis of 2011 market activity based on data from NEEC and IBOA showed two noteworthy trends:

» ***New certifications have begun to level off.*** As demonstrated by Figure 2-1, the number of new NEEC certifications in 2011 grew by approximately 13 percent

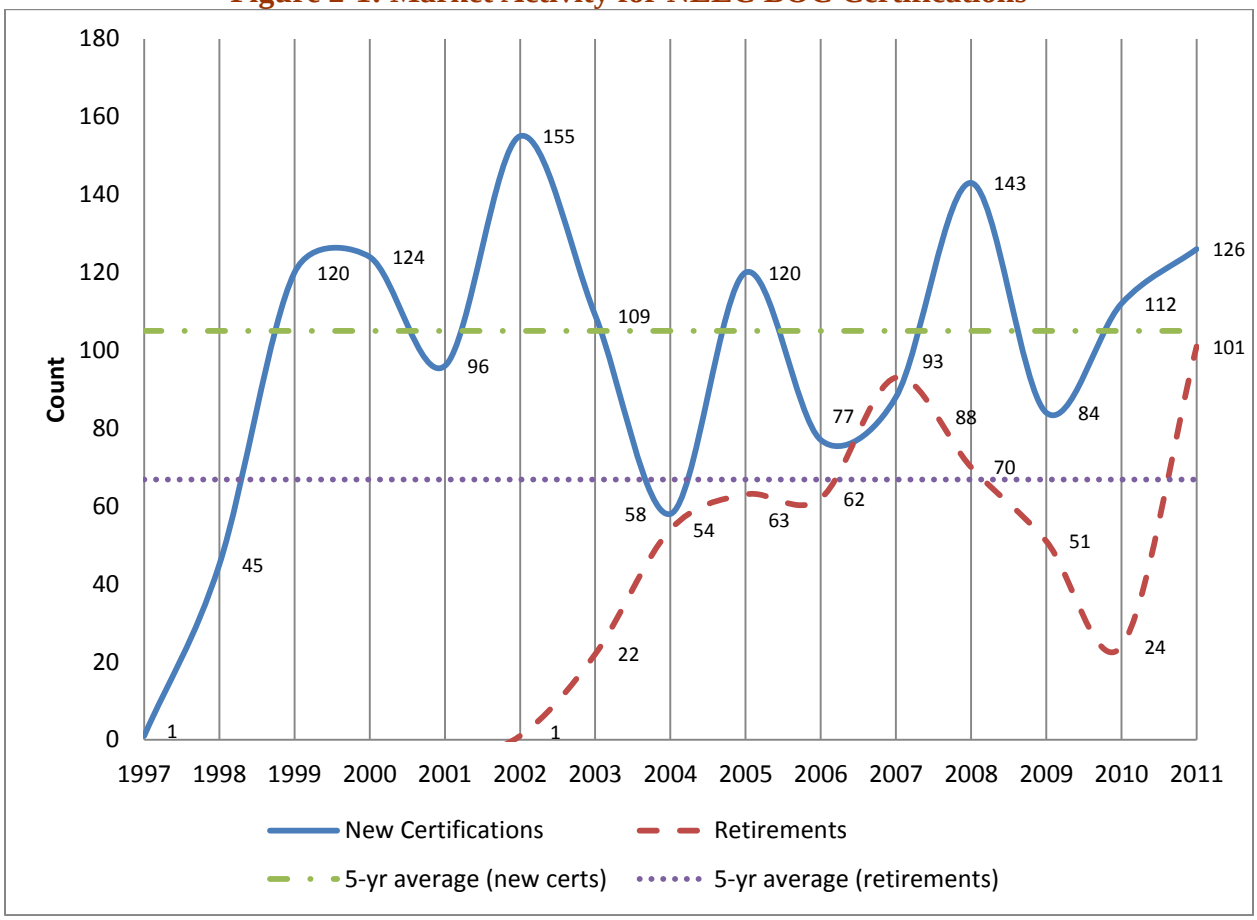
[3] Navigant remained consistent with the methodology used in the 2010-2011 LTMT and did not count any new Level II certifications if the person's Level I certification remained active.

compared to 2010; between 2009 and 2010, new certifications increased by 33 percent. This leveling of new NEEC certifications implies that the market may have begun to stabilize rather than continuing to fluctuate as seen in past years.[4] IBOA certifications, however, continued to fluctuate, increasing by 27 percent in 2010, but decreasing by 64 percent in 2011. New operators certified by NEEC in 2011 continued to slightly exceed the average over the last five years, which supports the idea that the value of BOC in the marketplace has increased over time.[5]

» ***Retirements increased sharply.*** Retirements in 2011 more than doubled from 61 in 2010 to 134 in 2011,[6] a sharp contrast from the retirement trend noted in 2010 and well above the five-year average. While NEEC administrators actively communicate recertification as a means for building operators to gain continuing education and maintain a credential that makes them more valuable to the industry, this trend suggests that opportunity remains for NEEC and IBOA to boost those efforts in the upcoming program year. In future years, NEEA may want to interview both recertifying and non-recertifying operators, to understand the primary drivers of recertification.

[4] The 2010 LTMT report discussed the fluctuating number of new certifications from year to year.
[5] For purposes of comparison to recent trends, Navigant used a five-year average to allow for the market activity ramping up that occurred during the first several years of the initiative.
[6] Retirements refer to those who have reached the five-year measure life.

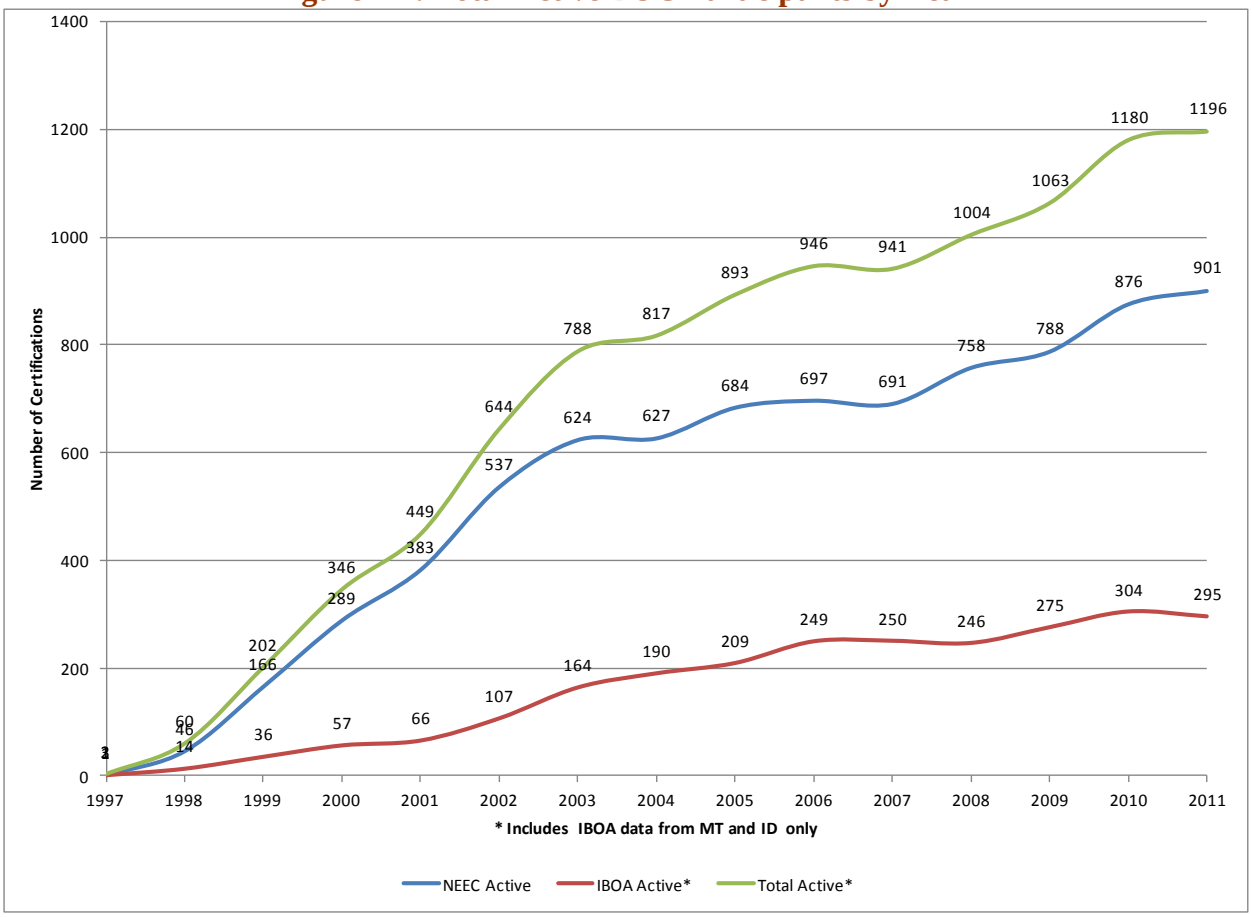
Figure 2-1: Market Activity for NEEC BOC Certifications



Source: Navigant analysis of 2011 NEEC certification database.

Overall, the total number of active operators continues to rise, but the trajectory seems to have begun to level off. Figure 2-2 shows total active operators certified by both NEEC and IBOA, demonstrates an increasing trend in the number of active, certified building operators in the Northwest.

Figure 2-2: Total Active BOC Participants by Year



Source: Navigant analysis of 2011 NEEC certification database, 2009 IBOA certification database, and 2010/2011 IBOA data from Idaho and Montana.

2.3.2 Baseline Activity

Navigant defines the baseline activity for the BOC initiative as the number of certified building operators that would exist without programs that NEEA influenced. This concept is highly subjective and difficult to quantify since baseline activity would depend on the existence of an alternative certification program as well as participation in such a program. The current methodology assumes zero baseline activity for building operator certifications before NEEC and IBOA training started in the 1990s, as these were the first programs of their kind when they began.

It is clear from the literature that formal building operator training has its roots in the Northwest and continues to grow nationally from this base. Studies of nationwide BOC training indicate that NEEC and IBOA started BOC training in the Northwest and that NEEA championed and supported the program in the early stages.[7] BOC training has now expanded to the Northeast, Midwest, and Southwest, using curricula developed by NEEC and IBOA.

[7] Marjorie McRae and Beatrice Mayo, *What Building Operators are Saying about BOC Training*, ACEEE 2006 Summer Study.

For 2011, Navigant used interviews with 17 non-participant building operators to inform the baseline activity of building operators in the Northwest region. The 17 interviewees represented various building sectors, including K-12 schools, government, property management, retail, manufacturing, healthcare, and municipalities. Table 2-3 provides a summary of the building types and locations of the completed non-participant sample. The NEEC contact list, which Navigant used to create the non-participant sample, contained no entries for Idaho or Montana operators; however, the states of Washington and Oregon represent the majority of square footage and total operators for the NEEA region.

Table 2-3: Summary of Completed Non-Participant Interviews

Primary Facility Type	Completed Non-Participant Interviews	State of Operation (OR or WA)
College	0	-
Government	1	WA
Healthcare	1	WA
K-12 School	7	5 WA, 2 OR
Manufacturing	2	1 WA, 1 OR
Municipality	2	1 WA, 1 OR
Property Management	2	2 WA
Retail	2	1 WA, 1 OR
Total	**17**	**-**

Source: Navigant survey of non-participating building operators, 2011.

Sixteen out of seventeen non-participants reported that they have *not* completed any type of formal building operator or energy efficiency certification, such as that offered by BOC. They indicated that a range of sources provided them with guidance about energy efficient building practices, as shown in Table 2-4 below.

Table 2-4: Sources of Guidance on Energy Building Practices, as Reported by Non-Participants

Sources of Guidance on Energy Efficient Building Practices	*Non-Participants (n = 17)*
Completed certificate from Association of Physical Plant Administration	1
Working toward formal certifications, including a Facilities Maintenance Administrator certification from the Building Owners and Managers Institute (BOMI) and a Certified Facility Manager from the International Facility Management Association (IFMA)	2
Supervisors or colleagues at work	5
On-the-job training	4
Energy Trust of Oregon (ETO) workshops	2
Internet research	2
Publications from the Building Owners and Managers Association (BOMA) and the Washington Association of Maintenance and Operations Administrators (WAMOA)	3

Source: Navigant survey of non-participating building operators, 2011.
Note: Respondents could provide multiple sources of guidance on energy efficient building practices.

Of the 17 non-participants interviewed, 15 said they were familiar with the BOC program. Most of the participants reported hearing of the BOC through professional organizations, such as WAMOA or BOMA. Others reported finding out about the BOC through trade magazines, conferences, and coworkers. Despite this high level of awareness, non-participants indicated the following reasons, shown in Table 2-5, for not participating in BOC training.

Table 2-5: Reasons for Not Participating in BOC Training, as Reported by Non-Participants

Reason for Not Participating in BOC Training	*Non-Participants (n = 17)*
Budgetary constraints	5
Time constraints / lack of interest	3
Pursuing other building certifications (from IFMA and BOMI)	2
Location (lives too far away from BOC training facility)	1
Perception that BOC is intended for smaller facilities requiring a single building operator with a diverse skill set, instead of larger facilities which may have multiple building system specialists	1

Source: Navigant survey of non-participating building operators, 2011.
Note: Respondents could provide multiple sources of guidance on energy efficient building practices.

At this time, Navigant recommends retaining the zero baseline estimate for the number of number of certified building operators that would exist without NEEA-influence. Less than a

quarter of non-participants have received or is currently pursuing other building certifications in the absence of BOC; furthermore, the other certifications provided by non-participant respondents do *not* appear to be equivalent to BOC in terms of a focus on energy efficiency.

While the alternative training and certification activity may lead to some energy-saving maintenance practices among operators without BOC certification, this does not alter the zero baseline. The LTMT analysis of per-unit savings captures any increase in the "baseline" level of building maintenance practices via comparison of behaviors before and after BOC training and, alternatively, via comparison between BOC participants and non-participants. See below for a discussion of per-unit savings.

2.3.3 Per-Unit Energy Savings

Navigant defines per-unit energy savings as the amount of energy saved during the project year by each active, certified operator as a result of the BOC program. For the 2011 analysis, Navigant updated its method to estimate savings. Similar to the 2010 analysis, three factors determine the per-unit energy savings:

- Square footage per operator
- Energy consumption per square foot of participating facilities
- Savings from certification (as a percentage of consumption)

The remainder of this section presents updates to each of these three inputs. Results from surveys with participating building operators inform all three of these updates. Results from surveys with non-participants provide an additional point of comparison for the analysis of savings from certification.

SQUARE FOOTAGE PER OPERATOR

In 2008, the LTMT team performed an in-depth assessment of the square footage for which an average building operator is responsible.[8] The analysis resulted in a value of 286,000 square feet per operator. This assumption remained constant for the 2009 and 2010 LTMT efforts and will remain constant for 2011. The analysis used to arrive at this estimate included data from hundreds of records in the BOC program databases. The sample size used for the 2011 LTMT participant survey does not result in statistically robust results; instead, it provided a test group for assessing the methodology and serves as a starting point on which future analyses can build. Therefore, this analysis uses the preexisting square footage estimate because it is more robust than any new data available through the 2011 LTMT effort.

A discussion of the square footage data from the 2011 LTMT sample provides some additional context for considering the results of this first stage of analysis. For 2011, Navigant surveyed square footage per operator based on in-depth interviews conducted with twenty BOC participants. Participants provided responses about the type of facility in which they worked and the square footage. If a participant had responsibility for multiple facilities, he reported the total square footage. The survey also asked participants to indicate how many other full-time

[8] Summit Blue Consulting, *Long-Term Monitoring and Tracking Report on 2008 Activities*, prepared for NEEA: Report #E09-207, 2009.

operations staff had received BOC certification. Table 2-6 provides a summary of the square footage estimates for the entire facility and per BOC operator.

Table 2-6: Facility Type and Square Footage Reported by Participants

Participant No.	Primary Facility Type	Work State	Total Square Footage Reported	Total BOC-Certified Operators Reported	Square Footage per BOC Operator**
01	Hospital/Medical	WA	1,200,000	11	109,091
02	Office	WA	1,200,000	1	1,200,000
03	School/University	WA	1,300,000	3	433,333
04	Office	WA	500,000	1	500,000
05	Data Center	WA	6,500	1	6,500
06	School/University	WA	3,300,000	1	3,300,000
07	Office	WA	1,000,000	3	333,333
08	Convention Center	WA	900,000	1	900,000
09	Residential/Apartment	WA	1,100,000	1	1,100,000
10	School/University	OR	177,000	1	177,000
11	School/University	WA	N/A*	N/A*	N/A*
12	School/University	WA	N/A*	N/A*	N/A*
13	Office	WA	750,000	2	375,000
14	School/University	OR	300,000	1	300,000
15	Office	OR	1,500,000	2	750,000
16	Government	WA	48,000,000	N/A*	N/A*
17	Naval Base	WA	17,807,000	2	8,903,500
18	Office	OR	N/A*	N/A*	N/A*
19	Library	WA	100,000	1	100,000
20	Government	OR	900,000	1	900,000

Source: Navigant survey of participating building operators, 2011.
* Indicates participants who responded "don't know."
** Square Footage per BOC Operator equals Total Square Footage Reported divided by Total BOC-Certified Operators Reported.

As Table 2-6 shows, the sample of building operators reported total square footages that are considerably higher than the average square footage calculated for previous studies. This is a direct result of many participants indicating that they conduct or manage operations at multiple facilities. For example, the 1.2 million square feet reported by Participant 4 is a sum of the area in 32 buildings for which he is responsible. Participant 16 reported 48 million square feet, and Participant 17 reported nearly 18 million. According to Participant 17, the approximately 18

million square feet includes about 950 buildings, which seven managers oversee and over 200 employees maintain.

Outliers, such as Participants 16 and 17, pose a particular challenge when applying savings per operator on a square footage basis. It is unclear whether a single BOC participant can significantly influence the energy efficiency of tens of millions of square feet. Large facilities also increase the risk of double-counting savings due to multiple BOC-certified operators. The far right column of Table 2-6 shows total square footage divided by total BOC certified operators reported. As Table 2-6 also indicates, multiple participants reported more than one BOC-certified operator per facility. Participant 1 reported the most BOC-certified operators, with ten working at its 1.2 million square-foot facility.

For this BOC analysis study, the LTMT team calculated both average and median values to account for the wide range of participant responses. Table 2-7 shows the average and median values for both total square footage and square footage per BOC operator reported.

Table 2-7: Average and Median Square Footages Reported

	Total Square Footage Reported (ft^2)	Square Footage per BOC Operator (ft^2)
Average	4,708,265	1,211,735
Median	1,000,000	466,667

Source: Navigant survey of participating building operators, 2011.

While the survey responses may suggest an increase in the total facility size overseen by a BOC-certified building operator, the sample size of the BOC participant survey is not large enough for the LTMT team to update its current square footage per operator estimate. As future studies provide a larger sample, Navigant may suggest an update of square footage per operator; however, for the 2011 analysis, the assumption of 286,000 square feet per operator should remain the accepted value.

Energy Consumption per Square Foot

For 2011, Navigant estimated electricity and gas consumption per square foot at the end-use level in addition to the whole-building level, which previous studies reported. These calculations relied on energy use intensities (EUIs) from a 2009 NorthWestern Energy End Use and Load Profile Study.[9] Navigant selected this study because it provided the most recent information on this subject for the region. While the distribution of building types in Montana may be different from that of the rest of the region, Navigant can find no reason to

[9] Nexant and Cadmus. 2009. "Energy End Use and Load Profile Study." Prepared for NorthWestern Energy. http://www.northwesternenergy.com/documents/defaultsupply/plan09/volume2/Chapter2-EndUseLoadProfile.pdf.

expect that best building operation practices would be substantially different. The 2009 Commercial Building Stock Assessment (CBSA), which served as the source for the 2010 LTMT effort, excluded end-use EUIs.[10]

The LTMT team calculated energy use per square foot using building type information reported by interview participants and corresponding building type end-use EUIs from the 2009 NorthWestern End Use report. Navigant used the following method to derive the final end-use intensity estimates:

1. All interviewed participants reported which type of business activity (or activities) occurred at their facility. If participants reported more than one activity, the survey administrator asked them to identify the primary (i.e., most common) use of the facility.
2. The team then matched primary business activities with the corresponding building type from the 2009 NorthWestern end-use report.

   The team derived final end-use intensity values using the reported categories from step (1) and the mapping process in step (2).

Table 2-8 and Table 2-9 provide final electric and gas end-use intensity estimates, respectively.

Table 2-8: Electric End-Use EUIs (kWh/ft^2.) Used for Savings Calculations

End Use	Education	Health Care	Lodging	Office	Retail	Warehouse	Misc.
Space Heating	0.26	0.59	0.56	0.74	0.09	0.03	0.09
Cooling	0.72	1.93	1.44	1.60	1.27	0.17	0.98
Ventilation	1.12	2.87	2.15	1.41	0.91	0.74	0.99
Water Heating	0.14	0.18	0.06	0.08	0.11	0.03	0.10
Lighting	3.69	7.56	3.54	3.89	5.32	1.87	2.68
Cooking	0.25	0.43	0.45	0.11	0.21	0.00	0.31
Refrigeration	0.44	0.54	0.46	0.32	0.97	2.59	0.84
Plug Loads	0.78	0.78	0.78	1.93	0.52	0.15	0.40
Other	0.71	3.11	1.53	3.43	0.95	0.28	1.24
Whole Building	8.11	17.99	10.98	13.52	10.35	5.86	7.63

Source: NorthWestern Energy, "Energy End Use and Load Profile Study," 2009.
Note: The LTMT team used a weighted average of EUIs to simplify four categories to two: health care and office. The 2009 NorthWestern study included both large and small health care facility EUIs and large and small office EUIs.

[10] Cadmus. 2009. "Northwest Commercial Building Stock Assessment." Prepared for NEEA.

Table 2-9: Gas End-Use EUIs (kbtu/ ft^2.) Used for Savings Calculations

End Use	Education	Health Care	Lodging	Office	Retail	Warehouse	Misc.
Space Heating	47.20	46.20	16.61	48.18	26.39	17.71	32.12
Water Heating	6.38	22.79	27.31	2.01	1.01	0.71	9.10
Miscellaneous	1.51	9.03	6.20	0.38	0.81	8.96	5.31
Whole Building	55.09	78.02	50.12	50.58	28.21	27.38	46.52

Source: NorthWestern Energy, "Energy End Use and Load Profile Study," 2009.
Note: The LTMT team used a weighted average of EUIs to simplify four categories to two: health care and office. The 2009 NorthWestern study included both large and small health care facility EUIs and large and small office EUIs.

Overall, the whole building EUIs from the 2009 NorthWestern end-use report are comparable to the whole building values in the 2009 CBSA.[11] The NorthWestern report values are generally lower than those in the CBSA, but the trend in whole building EUIs across most building types is similar. One notable difference is between the catch-all categories in the two studies. The "Other" category in the CBSA provides an EUI estimate of 14 kWh/ft^2 while the "Miscellaneous" category in the NorthWestern report estimates 7.63 kWh/ft^2.

Based on this comparison, Navigant decided that the NorthWestern EUIs represented suitable estimates for this LTMT analysis.

SAVINGS FROM CERTIFICATION

The 2011 analysis sought to build on previous years' analysis of per-unit energy savings associated with BOC training. In previous years, the LTMT team conducted secondary research and used engineering calculations to estimate the per-unit energy savings from BOC training. The 2011 analysis adds two more approaches to estimating per-unit energy savings:

1. **Changes in activity by participating building operators.** The survey questionnaire collects four pieces of data to calculate the amount of savings that BOC participants attribute to their participation in BOC:
   - » Current O&M practices
   - » The type of equipment upgrades completed since beginning participation in BOC
   - » The O&M practices they changed since participation in BOC

[11] The Cadmus Group, *Northwest Commercial Building Stock Assessment*, 2009.

» The degree of influence that the BOC training had on their decision to change their practices or install new energy-efficient equipment

The related analysis focuses on the savings associated with the *changes* in activity that NEEA influenced, according to the participating building operators. In this case, the "baseline" is the level and type of activity that the building operator implemented prior to participation in BOC.

2. **Comparison of actions taken by participating and non-participating building operators.** This approach relies on a comparison of the actions (in terms of frequency and content) that the survey respondents currently implement. Non-participants' current actions serve as the baseline in this approach; the LTMT team will subtract the savings created by the non-participants from the savings created by the participants. Note that this approach does not take into account any *changes* in behavior that participants report due to the BOC program; those changes are only considered in the first approach described above.

These different savings approaches allowed Navigant to identify any anomalies in the data and any differences in results from previous LTMT efforts. Triangulating the results in this way allowed the team to assess the impacts informed by the nuances of several types of data. Appendix A includes a detailed explanation of the methodology used to calculate savings.

Uncertainty accompanies each of the point estimates provided in this analysis. Uncertainty arises from the self-report method used in the survey as well as from the energy savings estimates used for the analysis. The energy savings estimates used for this analysis are proxies that represent average building performance rather than actual building performance in terms of both baseline and current activities. A more robust approach might assess pre-BOC training building performance and post-BOC training building performance, but such an approach would incur significantly higher costs than this study.

The remainder of this section presents the results of these two different approaches to assessing energy savings. The first section outlines the results of the *participant surveys*, including the total savings reported by respondents and the amount of savings that the respondents ascribe to their participation in BOC. The second section presents an assessment of energy savings estimates by comparing the results of the *participant and non-participant surveys*.

1. Savings Based on Changes in Activity by Participating Building Operators

Table 2-10 describes the two ways of calculating savings by participating building operators.

Table 2-10: Two Approaches to Reporting Savings for 2011 LTMT

Type of Savings	Description	Relevance
Total savings	Result from all of the actions that the participating building operators currently implement. Do not consider whether or not they credit participation in BOC with causing them to implement the actions.	Considers the gross impact of actions taken by BOC participants and non-participants. These savings are not relevant outside of the context of savings created by non-participants.
Savings due to BOC	Result from: (1) the *changes* in actions that the participating building operators made as a result of their participation in BOC, or (2) the *difference* in actions taken by BOC participants and non-participants.	Estimates the level of influence of the BOC and savings due to participation. This iteration of the report presents an initial estimate of savings from certification based on (1) and (2).

Source: Navigant analysis 2011.

TOTAL SAVINGS

The LTMT team calculated total savings from O&M improvements as well as equipment retrofits and upgrades. The team calculated total equipment and upgrade savings as the sum of savings from *each* energy end use surveyed in the following manner:

> *End Use Savings = EUI (kWh or Therm/ft^2) x Total Savings Ratio x Normalized Affected Area (ft^2),*

where:

> *End-Use Intensity* is based on 2009 NorthWestern Energy End Use data[12],
>
> *Total Savings Ratio* is equal to the percent of end-use energy saved; for equipment upgrades, these are based on the values provided in Table 2-11, and
>
> *Normalized Affected Area* is the affected square footages reported by survey participants,[13] normalized for 286,000 square feet.

The team used this method to calculate all new or retrofitted equipment end-use savings for seven of the nine technologies relevant to BOC. For the remaining two technologies, motors and variable frequency drives (VFDs), the team replaced the affected area with

[12] Nexant and Cadmus. 2009. "Energy End Use and Load Profile Study." Prepared for NorthWestern Energy. http://www.northwesternenergy.com/documents/defaultsupply/plan09/volume2/Chapter2-EndUseLoadProfile.pdf.

[13] Navigant survey of participating building operators, 2011.

horsepower, loading, and hours of operation characteristics. Table 2-11 provides the results of this method for all nine technologies.

Table 2-11: Total Savings Ratios for Equipment Upgrades

End-Use Upgrade	Total Savings Ratio
Lighting Controls[1]	30%
Lighting Equipment[1]	28%
Efficient Motors[2]	1.5%
VFDs[2]	30%
Efficient Heating[1]	4%
Efficient Cooling[1]	14%
Efficient Domestic Hot Water[1]	5%
Energy Management System (EMS)[1]	10%
Economizer[1]	5%
Sources: 1. Navigant engineering estimates. 2. ComEd Workpaper, 21-50 HP Op. Hours.	

The LTMT team then calculated total savings based on the sum of individual end-use savings:

Total Savings = Sum of End-Use Savings (for all surveyed end uses)

Total O&M savings calculations are similar to those for equipment installation measures except for two universal differences. First, O&M savings ratios are generally lower than those for equipment upgrade measures. In addition, the thoroughness and frequency of O&M activities heavily influence realized savings. Table 2-12 shows the estimated maximum savings ratio[14] from rigorous O&M practices for end uses investigated in this study.

[14] Maximum O&M savings ratios represent the assumed *maximum* percent of energy end use that operators can achieve via improved O&M practices.

Table 2-12: Maximum Savings Ratios for O&M Practices

O&M Category	Maximum O&M Savings Ratio
General Energy Management	1%
Building Shell	2%
Cooling[1]	5%
Heating	5%
Motors[2]	1%
Ventilation	5%
Electrical PM	0.5%

Sources:

1. Navigant estimate based on survey responses and conservative estimates based on Piper, J., "HVAC Maintenance and Energy Savings," Building Operating Management, March 2009. http://www.facilitiesnet.com/hvac/article/HVAC-Maintenance-and-Energy-Savings--10680. The paper notes, "Facilities in which proper HVAC maintenance is completed will use at least 15 to 20 percent less energy than those where systems are allowed to deteriorate." Navigant chose conservative estimates of HVAC maintenance savings, not knowing the existing state of facility maintenance.
2. Drivepower Technology Atlas (Volume IV), Esource. This reference indicates that optimal operations and maintenance practices can save 3 to 10 percent of all drive power, compared to very poor maintenance practices. Navigant assumes a conservative 1 percent improvement over existing practices.

Navigant modified the savings ratios in Table 2-12 by estimating the rigor of application. Rigor has two elements—content and frequency. The more O&M tasks that are applied (content), the more savings participants have likely achieved. Increased frequency of O&M activities creates additional savings, though with diminishing returns. Navigant assigned a *content* factor between 0 and 0.7 based on the number of new O&M activities performed for each measure as a result of the BOC training. Navigant also assigned a factor between 0 and 0.3, depending on whether the participant reported increased O&M *frequency* for each measure as a result of the BOC training. The LTMT team then calculated the total savings ratio for each participant as follows:

$$\textit{Total Savings Ratio} = \textit{Max Savings Ratio} \times (\textit{content factor} + \textit{frequency factor})$$

Table 2-13 shows total savings figures for the interview sample (n = 20) broken down as O&M only, equipment upgrades only, and total savings. The table includes both average and median savings for electricity and gas. As the table shows, participants from this sample reported, on average, 0.04 kWh/ft^2 of total O&M savings and 1.42 kWh/ft^2 of total equipment savings. These savings do *not* account for the influence of BOC. Figure 2-3 and

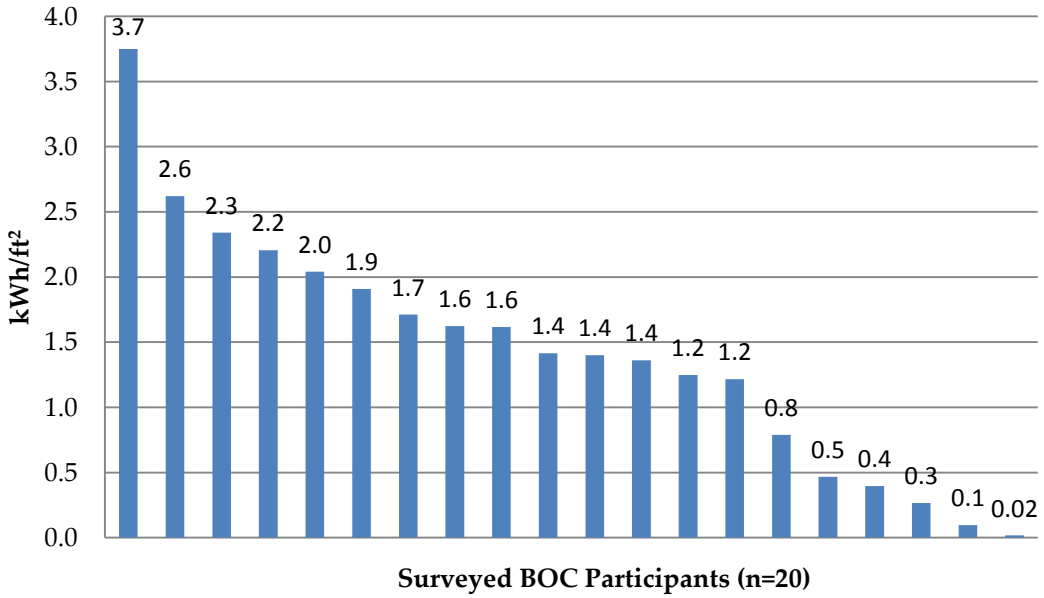
Figure 2-4 show total electric and gas savings per square foot, respectively, for the 20 surveyed BOC participants.

Table 2-13: Total Electric and Gas Savings for Surveyed BOC Participants (n = 20)

Savings Type	kWh/part.	kWh/ft²	Therm/part.	Therm/ft²
O&M				
Average	10,932	0.04	365	0.00
Median	6,371	0.02	-	0.00
Equipment Upgrades				
Average	370,869	1.38	1,370	0.01
Median	360,231	1.34	-	0.00
Total				
Average	381,801	1.42	1,735	0.01
Median	377,152	1.41	-	0.00

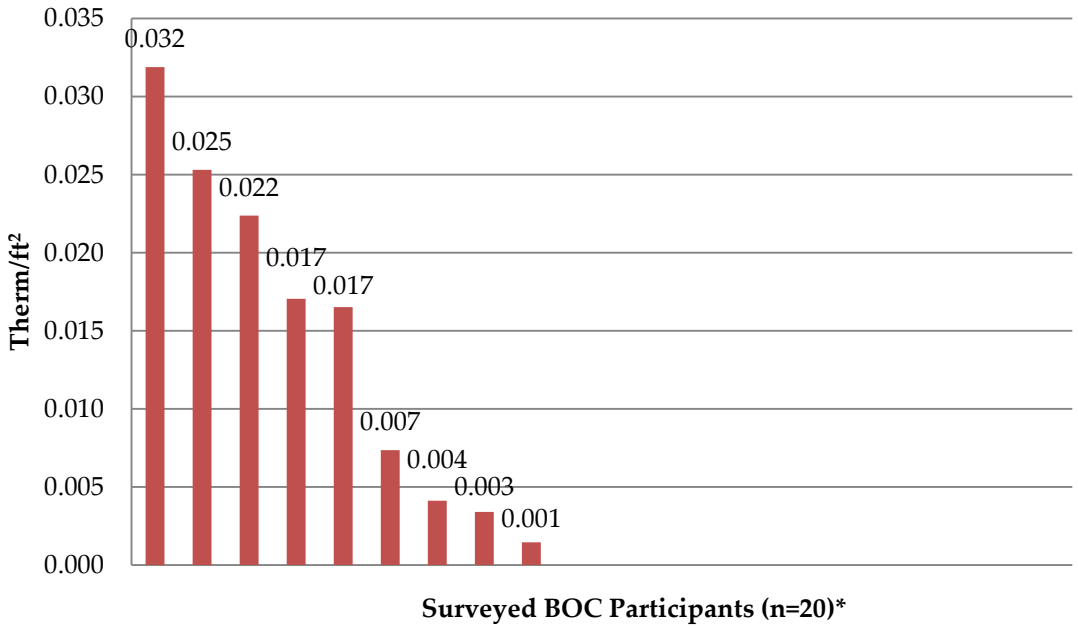
Source: Navigant survey of participating building operators, 2011.

Figure 2-3: Total Electric Savings per Square Foot for Surveyed BOC Participants (n = 20)



Source: Navigant survey of participating building operators, 2011.

Figure 2-4: Total Gas Savings per Square Foot for Surveyed BOC Participants (n = 20)



*Eleven of the 20 participants surveyed reported gas savings less than 0.001 therm/ft^2
Source: Navigant survey of participating building operators, 2011.

For the sample surveyed, equipment upgrades make up the overwhelming majority of savings. For example, of total savings, O&M measures make up about 3 percent. Lighting-related measures drive the majority of equipment upgrade savings. Of total electric equipment upgrade savings, lighting controls make up 37 percent, while lighting equipment retrofits make up nearly 48 percent; together, these categories of savings combine to make up 85 percent of upgrade savings.

A recent evaluation of the Midwest Energy Efficiency Alliance's (MEEA) BOC program conducted by Navigant[15] produced comparable results. The other program reported similar total savings per square foot (1.14 kWh/ ft^2), but O&M savings were more significant (11 percent, or 0.13 kWh/ft^2). Several factors may contribute to the differences between studies, including sample size (for MEEA study, n = 43), survey design, and regional differences.

SAVINGS DUE TO BOC

To determine the influence of BOC training, Navigant asked participants to rate the influence of the BOC training on each action taken, using a scale of 0 to 10, where 0 means no influence and 10 means great influence. Navigant considered actions with an influence rating of less than 3 (i.e., 0, 1, or 2) as only marginally influenced by the BOC training;

[15] Navigant, 2011. "Evaluation of MN BOC Training." Prepared for Midwest Energy Efficiency Alliance (MEEEA) and Minnesota Office of Energy Security. http://www.theboc.info/w-energy-savings.html

therefore, Navigant did not credit any savings to the program for these actions. For actions with ratings of 3 or greater, Navigant estimated the percentage of savings due to the training to be the stated influence score divided by ten (i.e. the highest possible response). For example, if a participant assigned an influence score of 6 to a particular action, then BOC received credit for 60 percent of the total savings from that action.

Navigant then calculated the savings due to the BOC program in the following manner:

Savings Due to BOC = Total Savings x BOC influence (%)

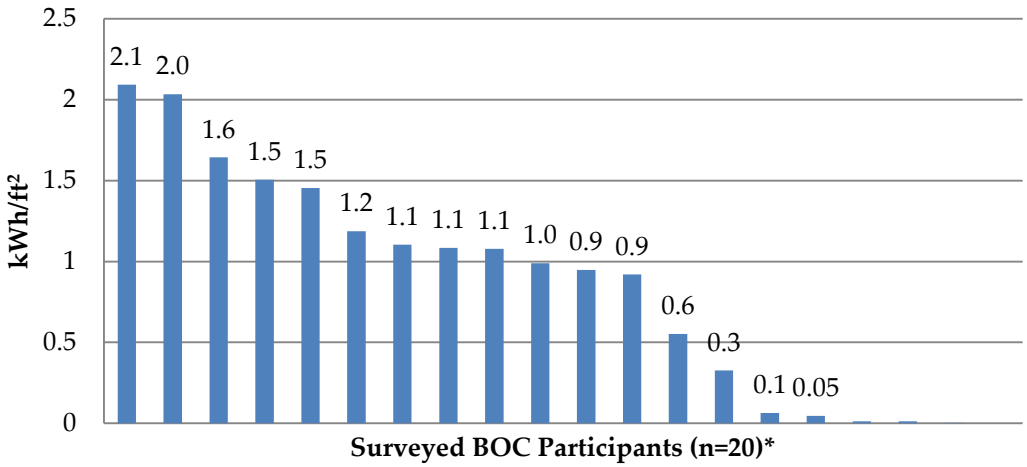
Table 2-14 shows savings due to BOC, in terms of both electricity and gas for the entire survey sample (n = 20) reported as O&M only, equipment upgrades only, and total savings. All categories include reports of both average savings and median savings. As the table shows, participants from this sample reported, on average, that 0.03 kWh/ft^2 of O&M savings and 0.82 kWh/ft^2 of equipment savings were due to participating in BOC. Figure 2-5 and Figure 2-6 show electric and gas savings due to the BOC per square foot, respectively, for the 20 BOC participants surveyed.

Table 2-14: Revised Electric and Gas Savings Due to BOC for Survey Sample (n = 20)

Savings Type	kWh/part.	kWh/ft²	Therm/part.	Therm/ft²
O&M				
Average	7,856	0.03	235	0.00
Median	4,363	0.02	-	0.00
Equipment Upgrades				
Average	220,684	0.82	577	0.00
Median	244,032	0.91	-	0.00
Total				
Average	228,540	0.85	812	0.00
Median	259,515	0.97	-	0.00

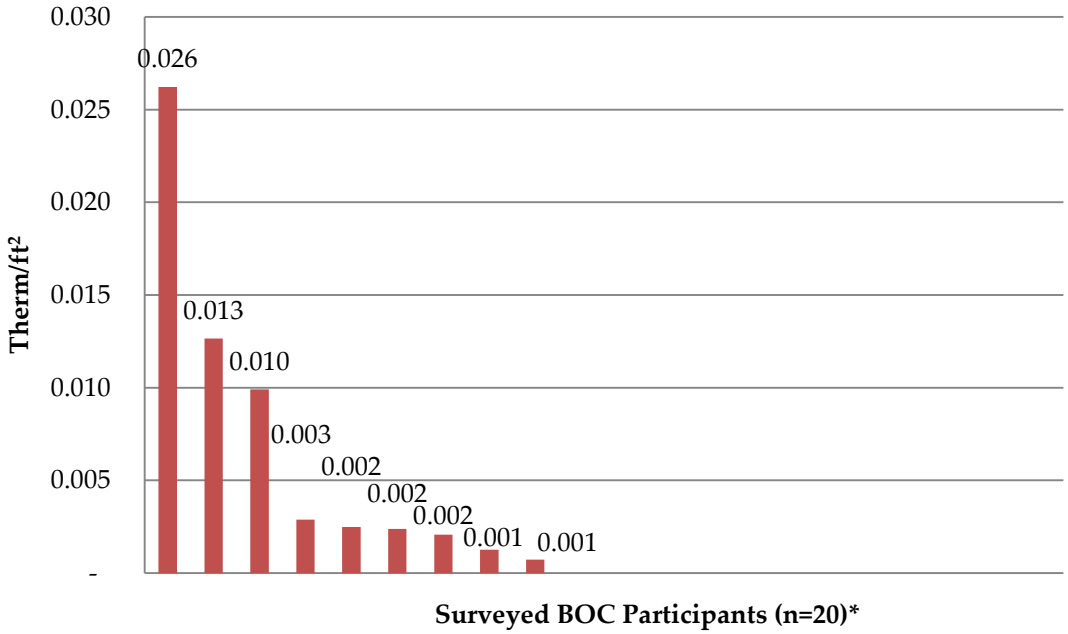
Source: Navigant survey of participating building operators, 2011.

Figure 2-5: Electric Savings per Square Foot Due to BOC Based on Surveyed BOC Participants (n = 20)



*Four of the 20 participants surveyed reported BOC-related electric savings less than 0.05 kWh/ft^2.
Source: Navigant survey of participating building operators, 2011.

Figure 2-6: Gas Savings per Square Foot Due to BOC Based on Surveyed BOC Participants (n = 20)

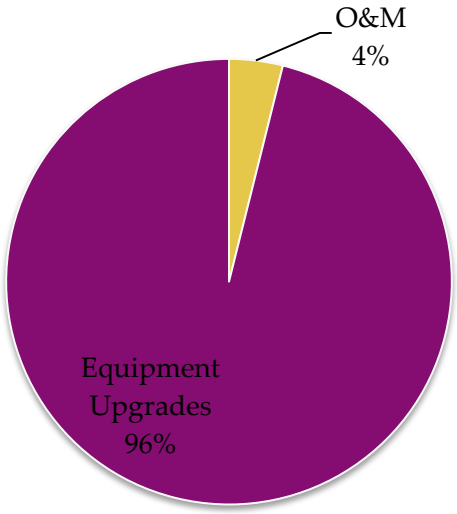


*Eleven of the 20 participants surveyed reported BOC-related gas savings less than 0.001 therm/ft^2.
Source: Navigant survey of participating building operators, 2011.

Since the NEEC curriculum includes instructive material on equipment upgrades, these savings continue to be a legitimate source of savings for the BOC program. The high rate of equipment upgrades reported by BOC participants suggests that BOC could be an effective vehicle for driving increased participation of existing utility rebate programs. Many survey participants identified lighting retrofit knowledge as their most significant take-away from the BOC training; this may help to explain the heavy influence of lighting for overall savings. Although equipment savings are dominant, the BOC training continues to be influential for O&M savings. Of the 20 participants surveyed, 18 reported changes made to their O&M practices due to the BOC.

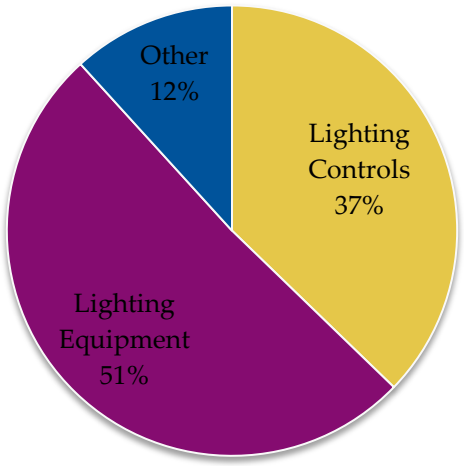
Similar to the findings on total savings, equipment upgrades make up the overwhelming majority of savings due to BOC in both samples. For example, of total average savings per square foot, O&M savings make up about 4 percent (Figure 2-7). Again, lighting drives equipment upgrade savings; of average equipment upgrade savings, lighting controls make up 37 percent while lighting retrofits make up 51 percent—or a combined 88 percent of upgrade savings (Figure 2-8).

Figure 2-7: Distribution of Total Savings (n = 20) Due to the BOC Program, Shown as Percent of 0.85 kWh/ft^2



Source: Navigant survey of participating building operators, 2011.

Figure 2-8: Distribution of Equipment Upgrade Savings (n = 20) Due to the BOC Program, Shown as Percent of 0.82 kWh/ft^2



Source: Navigant survey of participating building operators, 2011.

2. Savings Based on Comparison of Actions taken by Participants and Non-Participants

In addition to calculating savings based on the changes in actions taken by BOC participants, the LTMT team also investigated savings based on a comparison of actions taken by BOC participants and non-participants. In this case, Navigant considers participant actions to represent gross savings and the difference in actions between participants and non-participants to represent savings due to BOC influence.[16]

The interviewees represented various building sectors, including K-12 schools, government, property management, retail, manufacturing, healthcare, and municipalities. Table 2-15 shows a breakdown of the participant and non-participant samples according to these primary facility types.

[16] The purpose of this additional savings-estimation approach using non-participant surveys was to provide an alternative savings estimate to the one based on the participant surveys. Navigant recognizes the uncertainty in the quality of self-reported data and thus chose to estimate savings using two distinct, but related methods. As discussed below, the two approaches provided estimates on either side of the value from previous LTMT analyses, thus lending credibility to Navigant's prior assumptions.

Table 2-15: Facility Breakdown for Completed Participant and Non-Participant Interviews

Primary Facility Type	Completed Participant Interviews	Completed Non-Participant Interviews
College	1	0
Government	4	1
Healthcare	1	1
K-12 School	3	7
Manufacturing	2	2
Municipality	6	2
Property Management	3	2
Retail	0	2
Total	**20**	**17**

Source: Navigant survey of non-participating building operators, 2011.

Navigant asked participants and non-participants questions regarding their current O&M practices and any energy efficient equipment upgrades or retrofits that have occurred in the last three years. Both groups reported a vast array of energy efficiency upgrades, including lighting, HVAC, and motor equipment. Table 2-16 provides a comparison of average savings between participant and non-participant upgrades. As the table shows, participants reported more energy efficient upgrade projects, on average, than non-participants, in the majority of upgrade categories. Overall, participants reported over 1.38 kWh/ft^2 in total upgrade savings, compared to 1.02 kWh/ft^2 for non-participants. This implies that BOC participants save an average of 0.36 kWh/ft^2, or about 36 percent, more than their non-participant counterparts do. Similarly, BOC participants reported 9.3 therm/1000 ft^2 in upgrade savings, compared to 9.2 therm/1000 ft^2 for non-participants; therefore, BOC participants save an additional 0.1 Therm/1000 ft^2, or 1 percent, in natural gas compared to non-participants (Table 2-17).

Table 2-16: Electric Savings Associated with Efficient Upgrades for BOC Participants and Non-Participants

Upgrade Category	Participant Savings (kWh/ft²)	Non-Participant Savings (kWh/ft²
Light Controls	0.484	0.383
Lighting Equip.	0.663	0.446
EMS	0.072	0.146
Motors	0.002	0.012
VFDs	0.098	0.011
Heating	0.000	0.008
Cooling	0.058	0.007
DHW	0.000	0.001
Economizer	0.007	0.002
Total	**1.384**	**1.017**

Source: Navigant survey of non-participating building operators, 2011.

Table 2-17: Gas Savings Associated with Efficient Upgrades for BOC Participants and Non-Participants

Upgrade Category	Participant Savings (Therm/ft²)	Non-Participant Savings (Therm/ft²)
Heating (therm)	0.0042	0.0043
DHW (therm)	0.0051	0.0049
Total	**0.0093**	**0.0092**

Source: Navigant survey of non-participating building operators, 2011.

For participants and non-participants, Navigant compared the total reported savings between private sector and public sector respondents. As Table 2-18 shows, for non-participants, public sector reported savings were nearly double private sector savings, suggesting that public sector, non-participant firms may exhibit higher baseline activity than private sector, non-participant firms. For participants, however, private and public sector reported savings were nearly identical.

Table 2-18: Comparison of Electric Savings Associated with Efficient Upgrades for BOC Participants and Non-Participants, Private Sector Versus Public Sector

Upgrade Category	Participant Savings (kWh/ft²)	Non-Participant Savings (kWh/ft²)
Private Sector Avg.*	1.415	0.671
Public Sector Avg.**	1.367	1.258

Caution: small base for both groups:
*n = 7 for participants and non-participants
**n = 13 for participants; n = 10 for non-participants
Source: Navigant survey of non-participating building operators, 2011.

In addition to equipment upgrades, the LTMT team compared O&M savings of participants and non-participants based on their reported practices. Both groups indicated which O&M practices they conduct, as well as the frequency of each O&M activity. Similar to the participant savings analysis, Navigant assumes that the content and frequency of O&M practices drive the resulting savings.

In terms of the average percentage of total O&M activities performed by participants and non-participants (regardless of frequency), the numbers are similar between the two groups. Table 2-19 provides a comparison of O&M practices performed by BOC participants and non-participants, showing the average percentage of O&M activities performed by each group. As the table indicates, the reported practices of both groups are very comparable, with only minor differences in responses across all O&M categories.

Table 2-19: Comparison of the Number of O&M Practices Performed by BOC Participants and Non-Participants

O&M Activity Area	Participants (Avg. Percentage of Activities Performed)	Non-Participants (Avg. Percentage of Activities Performed)
General Energy Management	61%	69%
Building Shell	32%	27%
Cooling System	53%	56%
Heating System	51%	51%
Motor Equipment	46%	51%
Electrical System	30%	26%
Ventilation System	57%	57%

Source: Navigant survey of non-participating building operators, 2011.

In addition, Navigant compared the average frequency of O&M practices performed by participants and non-participants by assigning a frequency score to each response (Table 2-20).[17] Participants reported a greater frequency of O&M practices in five of the seven O&M categories compared to non-participants; however, for two of the categories (cooling and motor equipment), the difference between the two groups was less than 5 percent. In the two remaining O&M categories, general energy management and ventilation, non-participants reported greater frequency of O&M practices on average. This sample suggests that overall, non-participants' O&M practices may be similar to those of participants, although participants may perform these practices on a more frequent basis.

Table 2-20: Comparison of the Frequency of O&M Practices Performed by BOC Participants and Non-Participants

O&M Activity Area	Participants (Avg. Freq. Score)*	Non-Participants (Avg. Freq. Score)*	Percent Difference (%)
General Energy Management	1.303	1.408	-8%
Building Shell	0.517	0.471	10%
Cooling System	1.245	1.235	1%
Heating System	1.309	1.112	18%
Motor Equipment	1.292	1.245	4%
Electrical System	0.725	0.529	37%
Ventilation System	1.282	1.342	-5%

* Navigant determined average frequency scores based on the following O&M frequency scale: monthly = 5, quarterly = 4, semi-annually = 3, "other" = 3, annually = 2, and "as needed" = 1.
Source: Navigant survey of non-participating building operators, 2011.

Along with Navigant's previous assumption of 0.42 kWh/ft^2, the two analysis methods used in this report provided a triangulated approach for estimating energy savings due to the BOC. One of the methods resulted in 0.85 kWh/ft^2 (i.e., higher than the 2010 estimate of roughly 0.42 kWh/ft^2), while the other one resulted in 0.30 kWh/ft^2 (i.e., lower than the 2010 estimate). Therefore, Navigant sees no reason to update per-unit savings at the present time, and suggests NEEA continue to use the 2010 estimate. Based on the estimated 286,000 square feet managed, on average, by each certified operator, **Navigant estimates annual savings to be 119,273 kWh per certified operator.**[18]

[17] Navigant determined average frequency scores based on the following frequency scale: monthly = 5, quarterly = 4, semi-annually = 3, "other" = 3, annually = 2, and "as needed" = 1.
[18] The estimate of annual savings equals the product of savings per certified operator (0.417 kWh/ft^2) and average area managed per certified operator (286,000 ft^2).

MEASURE LIFE

The LTMT effort recommends holding the measure life assumption of five years constant for 2011. The intent behind the five-year expiration of BOC training is that building operators who do not continue training and certification activities gradually forget material and stop generating energy savings. Alternatively, they may transfer to new positions or to new facilities outside the Northwest. Operators must conduct some O&M measures every year to be successful in saving energy; however, other activities, especially equipment upgrade decisions, may have much longer lives.

These equipment upgrades represent a large, unknown, potential source of energy savings. If certified building operators continue to push for more energy-efficient equipment upgrades, they could generate larger energy savings over a longer period of time than currently assumed. However, this LTMT review identified no available data in the literature at this point. Given the uncertainty, the LTMT team suggests that NEEA continue to use the current five-year assumption for measure lifetime. If the rate of renewals among certified building operators continues to increase, the lifetime assumption will become less important.

2.4 Conclusions and Recommendations

The definition of market activity for BOC training in the Northwest is the net of new certifications less retirements. Market activity increased in 2010 and 2011, adding to the number of active operators in the region. BOC program administrators from various organizations seem to agree that demand for certification will continue to rise. Some concerns remain, however, relating to the availability of future funding assistance for program participants, and costs may remain prohibitive to potential students. Organizations in the Northwest actively promote recertification as a means to maintain a valuable credential and gain continuing education in the field of energy efficiency. Some of the specific findings from the 2011 LTMT effort include the following:

1. ***New certifications have begun to level off.*** The number of new NEEC certifications in 2011 grew by approximately 13 percent compared to 2010; between 2009 and 2010, new certifications increased by 33 percent. This leveling of new NEEC certifications implies that the market may have begun to stabilize rather than continuing to fluctuate as seen in past years. IBOA certifications, however, continued to fluctuate, increasing by 27 percent in 2010, but decreasing by 64 percent in 2011. New operators certified by NEEC in 2011 continued to slightly exceed the average over the last five years, which supports the idea that the value of BOC in the marketplace has increased over time.[19]

2. ***Retirements increased sharply.*** Retirements in 2011 more than doubled from 61 in 2010 to 134 in 2011, a sharp contrast from the retirement trend noted in 2010 and well above the five-year average. While NEEC administrators actively communicate recertification as a means for building operators to gain continuing education and maintain a credential that makes them more valuable to the industry, this trend suggests that opportunity

[19] For purposes of comparison to recent trends, Navigant used a five-year average to allow for the market activity ramping up that occurred during the first several years of the initiative.

remains for NEEC and IBOA to boost those efforts in the upcoming program year. In future years, NEEA may want to interview both recertifying and non-recertifying operators, to understand the primary drivers of recertification.

Table 2-21 summarizes the key indicators for market activity in 2011. NEEC and IBOA certified 150 new building operators, bringing the total number of active operators to 1,196. Incremental savings due to newly certified operators in 2011 reached approximately 2.0 aMW, and the cumulative impact in 2011 from all active certified operators reached 16.3 aMW.

Table 2-21: Summary of 2011 Key Indicators

Key Indicators Reviewed	2011 Incremental * (Due to *new* activity occurring in 2011)	2011 Cumulative* (Calendar year 2011 values due to all activity since program inception)	Source
Current Market Activity			
Number of active certified building operators	150	1,196	Included information from 2011 NEEC database and 2011 IBOA activity in Idaho and Montana. Refer to Section 2.3.1
Current Baseline Activity*			
Number of certified building operators in the Northwest	0	0	Refer to Section 2.3.2
Per-Unit Energy Savings			
Annual electricity savings per certified building operator	119,273	119,273	Refer to Section 2.3.3
Implied Energy Savings (aMW)**			
Implied Energy Savings (aMW)	2.0	16.3	Market activity minus baseline activity, times per-unit savings, divided by 8,760 hours

* The zero baseline reflects the conclusion that, in the absence of NEEA's BOC initiative, there would be no building operators certified by an equivalent training program. While alternative training and certification activity may lead to some energy-saving maintenance practices among operators without BOC certification, this does not alter the zero baseline. The LTMT analysis of per-unit savings captures any increase in the "baseline" level of building maintenance practices.

** Implied Energy Savings represent estimated savings from market activity less estimated savings from baseline activity. NEEA's reported values might not match those presented here since NEEA adjusts for the effect of utility incentives and other factors not taken into account in this LTMT analysis.

Source: IBOA and NEEC data and Navigant analysis.

In the future, NEEA may consider removing BOC from the LTMT effort because NEEA is currently funding the initiative. The LTMT effort is typically reserved for initiatives that NEEA no longer funds; since additional investment is not at stake, NEEA uses a lower level of rigor for LTMT. BOC may warrant deeper analysis in the future.

Navigant recommends the following steps to guide future assessment of the BOC initiative:

- **Encourage NEEC and IBOA to track square footage for participants.** The square footage that each certified operator maintains drives the energy savings estimates. NEEA should encourage NEEC and IBOA to track and include this information in the database. NEEA should also encourage NEEC and IBOA to track other building characteristics such as age (e.g. new construction vs. existing) to facilitate ongoing analysis and comparison in future LTMT years. In addition, NEEA should consider tracking the total number of buildings that each reported square footage represents.

- **Continue to conduct participant and non-participant surveys to refine per-unit energy savings and baseline energy savings estimates.** While the 2011 participant and non-participant interviews provide compelling evidence of the BOC's influence, future participant surveys, using a more robust sample size, will allow greater representation of building operators in the Northwest. Obtaining a larger sample of respondents will continue to build confidence in the current assumptions used for this LTMT effort. In addition, NEEA should consider other interviewing opportunities besides phone interviews to broaden the reach of the BOC survey. This could include partnering with an organization such as BOMA, and randomly recruiting BOMA event attendees.

- **Continue to use 2010 LTMT estimates of per-unit energy savings and baseline market activity.** Along with Navigant's previous assumption of 0.42 kWh/ft^2, the two analysis methods used in this report provide a triangulated approach for estimating energy savings due to the BOC. One of the methods resulted in 0.85 kWh/ft^2 (i.e., higher than the 2010 estimate of roughly 0.42 kWh/ft^2), while the other one resulted in 0.30 kWh/ft^2 (i.e., lower than the 2010 estimate); therefore, the LTMT team suggests continuing to use the 2010 estimate.

  For baseline market activity, the LTMT team found little evidence of programs similar to BOC in the Northwest region; however, it is apparent that non-participants use a variety of other energy efficiency education resources, including professional society publications, company trainings, and the internet. Since no evidence suggests that these programs are equivalent to BOC, the LTMT team recommends continuing to use the 2010 estimate of baseline market activity but suggests continuing the study of baseline market activity.

- **Refine participant and non-participant interview guides.** The LTMT team recommends refining participant and non-participant interviews to elicit greater clarity in responses. For example, one possible source of ambiguity arises in respondents' understanding of O&M frequency. For some respondents, "as needed" indicated a fairly frequent occurrence, such as daily or constantly (such as with an EMS monitoring

system). For other respondents, however, "as needed" was a much more infrequent occurrence, such as every two to five years. In order to better compare participants and non-participants, Navigant recommends refining interview questions to ensure greater consistency in interview responses.

In addition, Navigant suggests looking into maximizing response rates. For interviews exceeding a certain time length (e.g. 30 minutes), respondents, particularly non-participants, may exhibit a high non-response in the absence of an incentive. Providing an incentive to interviewees could ensure a successful complete rate.

- **Continue to further gather more details of building operators and the market.** As suggested in the attached market size memo[20] (see Appendix A.2), NEEA should consider researching the following questions:
  - How many building square feet do BOC participants oversee?
  - How many buildings do BOC participants oversee?
  - What is the number of buildings within each sector in the Northwest's territory?

  To answer these questions, Navigant recommends a more in-depth study that includes a thorough process evaluation and/or marketing assessment

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3 Commissioning and Commissioning in Public Buildings

NEEA has administered two separate but related building commissioning projects. Commissioning in Public Buildings, the original project launched in 1998, sought to make commissioning standard practice in public buildings in the Northwest. In 2000, NEEA funded a separate Commissioning industry effort aimed at supporting the Building Commissioning Association (BCA) and fostering special projects of the BCA, such as commissioning certification.

The first Commissioning LTMT review, conducted in 2005, consisted of a bottom-up accounting of commissioning activity that the LTMT team could identify through state records, other secondary data such as research reports, and interviews with selected commissioning providers. *The second LTMT effort* in 2007 characterized the changes in the market—including the amount of documented commissioning activity and the results of a recent survey of commissioning providers—and assessed the impact of NEEA's initiatives on commissioning activity and infrastructure in the Northwest. *The third LTMT effort* in 2009 updated state policies that promote/require commissioning and surveyed commissioning providers to understand the market trends and drivers of demand for commissioning services in the Northwest.

2011 LTMT effort: During the third effort in 2009, Navigant found that the service provider market appeared to be bifurcated and, as a result, activity in the new-building commissioning (Cx) market did not necessarily have the same characteristics as that of the existing-building retro-commissioning (RCx) market. This finding informed the development of the 2011 LTMT effort, which focused more on understanding the distinctions between the Cx and RCx markets in terms of market drivers, market penetration, and energy savings. For this LTMT effort, Navigant:

- Reviewed current measure life assumptions for commissioning and retro-commissioning measures;
- Estimated the current market share for commissioning and retro-commissioning in the Northwest, including the share of buildings that receives re-commissioning after the end of the useful life of a commissioning measure; and
- Estimated penetration levels for each market in the Northwest between 2010 and 2014.

3.1 Assumptions and Indicators for Review

Annual electricity savings from *new building commissioning* in the Northwest is the product of the following two factors:

- Commercial and public building space commissioned within the past five years[21] (in square feet)

[21] Five years is the assumed measure life for commissioning services. Navigant developed this assumption based on the LBNL report *Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions* by Evan Mills, 2009. Findings of the LTMT survey of commissioning providers further support the assumption.

» Annual electricity savings per square foot attributable to commissioning activities (kWh/ft^2)

Similarly, annual electricity savings from *retro-commissioning* in the Northwest is the product of the following two factors:

» Commercial and public building space retro-commissioned within the past five years (in square feet)

» Annual electricity savings per square foot attributable to retro-commissioning activities (kWh/ft^2)

Thus, the *total annual electric savings* from all commissioning in the Northwest is the sum of the two products described above.

Other indicators that the program tracked that may be relevant to evaluating the market transformation impacts include the following.

» Number of commissioning providers in each state

» Adoption of state or local requirements or policies regarding commissioning

3.2 Methodology

The data collection process included the following elements:

1. **Review secondary sources of information** to update 2009 list of state-level policies, with a distinction, if possible, between Cx and RCx policies. During the 2009 LTMT analysis, state liaisons provided Navigant with each state's Cx and RCx policies. Navigant consulted each state government's website, the U.S. Green Building Council website, and work products of research institutions such as NREL and Lawrence Berkeley National Lab (LBNL) for updated state building codes and policies.
2. **Conduct 23 online surveys with Cx and RCx providers** to quantify market share by building type, future penetration levels, and measure life. Navigant conducted online surveys similar to those conducted during the previous 2009 LTMT analysis. The sample frame for the surveys came from the Building Commissioning Association (BCA) member database and included a mix of commissioning only, retro-commissioning only, and combined commissioning and retro-commissioning service providers. The survey instrument appears in Appendix B.
3. **Conduct interviews with two regional utility program managers** to obtain industry activity estimates and trends. Navigant inquired about the program's activity levels by building type as well as program managers' assessment of the availability of qualified providers, customers' awareness of measure benefits, and commissioning requirement incorporation into new construction programs.
4. **Review secondary sources of information** on commissioning to revise the energy savings per ft^2 assumptions used in Navigant's 2009 LTMT efforts through evaluations of recent programs, if available; update estimates of total new construction in the Northwest; and validate current savings persistence by type of commissioning.

Table 3-1 summarizes the primary data collection efforts of the LTMT team.

Table 3-1: Primary Data Collection

Interviewee Group	Number of Interviews/Surveys	Topic/Issues
Utility program managers	2 telephone interviews	Program participation, availability of qualified providers
Commissioning and Retro-commissioning providers	23 online surveys	Trends in market activity over past two years, drivers of demand for commissioning services, predictions for future market activity

3.3 Findings

3.3.1 Market Activity

This section presents findings on current and projected commissioning, retro-commissioning, and re-commissioning activity in the Northwest, based on the results of surveys with commissioning and retro-commissioning providers and interviews with utility program managers.

COMMISSIONING OF NEW BUILDINGS

To assess the amount of new construction activity that undergoes building commissioning, it is necessary to first characterize the total amount of commercial new construction occurring in the Northwest states. Since 2007, the pace of new construction activity in the Northwest appears to have slowed significantly. Navigant reviewed several sources of data on total commercial new construction in the Northwest, including data from CoStar and McGraw-Hill/Dodge. Both sources indicated a significant drop in new construction activity starting in 2007 (Table 3-2). For 2010 and 2011 new construction, Navigant used the estimates based on Dodge new construction starts for 2009 and 2010 (assuming a one-year lag between starts and completion) because of uncertainty in the comprehensiveness of the CoStar database.

Table 3-2: Estimates of Total Commercial New Construction in the Northwest, 2003-2011

	New Construction Estimates Based on…		
	Previous LTMT Estimates (1000s ft^2)*	**CoStar New Construction Estimates (1000s ft^2)****	**Dodge New Construction Starts (1000s ft^2)*****
2003	**48,714**	31,379	49,864
2004	**53,585**	31,093	53,515
2005	**58,944**	38,050	52,040
2006	**64,838**	47,092	56,698
2007	**71,322**	47,012	66,600
2008	**65,551**	48,718	61,245
2009	**59,780**	34,431	52,554
2010	N/A	13,498	**30,502**
2011	N/A	9,824	**20,554**

Bolded text indicates estimates used in LTMT analysis.

*Previous LTMT estimates based on NWPPC estimates.

**CoStar data obtained from a NEEA memo entitled *Size of Public versus Private Northwest Commercial Building Market from 2001 to 2011* dated March 7, 2012. Assumed that rentable building area (RBA) represents 86 percent of total building floor space, per NEEA's memo.

***Dodge new construction starts data obtained from a NEEA spreadsheet entitled *new construction.xlsx.* Assumed a one-year lag from new construction starts to completions.

Despite the reduction in total new construction activity, interviews with utility program managers and the survey of commissioning providers suggest that the percentage of commissioned new construction is increasing in the region. Over half (57 percent) of surveyed commissioning providers believe that the percentage of new building square footage that is commissioned has increased in the past two years, and 26 percent said that it has remained the same.

Respondents' estimates of the commissioning market penetration (i.e., the percentage of all 2011 new construction square footage commissioned in the Northwest) ranged from 10 percent to 80 percent, with an average of 40 percent and a median of 35 percent. For comparison, in the last LTMT report, the LTMT team estimated the commissioning market penetration as 29.7 percent, so the median response in the 2012 survey of 35 percent represents a modest increase, which is consistent with the other survey findings.

The LTMT team applied the median 35 percent value to the best estimate of 2011 commercial new construction to estimate commissioned new construction at 7.2 million square feet for 2011. The LTMT team then assumed that the percentage of commissioned new construction has increased linearly from 2009 to 2011 and applied the average of the 2009 and 2011 market penetration values to the 2010 estimate of total new construction to estimate 9.9 million square feet of commissioned new construction in 2010. Adding in the estimates of commissioned space

for 2007-2009, as reported in the 2009 LTMT report, results in a 5-year total of 65.6 million square feet of commissioned new buildings in the Northwest (Table 3-3).

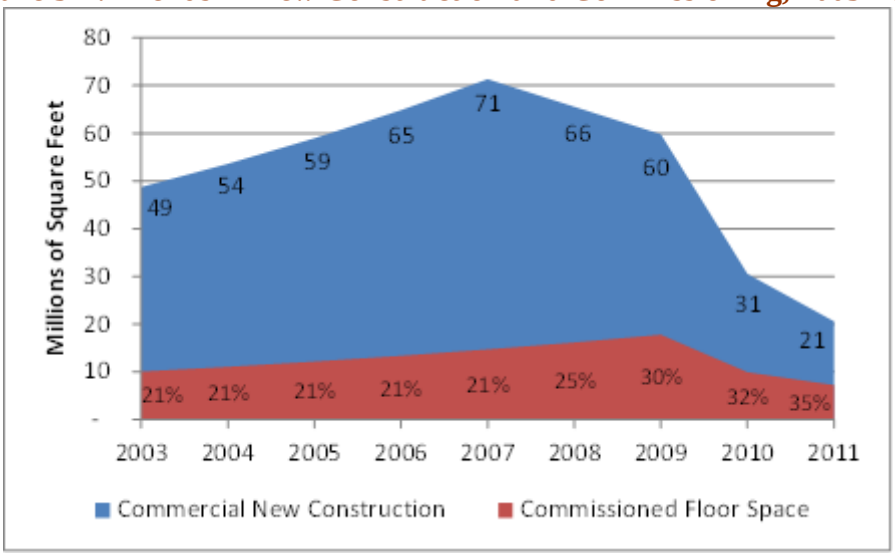
Table 3-3: Estimate of Commissioned New Building Square Footage, 2007-2011

Year	Commercial New Construction (1000s ft^2)	Percent Commissioned	Commissioned Floor Space (1000s ft^2)
2007	71,322	20.6%	14,678
2008	65,551	24.6%	16,146
2009	59,780	29.7%	17,760
2010	30,502	32.4%	9,869
2011	20,554	35.0%	7,194
Total	**247,709**	**26.5%**	**65,647**

Sources: Values for 2007 through 2009 values are estimates from the previous 2009 LTMT analysis. The 2010 and 2011 values for *new construction* reflect the Dodge estimates of new construction starts with an assumed one-year lag between starts and completions. *Commissioned floor space* is assumed to equal 35 percent of all commercial new construction in 2011, based on 2011 LTMT survey data; for 2010, the analysis assumes a linear increase in the percent of new construction that is commissioned from 2009's value of 29.7 percent to 2011's value of 35 percent.

Figure 3-1 presents a visual representation of the LTMT estimates of total new construction and commissioned square footage from 2003 through 2011 as well as the percentage of commissioned new construction square footage. The graphic demonstrates how commissioning has decreased in absolute square footage terms, but has increased as a percentage of all new construction due to the dramatic recent decline in new construction.

Figure 3-1: Trends in New Construction and Commissioning, 2003-2011



Source: Navigant analysis in 2005, 2007, 2009, and 2011 LTMT reports

One survey respondent summarized the changes in commissioning market activity succinctly as follows: "The No. 1 driver is the decline in the economy – less construction, hence less overall commissioning. However, the percentage of projects being commissioned is higher, due to increased interest in performance in a more competitive environment." Another key driver of new building commissioning is the presence of state and/or local policies that require or encourage public new construction (as well as large private sector new construction projects in some cases) to be commissioned, although the effect of these policies have been muted in the past few years with the decline in new construction. Table 3-4 provides more details on the applicable state policies in the four Northwest states.

Table 3-4: Summary of State Policies Related to New Building Commissioning

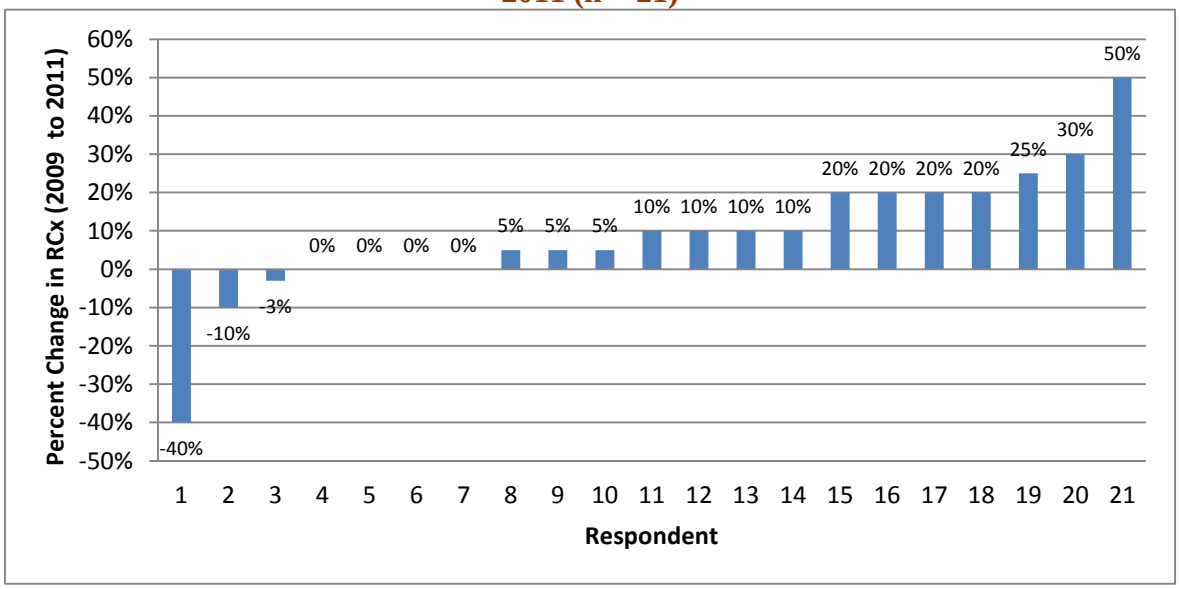
	Policies for State-Owned Buildings	Policies for Privately-Owned Buildings
Washington	All new state-owned buildings and major renovations must achieve LEED Silver certification, and most are seeking the extra point for enhanced commissioning. Policy enacted in 2005.	Section 1416 of the 2009 state energy code requires commissioning for new systems over a certain size in non-residential buildings.
Oregon	No overarching state requirement for commissioning, but commissioning is required for schools receiving public purpose charge funds for any capital project (new construction or major renovation).	Commissioning requirements and electives are included in the 2011 draft Oregon REACH Code, an *optional* set of statewide construction standards for energy efficiency that exceed the requirements of the state's mandatory codes. The state's Energy Loan Program offers financial assistance for commissioning, and the state offers a Business Energy Tax Credit to projects that achieve a LEED Silver rating.
Idaho	Commissioning is not required for new state buildings, but state officials must provide documentation of why they did not perform commissioning. Policy adopted in 2008.	No policies identified.
Montana	New state building projects over $500,000 requiring commissioning. Policy adopted in 2009.	No policies identified.
Source: Interviews with state liaisons (as part of 2009 LTMT effort), secondary research on state government agency websites, and update interviews with Idaho and Montana state liaisons to confirm findings.		

RETRO-COMMISSIONING OF EXISTING BUILDINGS

The LTMT team's estimates of retro-commissioning market activity for 2010-2011 build on the 2009 LTMT analysis and 2011 LTMT's survey responses of commissioning providers. Survey respondents reported, on average, an 8.9 percent increase in the square footage of retro-commissioned space over the 2009-2011 period. As such, the LTMT team estimated retro-commissioned floor space in 2011 to increase 8.9 percent from 2009 levels; the 2010 estimate used the average of the 2009 and 2011 retro-commissioned floor space values. The total 5-year estimate for 2007-2011 was 83.8 million ft^2 of retro-commissioned space.

To assess the level of retro-commissioning activity in 2010 and 2011, the LTMT team conducted interviews with utility retro-commissioning program managers and a survey of commissioning providers. Both sources indicated that while retro-commissioning overall has increased in the last two years, opinions varied on the magnitude of the change in market activity. Out of 23 service providers surveyed, 21 provided their opinion on how the retro-commissioning activity in the market changed between 2009 and 2011 (two did not know or did not provide a response). As seen in Figure 3-2 below, 14 respondents indicated that market activity has increased; four respondents believed that it has stayed the same, and only three respondents believed that retro-commissioning activity decreased between 2009 and 2011. The two utilities interviewed indicated that participation increased since 2009; however, one program manager commented that "most of the buildings participated a year into the program" towards the end of 2010.

Figure 3-2: Survey Respondent-Reported Percent Changes in RCx Activity from 2009 to 2011 (n = 21)



Source: Navigant survey of Northwest commissioning providers

When asked which three building types received commissioning services the most, service providers most frequently offered K-12 schools, universities, and government buildings. Program managers believe that larger, owner-occupied buildings are most likely to require commissioning. One program manager believes that owners with benchmarking capability are most likely to commission or retro-commission their buildings. Particularly, as one program

manager observed, "companies with large real-estate holdings, national retailers (like Safeway or Bank of America), and schools and higher education have multiple buildings that serve the same purpose" will be able to compare and benchmark their buildings and, as a result, are the "best actors" of commissioning. Both sources (utility program managers and commissioning providers) agree that the majority of current market activity stems from owner-owned institutions and organizations that are primarily public and have multiple buildings in their portfolio. Table 3-5 summarizes state policies related to existing building retro-commissioning.

Table 3-5: Summary of State Policies Related to Existing Building Retro-commissioning

	Policies for State-Owned Buildings
Washington	Major renovations of state-owned buildings must achieve LEED Silver certification. Policy enacted in 2005.
Oregon	Retro-commissioning required for capital projects funded by SB 1149 Public Purpose Funds. The state provides a list of pre-qualified commissioning service providers for schools.
Idaho	No policies identified.
Montana	Law does not require retro-commissioning for major state building, but state policy encourages it. The state offers a list of prequalified retro-commissioning service providers to assist with this process.
Source: Secondary source review update to 2009 LTMT; update interviews with Idaho and Montana state liaisons to confirm findings.	

As noted above, survey respondents indicated that the total square footage of retro-commissioned building space has increased on average by 8.9 percent in the past two years. The LTMT analysis applies that 8.9 percent value to the previous 2009 LTMT estimate, in order to estimate 2011 retro-commissioning levels; Navigant estimates 2010 levels to be the average of 2009 and 2011 levels. Table 3-6 summarizes the LTMT team's estimates of retro-commissioned floor space for the 2007-2011 time period. The total 5-year estimate is 83.8 million ft^2.

Table 3-6: Estimate of Retro-commissioned Floor Space, 2007-2011

Year	Retro-commissioned Square Footage (1000s ft^2)
2007	16,318
2008	16,318
2009	16,318
2010	17,044
2011	17,770
Total	**83,768**

Sources: Estimates for 2007-2009 are from previous 2007 and 2009 LTMT analysis. Navigant based the 2010-2011 values on the Cx and RCx provider survey conducted for the 2011 LTMT report.

RE-COMMISSIONING

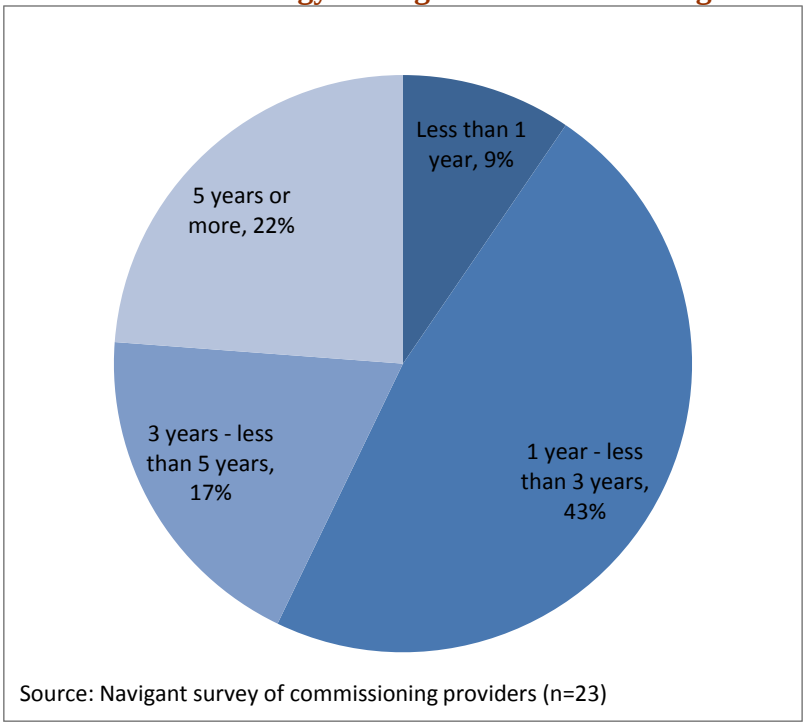
The surveyed commissioning providers indicated that very little re-commissioning occurs; it appears that even building owners/managers who recognize the benefits of commissioning a new building do not place a high value on re-commissioning buildings periodically, or they cannot afford to do so. Of respondents who provided estimates of their company's market activity in 2011, over half (61 percent) stated that they performed zero re-commissioning projects, and 33 percent stated that they re-commissioned just one building in 2011. One respondent stated that they performed 25 re-commissioning projects in 2011.

When asked to estimate the percentage of commissioned buildings that are re-commissioned, many survey respondents had a hard time estimating the percentage (largely because they believed the number to be very low). Responses ranged from 1 percent to 30 percent, with an average estimate of 14 percent of commissioned buildings receiving re-commissioning services periodically.

Respondents indicated that the average time period between initial commissioning and re-commissioning is 8.4 years. One respondent noted that re-commissioning should ideally occur at much more frequent intervals, stating that the lag is "1-5 years according to LEED, as funds become available according to Maintenance."

The surveyed commissioning providers had varying views on the persistence of savings, as shown in Figure 3-3. Nearly half (43 percent) believe that energy savings persist for 1-3 years after commissioning, though 22 percent believe that savings persist for 5 years or more.

Figure 3-3: Persistence of Energy Savings from New Building Commissioning



Source: Navigant survey of commissioning providers (n=23)

These findings indicate that only a small fraction of commissioned buildings are ever re-commissioned, and those that *are* re-commissioned are typically re-commissioned too infrequently to capture all potential energy savings.

PROJECTED FUTURE MARKET ACTIVITY

As shown in Table 3-7, all of the commissioning providers surveyed indicated that they anticipate the demand for new building commissioning and retro-commissioning to increase or remain steady in the next two years. Seventy percent said the new building commissioning market would increase, 30 percent said it would remain the same, and not a single respondent said that it would decrease over the next two years; when asked the same question about retro-commissioning, the responses were identical. Most expect re-commissioning (of previously commissioned buildings) to increase over the next two years as well, though one respondent indicated that he thought it would decrease because of strained maintenance budgets.

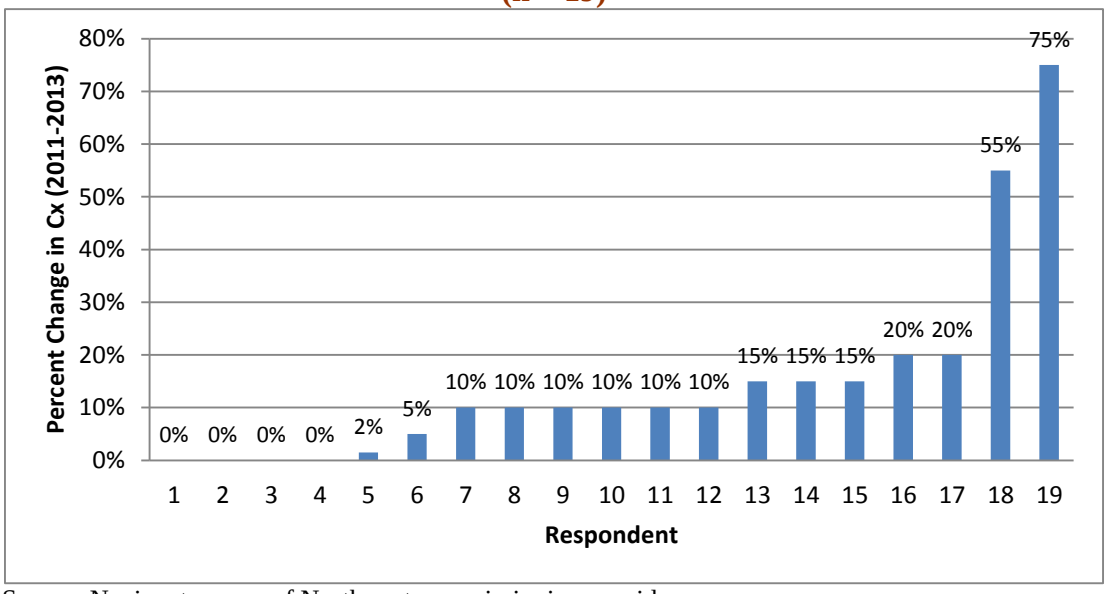
Table 3-7: Commissioning Providers' Predictions for Future Market Activity

	Increase	Stay the Same	Decrease	Average Forecasted Change
New building commissioning	70%	30%	0%	+15% (range of 0% to +75%)
Retro-commissioning of existing buildings	70%	30%	0%	+16% (range of 0% to +65%)
Re-commissioning of previously commissioned buildings	57%	30%	5%	+13% (range of 0% to +60%)

Source: Navigant survey of commissioning providers (n=23)

Most of the reasons cited for this forecasted increase involve the signs of a recovering economy, rising energy costs, or increasing market interest in LEED certification. Most survey respondents indicate that they foresee a modest growth (+20 percent or less) in new building commissioning activity in the next two years, though two foresee more significant growth of 55-75 percent, as shown in Figure 3-4.

Figure 3-4: Predicted Percent Changes in Cx Activity from 2011 to 2013 (n = 19)



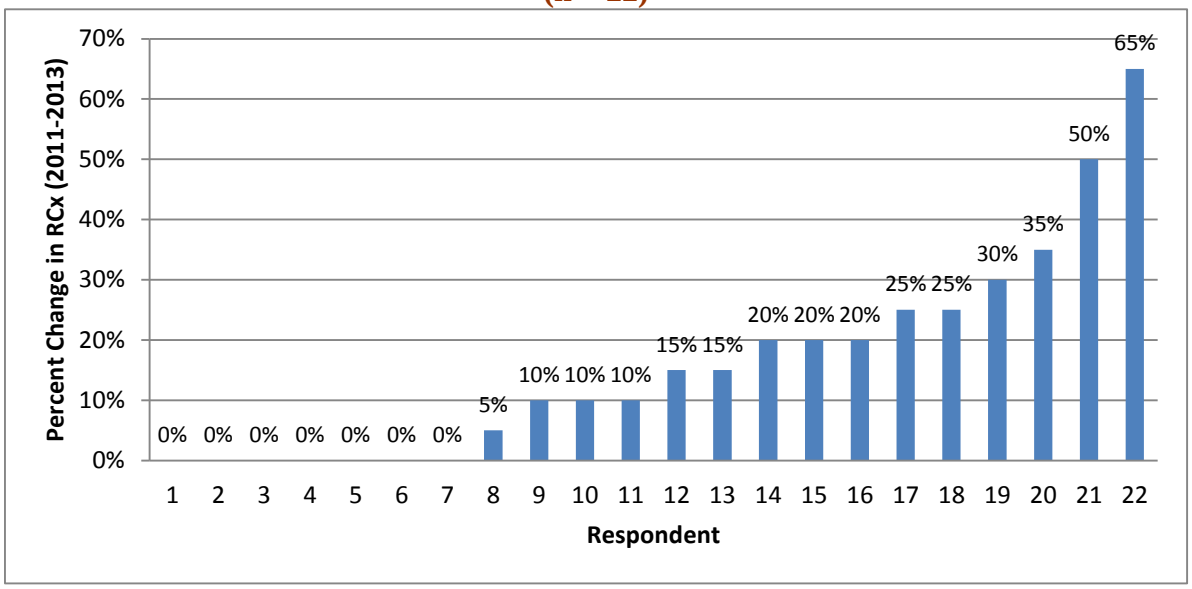
Source: Navigant survey of Northwest commissioning providers

Utility program managers and commissioning providers differ slightly on the outlook of future retro-commissioning market activity. Utility program managers believe that retro-commissioning activity will increase *only* if customers significantly improve their understanding of how their buildings work. In addition, market activity is limited currently not only because "there are not a

lot of good tools out there" for calculating savings[22] but also because service providers in existing building retro-commissioning "don't have the experience" and skill to deal with a field that is "very different from new building commissioning."

On the other hand, 15 out of 22 service providers believe that retro-commissioning activity will increase in the next two years, as seen in Figure 3-5 below (one did not know). No respondent believed that retro-commissioning activity would *decrease* in the next two years.

Figure 3-5: Predicted Percent Changes in RCx Activity from 2011 to 2013 (n = 22)



Source: Navigant survey of Northwest commissioning providers

When asked what changes in retro-commissioning activity will occur in the next two years, five survey respondents specifically stated that RCx activity will increase, citing the following reasons:

- Higher utility bills and energy costs (3 responses),
- Utility program incentives (1 response), and
- Increased standards (1 response).

Despite the positive outlook on commissioning in general, service providers did express some concern regarding the quality of current and future commissioning and retro-commissioning activity. Seven of the 22 respondents expressed a hope to see more standardization of service offerings which will enable "a consistent level of expectation for providers and owners." One service provider stated that with higher retro-commissioning activity, "quality [of services provided] might continue to decline, hopefully followed by an awakening and demand for greater quality supported by the willingness to pay for value added." Thirteen service providers

[22] One retro-commissioning provider echoed this specific sentiment, stating "We are pretty frustrated with the utility programs for RCx. Typically the findings are low cost, quick return, and the amount of time spent calculating and proving savings to them is driving up the ROI."

believe that the following trends and factors will increase quality of the general commissioning workforce:

- Standards from law and standardization of practices (7 responses),
- Higher customer/owner demand (5 responses), and
- More workforce experience (2 responses)

One respondent specifically called out the pending release of ASHRAE guidelines for existing building retro-commissioning as likely to improve market awareness and the quality of retro-commissioning services.[23]

3.3.2 Baseline Activity

Through 2006, NEEA assumed that baseline activity was 10 percent of estimated commissioning market activity, meaning that approximately 10 percent of the market activity occurred without the influence of NEEA's commissioning initiatives.[24] The 2007 and 2009 LTMT efforts updated this assumption to 30 percent based in part on the growing popularity of LEED certification. After assessing responses from service providers regarding their observations of market influences, the 2011 LTMT team updates the baseline activity assumption to 35 percent for new building commissioning and 40 percent for retro-commissioning.

It is clear from past LTMT efforts' interviews with state liaisons that NEEA had a significant influence in the adoption of commissioning in public buildings as a requirement or standard practice. NEEA also played a role in the creation of the Building Commissioning Association (BCA). However, it is difficult to assess how much influence NEEA had over the adoption of LEED or other green building policies, or on commissioning in the private sector, and within the past two years, there has been very little public sector new construction.[25]

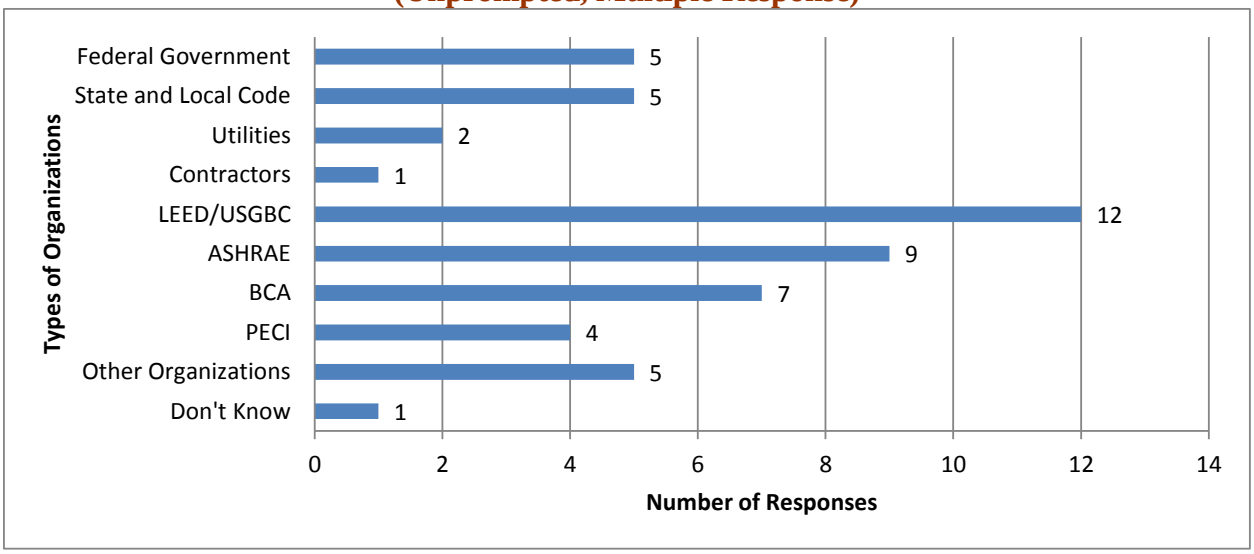
To help the LTMT team gain a broad understanding of market influences, the LTMT team asked service providers to identify organizations that influenced their business. One respondent said that "NEEA and NW utilities may be doing Cx related stuff, but if they are, it doesn't appear to be disseminated well to Cx providers." In fact, as seen in Figure 3-6 below, not one service provider directly mentioned NEEA as an organization that influenced their businesses. BCA was one of the top five organizations mentioned, but the influence of LEED/USGBC and, in aggregate, other organizations seem to be stronger.

[23] A summary of the expected ASHRAE guidelines can be found here: http://www.peci.org/ncbc/2009/docs/Casault_NCBC09.pdf.

[24] This assumption was based on the Excel file "2006 MAR Cumulative Savings 04-03-07.xls", which cited the high level of NEEA influence described by state liaisons in the 2005 LTMT report.

[25] According to CoStar estimates as presented in NEEA's memo *Size of Public versus Private Northwest Commercial Building Market from 2001 to 2011* dated March 7, 2012.

Figure 3-6: Organizations that Influenced Commissioning Service Provider Business (Unprompted, Multiple Response)



Source: Navigant survey of Northwest commissioning providers (n=23)

Navigant interviewed utility program managers, concluding that a combination of state policies and utility incentives help drive participants to the programs; however, according to service providers, neither driver represents a particularly strong influence. As such, while assessing survey responses and interviews with program managers, the LTMT team examined several potential market influences, such as state, county, and municipal government requirements for commissioning in public buildings (which NEEA's efforts may have influenced). The LTMT team examined the following market influences to reassess baseline activity:

1. The rise of LEED certification and green building, including a) state, county, and municipal government requirements for LEED certification in public buildings and incentives for LEED certification in private sector, and b) increased market interest in LEED/green building.
2. Utility incentives for commissioning and retro-commissioning in private sector.
3. Recent availability of ARRA stimulus funding for state energy office efforts and other energy-related projects.

The sub-sections below describe these influences.

Influence of LEED Certification

To obtain LEED certification at any level, some building commissioning must occur; providers often seek an additional bonus point for more extensive commissioning in order to achieve higher levels of LEED certification (e.g., LEED Silver, Gold, or Platinum). As reported in the previous LTMT report, the states of Washington and Oregon as well as several counties and major cities in those two states have adopted LEED requirements for publicly-owned buildings, as well as some incentives for privately owned buildings to seek LEED certification. According

to the U.S. Green Building Council's website, neither Montana nor Idaho has adopted state-level LEED requirements, although several counties in Idaho have adopted such policies.[26]

The survey of commissioning providers conducted by the LTMT team revealed that LEED ratings encourage and increase opportunities for commissioning. When asked to identify influential organizations that impacted service provider business, service providers most frequently responded with LEED/USGBC (mentioned by 12 respondents). Four of the survey respondents who mentioned LEED/USGBC as an influencing organization in their business stated (see Figure 3-6) specifically that "LEED increases our business" or "work opportunities." One survey respondent reported doing business specifically with companies that seek commissioning services in order to fulfill requirements for LEED certification.

One utility program manager also mentioned LEED as one of the factors—albeit not the most important one—which drive program participation in the new building commissioning program.

UTILITY COMMISSIONING AND RETRO-COMMISSIONING PROGRAMS

At least two utilities in the Northwest have implemented programs to incentivize commissioning and retro-commissioning in the past several years, including Puget Sound Energy (PSE) and Avista Utilities. For the 2011 LTMT effort, Navigant followed up with program managers from PSE and Avista Utilities to update their insights regarding NEEA's influence on their programs and program participation levels from their last interview in 2010.

Both program managers indicated that NEEA has not been a strong influencer of participation in their utility retro-commissioning programs. One program manager claimed that while NEEA has been "an incredible partner in everything else," retro-commissioning does not seem to be part of NEEA's marketing and promotional efforts. The other program manager offered that while NEEA "tried to train one of the largest service providers," most of NEEA's efforts "did not materialize" from "a lot of discussion."

PSE has seen an increase in commissioning of new buildings as well as retro-commissioning of existing buildings in its service territory. The majority of its new building commissioning is driven by new public buildings and state mandates for public buildings to be commissioned, which the LTMT team understands to be influenced by NEEA's Commissioning in Public Buildings initiative rather than utility incentives, though service providers may be unaware of NEEA's influence on state policies. On the other hand, PSE strongly believes that incentives drive the existing building commissioning activity, especially with people looking for "low cost or no cost activities" given the current economic situation.

Only about five facilities went through Avista Utilities' retro-commissioning program since its inception in mid-2009. However, the program manager believes that this number is an under-representation of the retro-commissioning activity in the service territory because customers participate through prescriptive programs after conducting retro-commissioning on their own.

[26] http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1852.

The majority of surveyed commissioning providers (61 percent) stated that utility programs/incentives have influenced commissioning and retro-commissioning activity in the past two years. One respondent described utility incentives as "a deal that can't be refused"; another stated that there was "no interest" in commissioning "without utility subsidy", indicating that they viewed utility incentives as the primary driver of market activity.

AVAILABILITY OF ARRA FEDERAL STIMULUS FUNDS

More than half (57 percent) of surveyed commissioning providers indicated that the availability of federal stimulus funds through the American Recovery and Reinvestment Act (ARRA) drove increased commissioning and/or retro-commissioning activity; anecdotal responses indicated that ARRA funding primarily increased retro-commissioning activity. The U.S. Green Building Council- promoted retro-commissioning as one of the primary ways that federal, state, and local government agencies could take advantage of ARRA funding opportunities.[27]

One surveyed commissioning provider credited ARRA funding with *all* of their recent projects, stating, "The economy has hurt everyone in the industry, as there isn't as much money to put toward projects. The projects we have managed to pick up have been a direct result of the ARRA funding."

Publicly available information on ARRA-funded projects is incomplete and difficult to review; while there is a public website called Recovery.gov that provides information on the size of the grant and the granting agency, there is very little description provided of the nature of the projects. Many projects targeted existing buildings and appeared to receive funding through energy-related federal or state agencies, but the project titles were rarely descriptive enough to understand whether the buildings received retro-commissioning, equipment upgrades/replacements, or other energy-related services. The LTMT team did identify one document from the Oregon Department of Energy about ARRA-funded energy-related projects which included numerous retro-commissioning projects, mainly at universities.[28]

SUMMARY OF BASELINE ACTIVITY

Private sector interest in LEED continues to be the primary non-NEEA influence in the new building commissioning market in the Northwest. Utility programs and ARRA funding appear to be having a more significant influence on commissioning and retro-commissioning activity than they did during the last LTMT analysis, although they appear to be almost exclusively influencing the retro-commissioning activity rather than new building commissioning.

The interviewed utility program managers and the surveyed commissioning providers rarely credited NEEA directly with influencing their commissioning and/or retro-commissioning business, though commissioning providers (who are all members of BCA) did frequently credit BCA as an influence and are likely unaware of NEEA's role in the formation of BCA. The previous LTMT reports found that state government officials widely credited NEEA with influencing state policies to require commissioning and retro-commissioning in public buildings

[27] http://www.fundinggreenbuildings.com/documents/Top10waysToGreenWithStimulusFunds.pdf.
[28] The Oregon Department of Energy document is titled *American Recovery and Reinvestment Act (ARRA) Funding of Energy Projects Group Three* and can be found at http://www.oregon.gov/ENERGY/Recovery/docs/ARRAGroup3Projects.pdf?ga=t.

and with establishing the BCA which has helped legitimize the commissioning industry and ensure the availability of a quality workforce.

The previous LTMT report estimated that 30 percent of commissioning and retro-commissioning was naturally occurring baseline activity, but also acknowledged the increasing influence of non-NEEA-related influences such as private sector demand for LEED and ARRA funding which the analysis note would be more prevalent in the 2010-2011 timeframe. The LTMT report's predictions came to fruition – private sector demand for LEED has continued to play an increasing role in driving new building commissioning market activity, and utility incentive programs and ARRA funding enabled retro-commissioning projects within the past two years that likely would not have occurred otherwise. Public sector new construction has slowed more dramatically than private sector new construction, which would indicate that the NEEA-influenced state policies to require commissioning of public buildings are having a smaller effect on overall commissioning market activity.[29]

Based on the above findings, the LTMT team recommends an increase in the naturally occurring baseline: from 30 percent to 35 percent for new building commissioning and from 30 percent to 40 percent for retro-commissioning. The increased retro-commissioning baseline may be temporary as the ARRA funding may have caused a temporary boost in retro-commissioning activity, and the next LTMT effort for the commissioning initiative should closely examine this issue.

3.3.3 Per-Unit Energy Savings

Previous LTMT efforts used the values presented in the 2004 LBNL study of 0.55 kWh/ft^2-year for new building commissioning and 1.70 kWh/ft^2-year for existing building retro-commissioning. While there was an update to that LBNL study conducted in 2009, the focus was not on collecting energy savings data (particularly electricity-only savings) and the data was not in a format which enabled a per-square-foot estimate of electricity-savings. However, on a percentage basis, the energy savings estimated presented in the 2009 LBNL study were similar enough to those in the 2004 LBNL study that the LTMT team concluded that the previous estimates of 0.55 kWh/ft^2-year (commissioning) and 1.70 kWh/ft^2-year (retro-commissioning) were reasonable to continue using.[30] LBNL has not updated the study since the last LTMT and Navigant's review of the existing literature found that most commissioning and retro-commissioning professionals and organizations rely on the LBNL data as the best source of average energy savings estimates. The LTMT team was unable to identify any additional reliable sources of information on per-square-foot savings for new building commissioning or retro-commissioning.

[29] NEEA memo entitled *Size of Public versus Private Northwest Commercial Building Market from 2001 to 2011* (dated March 7, 2012) indicated that public sector new construction square footage as a percentage of all commercial new construction in the 2010-2011 timeframe was just 4 percent, compared to previous years' estimates of 5-7 percent.

[30] The 2004 LBNL study presented median electricity savings of 9 percent for existing building retro-commissioning and 8 percent for new building commissioning. The 2009 LBNL study presented median electricity savings of 9 percent for existing building retro-commissioning (i.e., no change from 2004 estimates) but did not present electricity-specific savings estimates for new building commissioning. Thus, the 2004 LBNL study savings values were used.

3.4 Conclusions and Recommendations

NEEA initiatives supporting public building commissioning and the development of the BCA have accelerated the transformation of the commissioning market in the Northwest and helped to increase the number of commissioning providers as well as the quality of commissioning work completed, though outside influences including the popularity of LEED and the (temporary) availability of ARRA funding for energy-related projects have become increasingly significant drivers of market activity. The following are the major conclusions of the LTMT research:

1. **The pool of available commissioning providers in the Northwest has continued to increase,** based on a review of the BCA membership and anecdotes from utility program manager interviews and commissioning provider surveys. BCA membership has expanded in three out of the four Northwest states since the last LTMT analysis. There are currently 57 members in the Northwest (36 members in Washington, 16 in Oregon, three in Montana, and two in Idaho) compared to 49 as reported in the 2009 LTMT report.[31]

2. **Market interest in LEED certification continues to drive demand for commissioning services.** As found in the 2009 LTMT effort, some commissioning providers believe that building owners seeking LEED certification do not value the commissioning process and view it as merely a burdensome requirement that they have to meet for the lowest possible cost. Some commissioning providers question whether their competitors are underbidding the more qualified providers and providing lower quality commissioning services.

3. **ARRA funding and utility programs sustained the retro-commissioning industry during the economic downturn.** Several commissioning providers indicated that there are more incentive dollars available for retro-commissioning than commissioning, and the majority indicated that ARRA funding and utility program incentives had increased retro-commissioning activity in the past two years.

4. **There is a continued need for consumer education about the benefits of commissioning, especially retro-commissioning, and for standardization of quality services.** Utility program managers and commissioning providers alike indicated that building owners do not necessarily value commissioning (many see it as merely a hoop to jump through in order to obtain LEED certification) and that building owners poorly understand retro-commissioning. Commissioning providers believe that commissioning and retro-commissioning practices need more standardization so that customers know what to expect and are able to identify quality service providers. One provider stated, "The BCA still has a long way to go to instill a consistent level of expectation for providers and owners."

5. **Some market actors see a need for a simple and widely accepted method of calculating savings, particularly for existing building retro-commissioning**. One utility program manager specifically identified the lack of a good savings calculator for

[31] In comparison, the BCA membership reported in the 2009 LTMT report included 37 members in Washington, nine members in Oregon, two members in Idaho, and one member in Montana.

retro-commissioning projects as a barrier to greater market activity. Additionally, although the survey did not specifically ask commissioning providers about this topic, one respondent offered that the time spent calculating energy savings for utility retro-commissioning programs was unduly burdensome, indicating that service providers would benefit from a savings calculator or other simple savings estimation tool.[32]

Table 3-8 summarizes recommendations for the values of key indicators for projects completed in 2010 and 2011, and for the five-year period 2007-2011 (cumulative). Navigant estimates that in the past five years new building commissioning market activity was 65.6 million ft^2, and retro-commissioning activity was 83.8 million ft^2. Navigant assumes the baseline to be 35 percent for new building commissioning and 40 percent for retro-commissioning, and the per-unit energy savings remain the same as in the previous analysis. The implied energy savings are approximately 2.4 aMW (incremental) each year in 2010 and 2011, and the cumulative savings in 2011 for the five-year period from 2007-2011 is 13.5 aMW.

[32] The LTMT team identified a new Excel-based savings estimation tool for retro-commissioning that providers may be unaware of. California's PIER research program funded development of the tool, called C-BOA, and utility program administrators in California are currently reviewing it. It is unclear whether the tool will support only California-based analysis or whether it could adapt to other regions/climate zones. See http://www.cacx.org/resources/rcxtools/spreadsheet_tools.html.

Table 3-8: LTMT Recommendations for Key Indicators

Key Indicators Reviewed	2010 Incremental (Due to new activity occurring in 2010)	2011 Incremental (Due to new activity occurring in 2011)	2011 Cumulative (Calendar year 2011 values due to all activity since program inception)
Current Market Activity			
Commissioned buildings (millions ft^2)	9.9	7.2	65.6
Retro-commissioned buildings (millions ft^2)	17.0	17.8	83.8
Total Market Activity	26.9	25.0	149.4
Current Baseline Activity*			
Commissioned buildings (millions ft^2)	3.5	2.5	20.5
Retro-commissioned buildings (millions ft^2)	6.8	7.1	28.6
Total Baseline Activity	10.3	9.6	49.2
Per-Unit Energy Savings			
kWh/ft^2 (Commissioning)	No Change (0.55)		0.55
kWh/ft^2 (Retro-commissioning)	No Change (1.70)		1.70
Implied Energy Savings*			
Commissioned buildings (aMW)	0.4	0.3	2.8
Retro-commissioned buildings (aMW)	2.0	2.1	10.7
Total Implied Energy Savings (aMW)	2.4	2.4	13.5

* Estimated baseline activity for 2010-2011 is 35 percent of market activity for new building commissioning and 40 percent for retro-commissioning.

** Implied Energy Savings represent estimated savings from market activity less estimated savings from baseline activity. NEEA's reported values might not match those presented here since NEEA adjusts for the effect of utility incentives and other factors not taken into account in this LTMT analysis.

Source: Navigant analysis

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4 Drive Power

NEEA funded the Drive Power Initiative (DPI) between 1999 and 2004, and the Electric League of the Pacific Northwest administered this electric motor market transformation effort, which sought to attain the following objectives:

- Increase the region's overall motor fleet efficiency;
- Influence end users' repair/replace decision making for motors to encourage use of life-cycle costing in investment decisions; and
- Help motor service centers improve their repair practices and expand their motor management services.

The 2011 LTMT is the fifth such assessment of the DPI. The first effort, for 2007, focused on sales of National Electrical Manufacturers Association (NEMA) Premium™ motors and the share of these sales that NEEA influenced. The 2008 LTMT effort updated these figures and attempted to quantify the impact of new services and changes in practices at motor repair centers. The 2009 effort established a baseline and market activity trend for the motor repair market through detailed motor service center and market actor interviews. In addition, the 2009 effort updated savings from sales of NEMA Premium™ motors using the previously established methodology and newer motor shipment data. The 2010 LTMT effort updated savings from sales of NEMA Premium™ motors using the most recent shipment data available, but did not update savings from the motor repair market.

The 2011 effort built on previous LTMT efforts by (1) updating the market penetration of NEMA Premium™ motors *and* efficient motor rewinds using the most recently available data, (2) developing a more accurate baseline estimate of NEMA Premium™ motor sales and efficient motor rewinds, and (3) updating per unit savings for both NEMA Premium™ motors and efficient rewinds. The 2011 LTMT also accounts for motor lifetime to determine motor baseline and market penetration by adjusting for retirements.

4.1 Assumptions and Indicators for Review

To study the effect of the DPI on the motors market in the Northwest, Navigant identified a list of indicators that would track the progress of the DPI. This section defines these indicators and describes how they support DPI's market transformation effort.

Navigant identified the following indicators:

1. **Sales of NEMA Premium™ motors in the Northwest.** NEEA helped form a premium efficiency motors brand (NEMA Premium™)[33,] and through outreach and education, NEEA encouraged customers to purchase NEMA Premium™ motors.

[33] The 2007 report provided details of NEEA's efforts to help form the NEMA Premium™ brand, and the report discussed the savings attributable to NEEA through the sale of NEMA Premium™ motors in the Northwest.

2. **Energy-efficient repair and rewind activity.** Motor service centers in the Northwest are adopting energy-efficient repair methods consistent with Electrical Apparatus Service Association (EASA) best practices. Through these service centers, NEEA also tried to educate customers to request efficient rewinds. The 2007, 2008, and 2009 LTMT reports addressed this indicator. The 2010 report did not address this issue, but the 2011 report revisits this topic.[34]

An important assumption underlying the analysis of savings from sales of new motors is a measure life of ten years, which is approximately the average life of a motor before it is retired or rewound.[35] Since NEMA Premium™ motors first appeared in 2001, previous LTMT analyses have assumed no degradation of energy savings due to retirements; however, 2011 marks the first year of motors reaching retirement. For this reason, the 2011 LTMT considers motor retirements as a factor in estimating savings.

4.2 Methodology

The 2011 LTMT research built on the activities conducted for the first four LTMT assessments of the DPI. Specifically, Navigant performed the following research activities:

- **Obtained motor shipment data from the Consortium for Energy Efficiency (CEE).** Motor sales data is not widely collected and is difficult to obtain, but shipment data is reasonably available and serves as a proxy for estimating sales. NEMA generates this data and the CEE distributes the NEMA data to its members. Navigant obtained 2009 shipment data for both standard and NEMA Premium™ motors.

- **Obtained motor repair data from the Green Motors Practices Group (GMPG).** The LTMT team contacted the GMPG and obtained data on efficient motor rewinds in the Northwest. The GMPG provided data on efficient motor rewinds for the 2010 LTMT as well.

- **Re-contacted and interviewed experts in the motor repair market.** The LTMT team contacted the GMPG, the Bonneville Power Administration (BPA), and PacifiCorp. The GMPG and Bonneville also contributed to the 2010 LTMT report. The LTMT team interviewed these market actors to (a) determine number of motors rewound annually and understand what percentage of these total rewinds are energy efficient rewinds; (b) gain insight into energy savings due to efficient rewinds; and (c) estimate the effect of the DPI on the prevalence of energy efficient rewinds in the Northwest. Navigant also asked market experts if surveys of motor service centers would provide any additional insight of market trends since Navigant's last 2009 survey.

[34] Navigant has examined a third indicator, effect of outreach activities, in past LTMT reports. See the 2007 LTMT for additional detail.

[35] According to DOE (September 2005), motors last between 30,000 and 40,000 hours. This translates to approximately ten years based on motor usage of 3,500 hours per year.

Table 4-1 summarizes Navigant's primary data collection efforts.

Table 4-1: Primary Data Collection Activities for 2011 Drive Power LTMT

Interviewee Group	Number of Interviews/Surveys	Topic/Issues
Green Motors Practices Group (GMPG)	One extended interview with GMPG management via telephone and email	• State of the current motor repair market in the Northwest • Assessment of NEEA's influence on market baseline • Difference in motor rewind practices between GMPG member and non-member motor service centers
Bonneville Power Administration (BPA)	One interview with BPA management via telephone	• State of the current motor repair market in the Northwest • Assessment of NEEA's influence on market baseline
PacifiCorp.	One interview with PacifiCorp. management via telephone	• State of the current motor repair market in the utility's territory • Current incentives offered for energy efficient motor rewinds

Source: 2011 Navigant analysis

4.3 Findings

This 2011 LTMT report divides findings into two distinct categories: 1) sales of NEMA Premium™ motors, and 2) energy efficient rewinds. Within each of these sections, Navigant addresses the following three subtopics: market activity, baseline activity, and per-unit savings.

4.3.1 Sales of NEMA Premium™ Motors

MARKET ACTIVITY

Motor *sales data* is not widely collected and is difficult to obtain, but *shipment data* is reasonably available and serves as a proxy for estimating sales. National shipment data for NEMA Premium™ motors dates back to 2001, with 2009 the most recent year covered in the shipment data distributed by the CEE through NEMA. Regional data has been available since 2004. As pointed out in previous LTMT efforts, motor shipment reporting sources were not consistent at several points in time since 2004.[36] For this reason, Navigant has estimated the true number of motor shipments since that time.

Similar to the 2010 LTMT analysis, the 2011 analysis used *regional* shipment data, combined with *national trends,* to estimate Northwest sales of NEMA Premium™ motors. The following

[36] Motor shipment data does not include original equipment manufacturers (OEMs) in 2004, and one of the major motor manufacturers dropped out of the survey in 2005 (rejoining in 2008).

explanation of LTMT findings begins with a discussion of motor shipment data, and addresses the national trends that form the basis of regional sales estimates.

REPORTED MOTOR SHIPMENT DATA

As noted in the 2010 LTMT, the raw shipment data as reported by NEMA indicate that national shipments of NEMA Premium™ motors increased steadily between 2001 (the first year the branded motors were available) and 2006, dropping in 2007. Reported shipments in 2008 increased when compared to 2007, but the 2008 figures included one additional motor manufacturer relative to the prior three years.[37] In 2009, the same set of manufacturers reported shipment data as in 2008; therefore, the two years are directly comparable. Table 4-2 shows reported shipments of NEMA Premium™ and standard efficiency motors in 2009, and for comparison, Table 4-3 shows the same shipment data for 2008. Shipment data for years prior to 2008 (2001-2007) is included in the Appendix.

According to the most recent NEMA data (Table 4-2), over 830,000 non-OEM (Original Equipment Manufacturer) standard efficiency and NEMA Premium™ motors were shipped in 2009. Total motor shipments decreased by 14 percent in 2009 compared to the nearly 965,000 total shipments in 2008 (Table 4-3). At a national level, the percent market share of NEMA Premium™ motors remained fairly constant from 2008 to 2009, with 25 percent market share in 2008 and 24 percent market share in 2009. In terms of the number of motors shipped, however, the total number of NEMA Premium™ motors shipped nationally fell 16 percent, from roughly 241,000 motors in 2008 to 202,000 motors in 2009.

At the same time that NEMA Premium™ motor sales fell 16 percent nationally from 2008 to 2009, sales of these motors increased nearly 55 percent in the Northwest, from 15,646 motors in 2008 to 24,190 motors in 2009. In terms of market share, NEMA Premium™ motors grew from 39 percent of all non-OEM sales in the Northwest in 2008 to 64 percent of these sales in 2009.

[37] The raw data for 2004 to 2007 are incomplete because the records exclude motors from OEMs, and at least one of the non-OEM manufacturers pulled out of the motor surveys beginning with the 2005 reporting year. (Sources: 2007 interviews with GMPG and Baldor Electric Co.) The data for 2008 includes all major motor manufacturers and no OEM motors.

Table 4-2: Reported Shipments of NEMA Premium™ and Standard Efficiency Motors, 2009

Region	Premium	Non-Premium	Total	% Premium
Idaho	11,830	4,455	16,285	**73%**
Montana		**(Included in Idaho)**		
Washington	2,379	5,314	7,693	**31%**
Oregon	9,981	4,016	13,997	**71%**
Northwest	24,190	13,785	37,975	**64%**
Nation	201,933	628,118	830,051	**24%**

Source: NEMA motor shipment data as reported by the CEE.

Table 4-3: Reported Shipments of NEMA Premium™ and Standard Efficiency Motors, 2008*

Region	Premium	Non Premium	Total	% Premium
Idaho	9,143	6,521	15,664	**58%**
Montana		**(Included in Idaho)**		
Washington	3,028	8,046	11,074	**27%**
Oregon	3,475	9,724	13,199	**26%**
Northwest	15,646	24,291	39,937	**39%**
Nation	240,912	723,826	964,738	**25%**

* The motor manufacturer that had previously dropped out of the survey reported motor shipments in 2008 for the first time since 2004.
Source: NEMA motor shipment data as reported by the CEE.

National Motor Shipment Trends

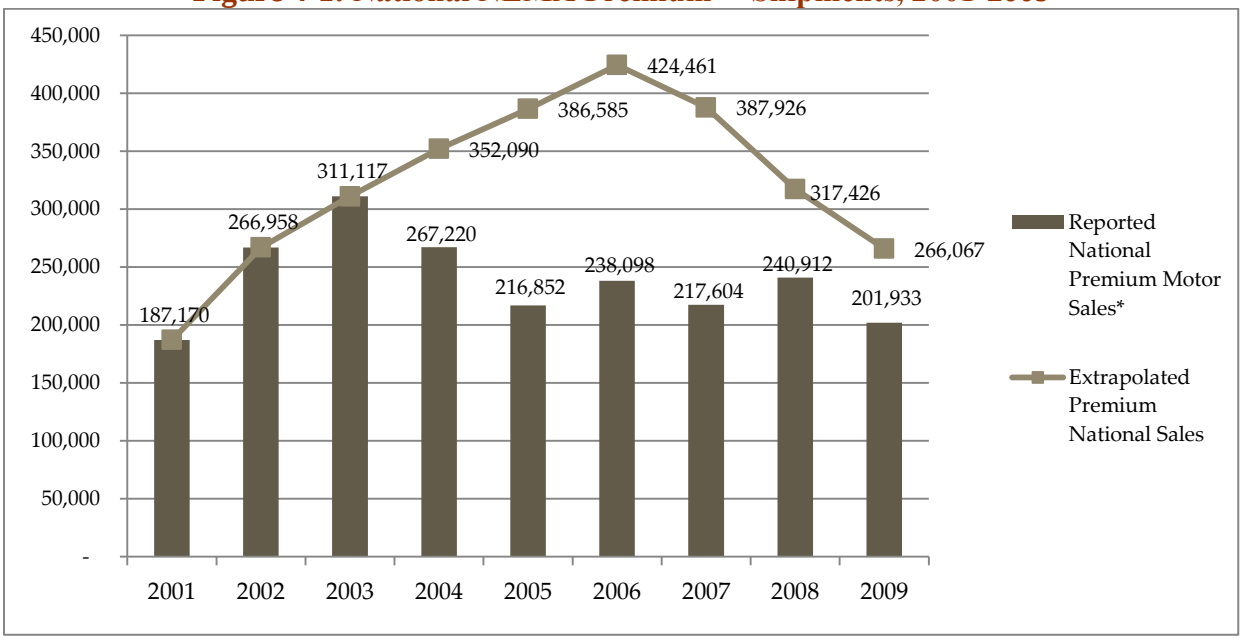
In past LTMT efforts, Navigant estimated national NEMA Premium™ motor shipment trends based on the NEMA shipment data. In the 2010 LTMT, Navigant provided a detailed methodology of national motor shipment estimation, which is included in the Appendix, and which remains unchanged for 2011. Navigant provides an analysis-based estimate of national and regional motor sales due to the fact that the composition of the NEMA data has changed over the years. For example, from 2001 to 2003, NEMA shipment data contained motor shipments from all major manufacturers, including original equipment manufacturers (OEMs). Hence, Navigant's estimate of national NEMA Premium™ motor shipments for 2001 to 2003 is equal to NEMA reported sales. In 2004, however, NEMA data no longer included OEM shipments; therefore, Navigant estimated total sales based on interviews with the market actors and analysis.[38] In 2005, one major manufacturer ceased reporting to NEMA, but started reporting again in 2008. The composition of the 2009 data is consistent with the 2008 data; thus, Navigant calculates 2009 shipments in the same way it calculated

[38] According to interviews with GMPG, OEMs account for approximately 33 percent of total motor sales. If this were accurate, then the required adjustment factor to correct for the incomplete reporting data would be 1.5. The LTMT estimate resulted in an adjustment factor of 1.318.

2008 shipments. The Appendix contains the details of Navigant's methodology to calculate total national shipments based on NEMA data.

Figure 4-1 shows the current estimate of NEMA Premium™ motor shipments in the US. *As* Figure 4-1 illustrates, estimated national NEMA Premium™ motor shipments dropped by 16 percent from 2008 to 2009 to approximately 266,000 units.

Figure 4-1: National NEMA Premium™ Shipments, 2001-2009



*Only non-OEM motor shipments were reported from 2004 onwards; one major manufacturer ceased reporting beginning in 2005, but began again in 2008.
Source: NEMA data reported by the CEE and 2011 Navigant analysis.

REGIONAL SALES

In addition to estimating national sales of NEMA Premium™ motor shipments, Navigant also estimated regional shipments of these motors in previous LTMT efforts. For the 2010 LTMT effort, Navigant provided a detailed methodology of regional NEMA Premium™ motor shipment estimation for the period since 2001 (For details of the methodology, see the Appendix). In summary, the LTMT effort in 2010 estimated total regional sales using regional NEMA shipment data (from 2008) adjusted for OEM sales. Since the composition of the NEMA data remained unchanged from 2008 to 2009 (the most recent year reported), Navigant applied the same calculation methodology for the 2011 LTMT, using the updated regional NEMA shipment data (from 2009) adjusted for OEM sales.

Since 2005, NEMA obtained sufficient data from motor manufacturers to publish a national and state motor shipment report for both NEMA Premium™ and non-NEMA Premium™ motors. Table 4-4 shows a detailed summary of motor shipments in the Northwest for 2009. The table provides a breakdown of motor shipments both by efficiency (NEMA Premium™ and standard) and by HP class. As the table indicates, NEMA Premium™ motors accounted for 64 percent of

all motors sold in the Northwest in 2009. In comparison, NEMA Premium™ motors accounted for an average market share of 39 percent in the Northwest in 2008.

Table 4-4: Total Motor Shipments in the Northwest by Size, 2009

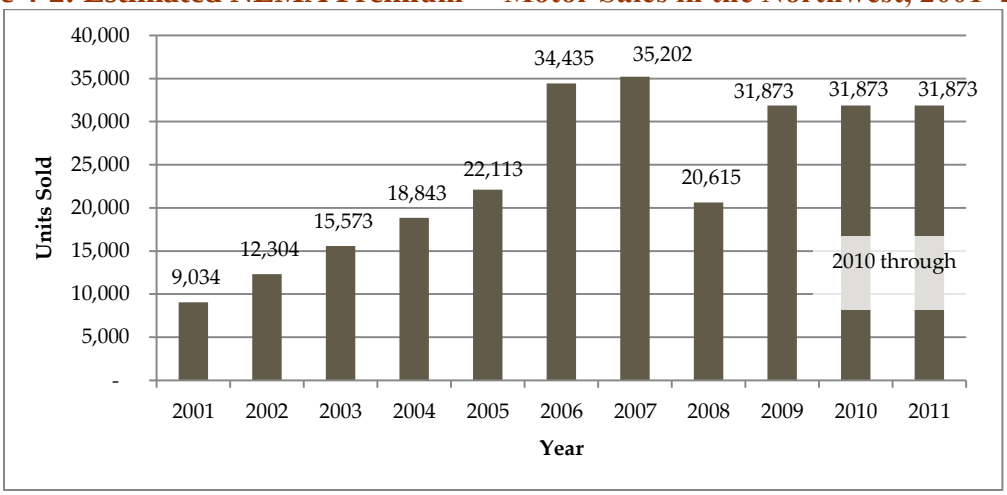
	1-5 HP	6-20 HP	21-50 HP	51 - 100 HP	101 - 200 HP*	201-500 HP*	Total**
NEMA Premium™ Motors	17,854	3,768	1,480	689	286	113	24,190
Non-NEMA Premium™ Motors	8,310	3,038	1,552	514	248	123	13,785
Total Motor Shipments	26,164	6,806	3,032	1,203	533	237	37,975
NEMA Premium™ Share of All Motors	68%	55%	49%	57%	54%	48%	64%

*Some states did not separate 101-200 HP motors and 201-500 HP motors in their data. Therefore, Navigant weighted these categories based on the CEE national average for each respective HP class.
**The figure of 24,190 for total NEMA Premium™ motors shipped in 2009 is directly from the CEE data. As discussed below, the LTMT analysis has estimated the total to be 31,873, which accounts for missing data for non-OEM motors.

Source: NEMA Premium™ and Non- NEMA Premium™ motor data as reported by the CEE.

Figure 4-2 presents Navigant's estimate of NEMA Premium™ motor sales in the Northwest from 2001 through 2011. The figure illustrates the growth in NEMA Premium™ motor sales in the Northwest since 2001, followed by a leveling off in 2007 and a decline in 2008. Regional sales estimates for 2009 (about 32,000 units) suggest a significant recovery from the 2008 level; however, sales estimates are still below the 2007 peak. Due to market uncertainty, Navigant assumes that sales in 2010 and 2011 will remain flat. Based on these estimates, total premium motor sales in the region since 2001, before accounting for retirements, are nearly 264,000 units.

Figure 4-2: Estimated NEMA Premium™ Motor Sales in the Northwest, 2001–2011 *



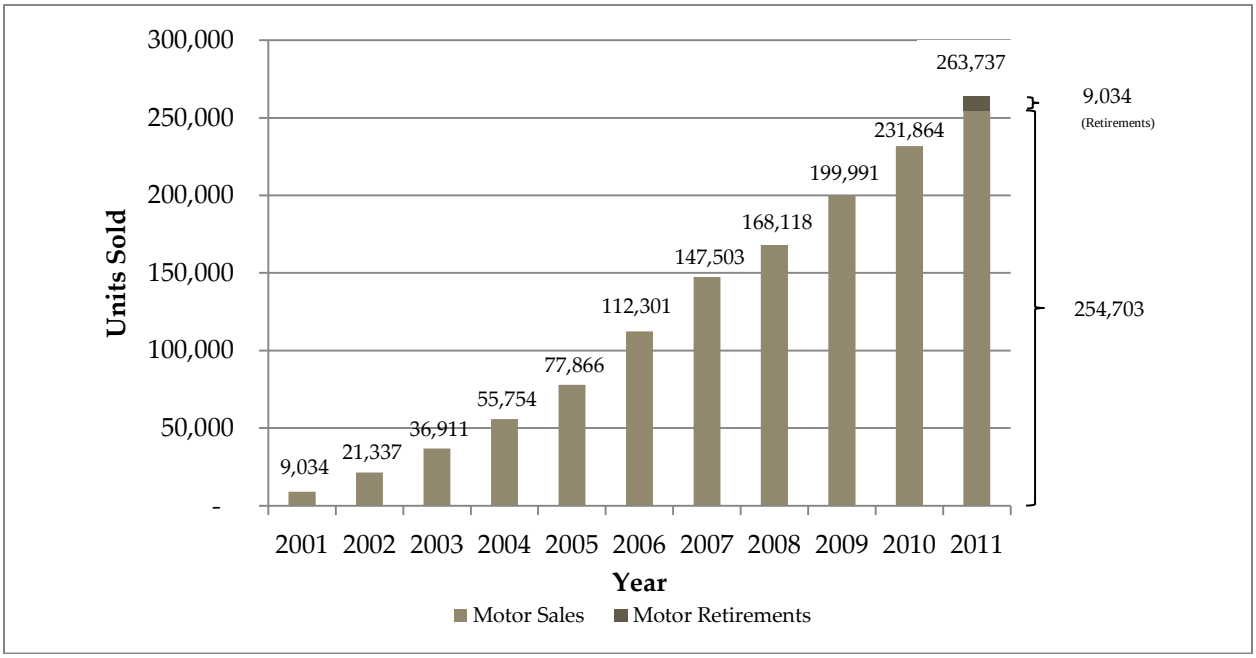
*Navigant projects values based on reported national shipment data from 2001 through 2008 and on regional data from 2004 through 2008. Navigant assumes that premium motor sales remain flat between 2009 and 2011.
Source: NEMA data and Navigant analysis.

For 2011, Navigant adjusted the total cumulative market activity to account for the first year of NEMA Premium™ motors entering retirement.[39] Navigant subtracted the 9,034 NEMA Premium™ motors sold in 2001 from the 2011 cumulative market activity total to arrive at the 2011 adjusted cumulative estimate of approximately 254,700 units.

Figure 4-3 shows the cumulative sales of NEMA Premium™ motors from 2001 to 2011, with motor retirements included.

[39] Navigant bases the cumulative baseline activity adjustment on an assumed motor lifetime of ten years. According to DOE (September 2005), motors last between 30,000 and 40,000 hours. This translates to approximately ten years based on motor usage of 3,500 hours per year.

Figure 4-3: Estimated Cumulative NEMA Premium™ Motor Sales in the Northwest, 2001–2011



Source: NEMA data and Navigant analysis.

BASELINE ACTIVITY

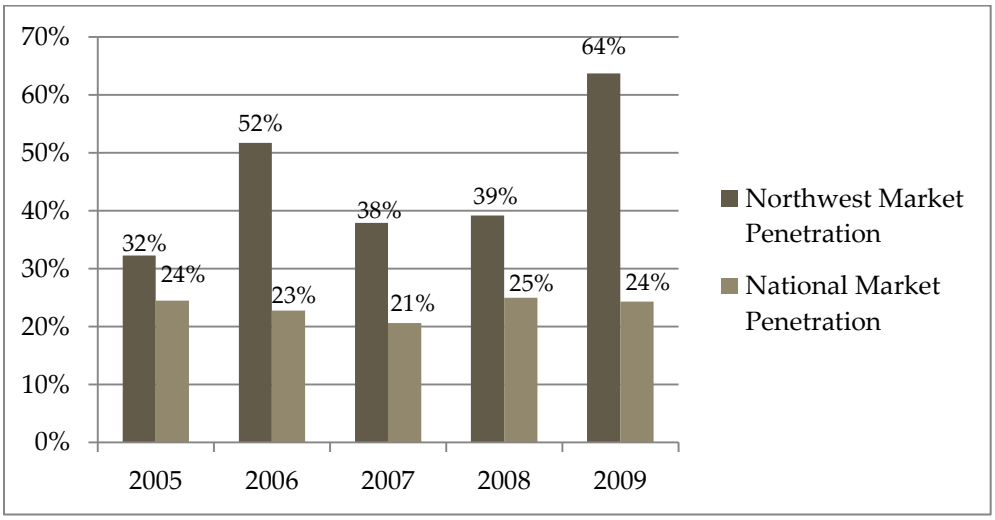
Baseline activity refers to sales of NEMA Premium™ motors that would have occurred in the absence of NEEA's Drive Power effort. As discussed in the 2007 LTMT report, a standard for efficient motors existed prior to NEMA; however, consumers often regarded this standard as unclear and confusing. This gave rise to the need for a new, easily recognizable specification. A summit held with NEEA, CEE, the U.S. Environmental Protection Agency (EPA), and various motor manufacturers in 1999 and 2000 led to the establishment of the NEMA Premium™ brand. NEMA Premium™ is an easily recognizable third-party brand that can provide credibility to an efficient motor product.

NEEA actively participated in all the decisions that led to the formation of the NEMA Premium™ brand; it also provided the working committee with some case studies. NEEA can claim some responsibility for the savings from the sale of NEMA Premium™ Motors, as NEEA was integrally involved in the formation of the NEMA Premium™ brand. Through other programs in which NEEA participated, such as one-on-one consumer outreach activities, the NEMA Premium™ brand awareness grew in the Northwest, leading to higher market penetration.

Past LTMT research indicated that NEEA's influence on the sale of NEMA Premium™ motors was minimal in 2001. Therefore, the 2001 baseline is the same as the estimated market activity of approximately 9,000 units. The analysis of baselines for 2002 through 2004 uses linear interpolation between the 2001 and 2005 values; *for 2005 through 2009, the baseline market share uses NEMA Premium™ motors' share of all motors shipped in the nation* as reported by

NEMA to the CEE. The national market share for NEMA Premium™ motors, shown in Figure 4-3, was 24 percent of *all motors sold* in 2005, dropping to 21 percent in 2007 and increasing to 25 percent in 2008. In 2009, the national market share fell slightly, down to 24 percent. For comparison, Figure 4-4 also presents NEMA Premium™ market shares for the Northwest. NEMA Premium™ market share for the Northwest rose significantly from 2008 to 2009, reaching an all-time high of 64 percent.

Figure 4-4: NEMA Premium™ Motor Sales as Share of All National and Regional Motor Sales



*Source: NEMA motor shipment data as reported by the CEE.

Based on the approach described above, the LTMT assessment calculated baseline sales of premium efficiency motors in the Northwest for 2005–2009 by multiplying each year's *national market share* (in percent) by the estimated *total motor sales* in the Northwest (see Market Activity, above). Navigant assumes that, for 2010 and 2011, the baseline value remains constant at the value calculated for 2009. (This assumption is consistent with the flat projection of sales of NEMA Premium™ motors, above.) This resulted in a 2011 baseline sales estimate of more than 12,000 motors and a cumulative baseline through 2011, before accounting for retirements, of nearly 150,000 units. Table 4-5 presents the estimated baseline sales of NEMA Premium™ motors in the Northwest from 2001 to 2011. For 2011, Navigant adjusted the total cumulative baseline activity to account for the first year of NEMA Premium™ motors entering retirement.[40] Navigant subtracted the 9,034 NEMA Premium™ motors sold in 2001 from the 2011 cumulative baseline activity total to arrive at the 2011 adjusted cumulative baseline estimate of approximately 139,500 units.

[40] Navigant bases the cumulative baseline activity adjustment on an assumed motor lifetime of ten years. According to DOE (September 2005), motors last between 30,000 and 40,000 hours. This translates to approximately ten years based on motor usage of 3,500 hours per year.

Table 4-5: Estimated Baseline Sales of NEMA Premium™ Motors in the Northwest, 2001–2011*

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total**
Northwest Regional Sales**					66,754	84,188	90,458	52,621	50,036			NA
National NEMA Premium™ Market Share		NA			24%	23%	21%	25%	24%	NA		NA
Baseline Motor Sales	9,034	10,971	12,908	14,845	16,782	15,165	19,128	13,140	12,173	12,173	12,173	139,457

*Navigant assumed all sales in 2001 to be part of the baseline. Complete regional shipment data (including non-premium motors) was not available until 2005; therefore, Navigant estimated baseline sales values for 2002–2004 based on linear interpolation between 2001 and 2005. For 2005–2009, Navigant estimated baseline sales by multiplying each year's *national market share* (in percent) by the estimated *total motor sales* in the Northwest. Navigant assumes that baseline sales remain constant in 2011 and 2010 at the 2009 level.

**For the 2011 LTMT, Navigant adjusted the total cumulative baseline activity to account for motor retirements. Using a ten-year motor lifetime assumption, cumulative baseline activity in 2011 equals the sum of all previous baseline motor sales (2001-2011) less motor sales from ten or more years prior (2001).

Source: CEE and 2011 Navigant analysis.

PER-UNIT ENERGY SAVINGS

Estimation of per-unit savings values uses the approach from the 2009 LTMT report but with the most recent motor shipment data (for calendar year 2009). A per-unit savings of 346 kWh per year results. To estimate the savings from replacing standard efficiency motors with NEMA Premium™ motors, Navigant compiled data for hours of operation and average efficiency[41] for Energy Policy Act (EPAct) and premium efficiency motors.[42]

Annual energy consumption for a motor is the product of the following factors:

1) Motor horsepower multiplied by the kW conversion factor of 0.746 kW/hp[43]
2) Annual run-time hours[44]
3) Motor loading factor[45]
4) The number 1 divided by motor efficiency[46]

The savings due to use of a more efficient NEMA Premium™ motor is then the difference in energy consumption between the old motor and the premium efficiency motor. Table 4-6 presents per-unit energy savings due to the use of premium efficiency motors in the Northwest. Navigant weighted savings for various motor size categories according to regional sales volumes from the most recent year of available data (2009). For purposes of calculating energy consumption, Navigant assigned a representative horsepower value to each size category. For this representative horsepower value, Navigant used the average horsepower rating among all NEMA Premium™ motor sizes sold in the Northwest in each size category.[47] This approach resulted in a single per-unit savings estimate of 346 kWh/year. The 2011 per-unit estimate (346 kWh per year) savings is significantly lower than the 2010 estimate (620 kWh per year) due to

[41] Hours of operation are available for six size ranges only, but motor efficiencies are available for each motor size that is commercially available. Energy savings calculations for motors in a given size range uses an average efficiency for available motors in that size range. This average efficiency is the average of the respective nominal efficiencies of different motor sizes.

[42] The source of the motor operation and efficiency data was a DOE report titled *"United States Industrial Electric Motor Systems Market Opportunities Assessment,"* December 2002. Also, see CEE, "CEE Premium Efficiency Motors Initiative – Efficiency Specifications," 2010.

[43] One kilowatt is equal to 0.746 horsepower. The factor converts motor power ratings (reported in hp) to kilowatts, the units commonly used by NEEA for measuring energy savings.

[44] Run-time hours vary for motors of different sizes. Navigant obtained these values from the Green Motors Practices Group's July 2007 submittal to the Northwest Power and Conservation Council's Regional Technical Forum.

[45] Motor loading factor is the percentage of total operation hours that a motor runs on full load. Navigant assumed that the motor loading factor was 0.68. Source: "Quality Motor Rewinding an Energy Efficiency Measure." See RTF submittal from previous footnote.

[46] For each motor size, Navigant averages the efficiency figures across the values for three revolutions per minute (RPM) levels as well as both open and drip-proof motors. Base efficiency assumptions were for efficiencies of federal standard (EPAct) efficiency motors. CEE publications are the source of NEMA Premium™ efficiencies.

[47] For example, available motor sizes in the 1 to 5 hp category include 1hp, 1.5hp, 2hp, 3hp, and 5 hp, for an average of 2.5 hp. By contrast, the 2008 M&T analysis assumed a simple average of the high and low values within the size category (i.e., the average of 1hp and 5 hp equals 3 hp). Source: DOE.

an increase in the sale of small motors (1 to 5 HP) by 150 percent. NEEA contacted NEMA™ regarding the drastic increase, and NEMA™ confirmed Navigant's finding.[48]

Navigant calculated total savings from sale of NEMA Premium™ motors from 2009 through 2011 by multiplying the per-unit savings value (346 kWh/year) to motor sales in those years. For each prior year where shipment data was available by horsepower (2005 through 2007), Navigant applied the per-unit savings calculated from that year's data. The analysis applied the per-unit savings value from 2005 to all previous years.

Table 4-6: Average Per-Unit Energy Savings and Regional Savings from NEMA Premium™ Motors in the Northwest, 2009

Size Category (HP)	Size of Average Motor (HP) (A)	Average Annual Hours of Operation (B)	Average EPAct Efficiency * (C)	Average NEMA Efficiency * (D)	Average Per-Unit Savings ** *kWh* (E)	Annual Sales in the Northwest *** (F)	Annual Savings in the Northwest *MWh* (E*F/1000)
1 to 5	2.5	2,745	84.2%	86.2%	99	17,854	1,768
6 to 20	13.1	3,391	89.8%	91.2%	408	3,768	1,537
21 to 50	36.3	4,067	91.9%	93.0%	1,012	1,480	1,498
51 to 100	78.3	5,329	93.4%	94.4%	2,259	689	1,556
101 to 200	143.8	5,200	94.4%	95.2%	3,281	319	1,047
201 to 500	350.5	6,132	94.4%	95.2%	9,435	80	755
Total		**N/A**	**N/A**	**N/A**	**346******	**24,190**	**8,161**

* Motor Efficiency data were available for different motor sizes (hp). Navigant calculated an average efficiency for a particular size range to estimate per-unit energy savings. Navigant assumed that all sizes had equal weight.
** Navigant calculated per-unit energy savings according to the following formula (using lettered column labels above): kWh savings = A*(0.746)*B*(0.68)*(1/C – 1/D).
*** CEE shipment reports for 2009 provide the annual NEMA Premium™ sales by motor size.
****This shows the weighted average of per-unit savings per size category and annual NEMA Premium™ sales per size category, in the Northwest.
Source: Navigant analysis and DOE. December 2002. *United States Industrial Electric Motor Systems Market Opportunities Assessment.* Table 1-15.

4.3.2 Energy Efficient Motor Rewinds

MARKET ACTIVITY

For the 2011 LTMT, Navigant based its estimate of energy efficient motor rewind market activity on (a) interviews with market actors close to the rewinds market, (b) current GMPG motor rewind data for 2009 to 2011, and (c) data from the 2009 Navigant survey. Navigant estimates that efficient motor rewind market activity grew by approximately 28 percent from

[48] November 14, 2011 NEEA email conversation with NEMA™.

2009 to 2010, and then fell by 15 percent in 2010, resulting in an overall growth of 16 percent since 2009[49].

As a part of the 2007 LTMT report, Navigant estimated that in 2001 less than 10 percent of motor service centers provided energy efficient rewinds. This situation has evolved over the past few years in part due to the formation of the Green Motors Practices Group (GMPG), through the support of the DPI, which encouraged the use of energy efficient rewinds. To better understand service center practices, Navigant conducted a more detailed survey of 18 service centers in the Northwest as part of the 2009 LTMT effort. Table 4-7 provides a summary of the 2009 Navigant survey results. Ten GMPG members and eight non-members reported a total of 1,831 motor rewinds. GMPG members reported that 82 percent of their rewinds met EASA Tech Note 16[50] specifications, compared to 5 percent of non-member rewinds.

Table 4-8 shows the survey data extrapolated for the Northwest's total motor service center industry (99 total service centers as of 2009). The table provides Navigant's 2009 LTMT estimate of 3,992 total energy efficient, Tech Note 16-compliant motor rewinds for the Northwest.

[49] The 2009 LTMT was the most recent effort that addressed energy efficient motor rewinds.
[50] In theory, 100% of GMPG rewinds should meet EASA Tech Note 16; however, as the GMPG noted in a 2011 interview, some motors can never be brought into compliance due to excessive core damage.

Table 4-7: Energy Efficient Rewinds Performed in the Northwest in 2009 (Survey Results)

	Total Rewinds Performed	# of EE Rewinds Performed		EE Rewinds as a Share of Total Rewinds	
		Self-Defined	EASA-Compliant	Self-Defined	EASA-Compliant
GMPG Members	1,054	894	861	85%	82%
Non-members	777	163	41	21%	5%
Total	1,831	1,057	903	58%	49%

Source: 2009 Navigant motor service center survey (n=10 for GMPG members; n=8 for non-members)

Table 4-8: Estimate of Energy Efficient Rewinds Performed in the Northwest in 2009

	EASA-Compliant Rewinds Performed **(Survey Respondents)**	Ratio of Population to Survey Respondents	EASA-Compliant Rewinds Performed **(Population)**
GMPG Members	861	4.3	3,704
Non-members	41	7	288
Total	903	4.4	3,992

Source: 2009 Navigant motor service center survey and GMPG

For the 2011 LTMT effort, Navigant interviewed market actors including GMPG and BPA to assess the results of the 2009 Navigant survey. In terms of *total* rewinds performed in the Northwest, Navigant asked whether the 2009 estimate of approximately 10,300 rewinds seemed reasonable for the region in 2011. Both market actors confirmed that this estimate is reasonable; BPA estimated that the market may have grown 5-10 percent, but agreed with Navigant's conservative estimate of a flat market from 2009 through 2011. BPA stated that industries closing have hurt the motor rewind industry in the last two years, but rising NEMA Premium™ motor prices have counter-acted this effect.

Navigant asked the GMPG and the BPA if the percent share of total rewinds done according to EASA-Tech Note 16 guidelines (efficient rewinds) from the 2009 survey (82 percent for GMPG members and 5 percent for GMPG non-members) seemed appropriate for the region in 2011 as well. Both agreed that the 2009 estimates were reasonable and still hold true in 2011. GMPG stated that, ideally, 100 percent of GMPG-member shop rewinds would comply with EASA-Tech Note 16 guidelines; however, some motor rewinds cannot meet EASA-Tech Note 16 rewind standards due to excessive existing core damage. GMPG and BPA estimated that among non-members, only about 5 percent – 10 percent of total rewinds are Tech Note 16-compliant. This is primarily due to lack of necessary equipment required to perform a Tech Note – 16 compliant rewinds.

Navigant also requested records of energy efficient rewinds performed in the Pacific Northwest from GPMG for all available years. Service centers that are members of the GMPG report Tech Note 16 compliant rewinds to their local utilities and to the GMPG. Table 4-9 provides motor rewind data reported to GMPG for 2009 through 2011, broken down by HP class. The number of reported rewinds increased by approximately 28 percent from 2009 to 2010, and then decreased by approximately 15 percent in 2011; overall, reported rewinds increase about 16 percent from 2009 to 2011. GMPG noted that their reported rewinds comply with a standard that is even more stringent than Tech Note 16. They accounted for the 2010 – 2011 decline to the departure of two service centers from the GMPG and stated that the number of Tech Note-16 compliant rewinds would otherwise have likely remained constant or grown during that time period.

Table 4-9: Motor Rewinds Reported to GMPG, 2009-2011

Size Category (HP)	2009	2010	2011
Less than 75	135	190	174
75 – 100	47	67	56
125 – 200	74	101	73
250 – 500	82	110	92
600 - 1000	10	11	10
1250 - 5000	9	13	9
Total Reported	**357**	**492**	**414**
Total Extrapolated*	**3,992**	**5,502**	**4,629**

* The GMPG-reported rewinds in 2009 (357) are 9 percent of total rewinds estimated by Navigant in that year (3,992), which is in agreement with GMPG's estimate of percentage of efficient rewinds reported by service centers. Navigant analysis assumes that trends in GMPG data reflect trends in overall regional market activity.
Source: GMPG motor rewind data and 2011 Navigant analysis.

GMPG estimates that service centers report about 10 percent of total Tech Note-16 compliant rewinds performed in the region. The GMPG-reported rewinds in 2009 (357) are 9 percent of total rewinds estimated by Navigant in that year (3,992), which is in agreement with GMPG's estimate of percentage of efficient rewinds reported by service centers. Navigant analysis assumes that trends in GMPG data reflect trends in overall regional market activity. Using the

GMPG data from Table 4-9 provides a market activity estimate of approximately 5,500 Tech Note 16-compliant rewinds in 2010 and 4,600 rewinds in 2011.

BASELINE ACTIVITY

Navigant defines baseline activity as the number of energy efficient rewinds that would occur without programs that NEEA influenced. For the 2011 LTMT, Navigant based its estimate of energy efficient motor rewind baseline activity on (a) interviews with market actors close to the rewinds market, and (b) data from the 2009 Navigant survey. Navigant found that its estimate of efficient motor rewind baseline activity in the 2009 LTMT (5 percent of market activity) remains unchanged for 2011.[51]

For the 2011 LTMT, Navigant interviewed program managers from GMPG and BPA, asking them what percentage of motor service centers would be providing Tech Note 16-compliant rewinds in 2012 if the region had not funded the DPI. The GMPG estimated that "less than 10 percent" would be performing such rewinds, commenting that before the DPI, they knew of only two or three service centers in the Northwest providing energy efficient rewinds. In their opinion, the share of service centers offering Tech Note 16 rewinds would *not* have increased naturally over time without NEEA influence. The BPA indicated that baseline activity of energy efficient rewinds would likely be 5-10 percent of motor service centers if the region had not funded the DPI, 5 percent if the standard of baseline activity was strictly Tech Note 16-compliant, and 10 percent if the standard included shops completing the vast majority of Tech Note 16 protocols. The BPA also noted that some organizations, such as the US Navy, have always required strict rewind procedures; however, before NEEA intervention and the DPI, motor service centers performed rewinds more for the purpose of longer lifetimes and higher reliability than energy efficiency.

According to the BPA, the share of service centers offering Tech Note 16 rewinds would *not* have increased to date naturally over time without NEEA influence; however, they noted that the economics of energy efficient rewinds might become more attractive for a greater number of customers in the future. They cited rising prices of new motors due to increases in raw material costs (mainly copper and steel) as a possible driver of increased rewind adoption.

In previous LTMT efforts, Navigant has estimated baseline activity at 5 percent of market activity[52]. Based on the current data available, including the primary survey data collected in 2009 and the market actor interviews conducted in 2011, Navigant finds it is unlikely that many

[51] Navigant surveys conducted in 2009 with 18 motor service centers assessed the familiarity of service centers with the DPI and the influence of the DPI on the availability of EASA Tech Note 16-compliant rewinds in the market. Familiarity with the DPI was high among survey respondents, with 15 of 18 being at least "somewhat" familiar with the initiative, including seven of the eight service centers that were not GMPG members. Nearly 40 percent of respondents believed that the number of efficient rewinds performed currently would be lower without the DPI, and only three believed that the number would be the same. Survey respondents cited *increased availability of information* and *awareness of efficient rewinds* as reasons for the influence of the initiative on the market.

[52] GMPG stated that before they formally started their efforts, only less than 10% of service centers had the means and the know-how to perform an efficient rewind, and the 2007 M&T report estimated the rewind baseline at less than 5% of all energy efficient rewinds performed.

EASA Tech Note 16-compliant rewinds would be occurring in the Northwest in absence of the DPI. As such, Navigant suggests that NEEA continue to use a 5 percent baseline (of market activity), which translates to 275 rewinds in 2010 and 231 rewinds in 2011.

PER-UNIT ENERGY SAVINGS

Navigant calculates energy savings for energy efficient rewinds in a similar manner to savings from use of NEMA Premium™ motors. The only difference is, rather than comparing efficiencies of standard versus NEMA Premium™ motors, the calculation compares efficiencies of *standard* versus *energy efficient* (Tech Note 16-compliant) *rewinds*. Based on the relative efficiencies presented by the GMPG, per-unit savings from efficient rewinds of motors of various sizes are calculated and presented in Table 4-10.

Table 4-10: Average Annual Per-Unit Energy Savings from Efficient Motor Rewinds

HP	Average Annual Savings (kWh)	HP	Average Annual Savings (kWh)	HP	Average Annual Savings (kWh)
1	16	25	573	200	2,809
1.5	25	30	621	250	4,136
2	33	40	732	300	4,952
3	48	50	796	350	5,732
5	80	60	1,046	400	6,542
7.5	146	***75***	***1,097***	450	7,349
10	196	100	1,456	500	8,165
15	291	125	1,771	1,000*	16,210
20	385	150	2,116	5,000*	81,098

* Extrapolated by Navigant based on GMPG data.
Source: Green Motors Practices Group (GMPG), 2007. "Quality Motor Rewinding an Energy Efficiency Measure."

The average size of motors receiving efficient rewinds is not known with certainty, but can be estimated from available data and interviews conducted for the LTMT analysis. In 2009, the GMPG indicated that motors larger than 75 HP are typically rewound, whereas motors smaller than 75 HP are typically replaced by new motors. In addition, GMPG members reported 357 rewinds in 2009 representing 71,390 HP, or 200HP per motor. Thus, a reasonable estimate for the size of a typical motor receiving an energy efficient rewind is in the range of 75 - 200 HP. The 2009 LTMT used the low-end estimate of 75 HP, which corresponded to annual savings of 1,097 kWh per motor (Table 4-10).

For the 2011 LTMT, Navigant relied on two sources of information to estimate average per-unit energy savings: GMPG rewind data from 2009 to 2011, and interviews with GMPG and BPA. Table 4-11 shows the number of rewinds, total HP of rewinds, and average HP per rewind reported to the GMPG for 2009 to 2011. The data shows that the average HP per motor rewound in 2010 and 2011 increased from the 2009 level. GMPG noted, however, that the increase in average HP has been caused primarily by an increased number of very large (2500 – 5000HP) rewinds (Table 4-12). As Figure 4-5 shows, the vast majority (73 percent) of rewinds reported to GMPG are 200HP or less. Forty percent of all rewinds reported are 75HP or less. The increase in very large motors, according to GMPG, is not a trend but a unique occurrence in 2011 as shown in Table 4-12.

Table 4-11: Motor Rewinds Reported to the GMPG, 2009-2011

	2009	2010	2011
Total Rewinds Reported	357	492	414
Total HP of Reported Rewinds	71,390	112,325	97,465
Average HP per Rewind*	200	228	235

*Average HP per rewind is equal to total HP of reported rewinds divided by total rewinds reported.

Source: GMPG motor rewind data.

In the 2011 interview, the GMPG estimated that the most prevalent motor group to receive a Tech Note 16-compliant rewind is in the range of 75 to 200 HP. BPA agreed that 75 to 200 HP has been the most prevalent group to receive a rewind in the past, but noted that the range may be shifting downward toward 50 – 200HP. As evidence, BPA suggested that rising raw material costs (mainly copper and steel) and the recent NEMA Premium™ motor standard have caused new motor prices to increase, thereby improving the cost effectiveness of motor rewinds. PacifiCorp reported that their incentivized energy efficient rewinds have ranged from 40 to 400 HP, with an average of about 200HP. They noted, however, that only two of these rewinds were from states in NEEA territory.[53]

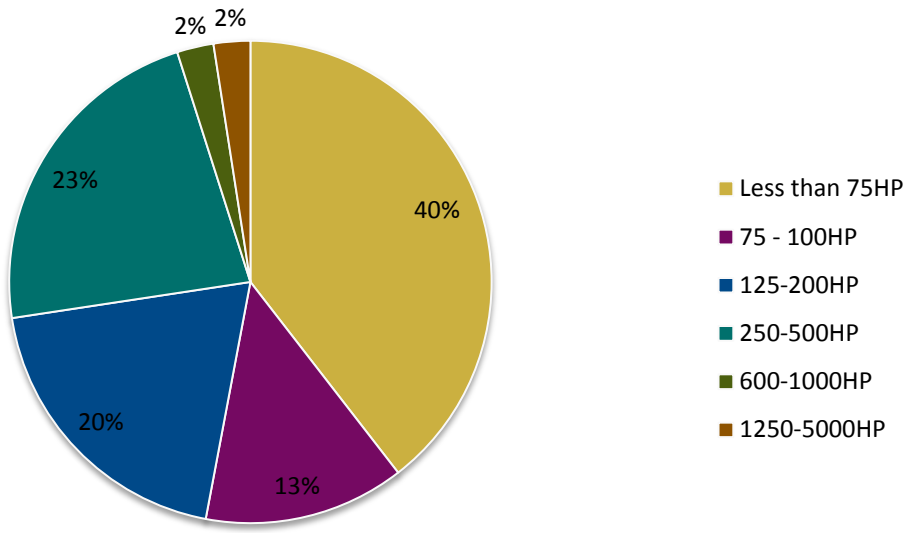
[53] Navigant phone interview with PacifiCorp management, 2011.

Table 4-12: Motor Rewinds Reported to the GMPG, by HP, 2009 to 2011

HP Class	2009	2010	2011
Less than 75HP	135	190	174
75 - 100HP	47	67	56
125 - 200HP	74	101	73
250 - 500HP	82	110	92
600 - 1000HP	10	11	10
1250 - 5000HP	9	13	9

Source: GMPG motor rewind data.

Figure 4-5: Distribution of Motor Rewinds Reported to GMPG, by HP Class (2009 – 2011)



Source: GMPG motor rewind data. Chart shows percent distribution of motor size for 1,263 total rewinds.

Based on all previous DPI LTMT research and the most current 2011 data collection, Navigant considers its estimate of 75 HP as a representative average motor size for energy efficient rewinds to be conservative and recommends using that size to calculate energy savings from efficient rewinds. This results in a per-unit savings estimate of 1,097 kWh.

4.4 Conclusions and Recommendations

NEEA initiatives focusing on motors have led to a significant market transformation in the Northwest, as evidenced by the following:

- Sales of NEMA Premium™ motors in the Northwest grew significantly through 2006 and continued to increase in 2007, while national sales appeared to rise linearly through 2006 and decline starting in 2007.
- In 2009, sales of NEMA Premium™ motors in the Northwest continued to outpace national sales. While NEMA Premium™ motor sales fell 16 percent nationally from 2008 to 2009; NEMA Premium™ motor sales increased nearly 55 percent in the Northwest, from 15,646 motors in 2008 to 24,190 motors in 2009.
- NEMA Premium™ motor market share grew from 39 percent of all non-OEM sales in the Northwest in 2008 to 64 percent of these sales in 2009, an all-time high. At the same time, national market share fell from 25 percent in 2008 to 24 percent in 2009.
- The number of energy efficient motor rewinds reported to GMPG increased about 16 percent from 2009 to 2011, and the total HP rewound rose 37 percent during the same time.[54]

Table 4-13 and Table 4-14 summarize recommendations for the values of key indicators for both premium motor sales and energy efficient rewinds. Navigant estimates that NEMA Premium™ motor sales in the Northwest in 2011 exceeded 31,000 units, bringing cumulative sales since 2001 to more than 250,000 units. Navigant estimates baseline sales at approximately 12,200 units in 2011, or about 38 percent of the total market activity. With an annual per-unit savings of 346 kWh, the incremental energy savings implied by these figures is 0.8 aMW in 2011, for a cumulative total of 5.3 aMW.

[54] Based on 71,390 total HP rewound in 2009 and 97,465 total HP rewound in 2011.

Table 4-13: Recommendations for Key Indicators—NEMA Premium™ Motor Sales

Key Indicators Reviewed	2011 Incremental (Due to new activity occurring in 2011)	2011 Cumulative (Calendar year 2011 values due to all activity since program inception)	Source
Current Market Activity			
NEMA Premium™ motors sold in the Northwest	31,873	254,703	Section 4.3.1 (Market Activity)
Current Baseline Activity			
NEMA Premium™ motors sold in the Northwest	12,173	139,457	Section 4.3.1 (Baseline Activity)
Per-Unit Energy Savings			
Annual energy savings per motor (kWh/motor per year)	346	399	Section 4.3.1 (Per-unit Energy Savings)
Implied Energy Savings*			
Implied Energy Savings (aMW)	0.8	5.3	Market activity minus baseline activity, times per-unit savings, divided by 8,760 hours, divided by 1000
Total, including energy efficient rewinds (aMW)	1.4	7.0	

* Implied Energy Savings represent estimated savings from market activity less estimated savings from baseline activity. NEEA's reported values might not match those presented here, because NEEA adjusts for the effect of utility incentives and other factors not taken into account in this LTMT analysis.

**For this and the following table, Navigant rounded the individual energy savings for NEMA Premium™ motor sales (5.3 aMW) and energy efficient rewinds (1.8 aMW) to one decimal place. This accounts for the difference between the implied total savings of the two programs (7.1 aMW) and the actual calculated total savings (7.0 aMW) provided here.

Source: Navigant analysis 2011.

For energy efficient rewinds, Navigant estimates that service centers performed nearly 4,700 EASA Tech Note 16-compliant energy efficient rewinds in 2011, with a baseline of 5 percent of market activity. The per-unit savings of 1,097 kWh per years implies that energy savings attributable to NEEA were 0.6 aMW in 2011,[55] for a cumulative total of 1.8 aMW.

[55] As noted above, the GMPG provided the LTMT team with data on energy efficient rewinds reported to them by their members. According to the GMPG, the 342 efficient rewinds represented roughly 66,000 horsepower and accounted for approximately 0.14 aMW of savings. GMPG recognized that these reported rewinds represented only a fraction of efficient rewinds performed in the market. Findings from the M&T analysis suggest that less than 10% of efficient rewinds are reported, but that these include many of the largest rewinds that generate the most savings. In total, roughly 30% of the estimated savings are accounted for by rewinds reported to the GMPG.

Navigant estimates total incremental savings in 2011 from *both* NEMA Premium™ sales and efficient rewinds at 1.4 aMW, and a cumulative total savings from both DPI programs of 7.0 aMW.

Table 4-14: Recommendations for Key Indicators – Energy Efficient Rewinds

Key Indicators Reviewed	2011 Incremental (Due to new activity occurring in 2010)	2011 Cumulative (Calendar year 2011 values due to all activity since program inception)	Source
Current Market Activity			
EASA Tech Note 16-compliant rewinds performed in the Northwest	4,629	14,123	Section 4.3.2 (Market Activity)
Current Baseline Activity			
EASA Tech Note 16-compliant rewinds performed in the Northwest	5% of market activity (231 motors)	5% of market activity (706 motors)	Section 4.3.2 (Baseline Activity)
Per-Unit Energy Savings			
Annual energy savings per motor (kWh/motor per year)	1,097	1,097	Section 4.3.2 (Per-Unit Energy Savings)
Implied Energy Savings*			
Implied Energy Savings (aMW)	0.6	1.8	Market activity minus baseline activity, times per-unit savings, divided by 8,760 hours, divided by 1000
Total, including NEMA Premium™ motor sales (aMW)**	1.4	7.0	

* Implied Energy Savings represent estimated savings from market activity less estimated savings from baseline activity. NEEA's reported values might not match those presented here, because NEEA adjusts for the effect of utility incentives and other factors not taken into account in this LTMT analysis.

**For this and the previous table, Navigant rounded the individual energy savings for NEMA Premium™ motor sales (5.3 aMW) and energy efficient rewinds (1.8 aMW) to one decimal place. This accounts for the difference between the implied total savings of the two programs (7.1 aMW) and the actual calculated total savings (7.0 aMW) provided here.

Source: Navigant analysis 2011

Future LTMT efforts should continue tracking of new premium efficiency motor sales and attempt to better quantify the rewind market and associated savings. Specifically, Navigant recommends the following steps for future LTMT efforts:

- **Consider how to address savings from NEMA Premium™ motor sales in the Northwest moving forward.** Since NEMA motor shipment data is from two years prior to the release date, the next data released by NEMA will be 2010. This is the first year in which NEMA Premium™ motors represent the federal standard. For the next LTMT, Navigant recommends looking at the availability of non-NEMA Premium™ motors to assess whether new premium motor sales should contribute to regional savings estimates.
- **Continue to collect GMPG motor rewind data and any other rewind data which could improve total regional extrapolation.** GMPG motor rewind data, in conjunction with primary survey data from the 2009 Navigant LTMT, serves as the only metric to estimate total energy efficient rewinds in the Northwest region. While Navigant considers the current methodology to be the best available, NEEA should continue to understand how closely GMPG rewind activity represents the regional market. Navigant recommends that NEEA continue to conduct market actor interviews (and follow-up surveys of motor service centers) to remain up-to-date in quantifying baselines and energy efficient rewind practices in the region.
- **Consider regional forces which may impact future motor rewind savings**. According to the BPA, the Regional Technical Forum's (RTF) deemed savings for efficient motor rewinds is currently out of compliance, which could affect future uptake of efficient motor rewinds in the Northwest. Navigant recommends researching the RTF rewind measure and its impact on rewind adoption in the region.

4.5 Bibliography

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5 ENERGY STAR Residential Windows

The Northwest Energy Efficiency Alliance funded the ENERGY STAR Residential Windows initiative from February 1998 to June 2001. The key market actors targeted by the initiative included, among others, window manufacturers, regional utilities, builders, retailers, and wholesalers. The initiative intended to increase the market penetration for high-efficiency fenestration products in the residential market and to decrease at least two market barriers—lack of awareness and initial cost premiums.

The focus of the LTMT efforts to assess the ENERGY STAR windows initiative has evolved over the years. The early efforts focused on estimating the size of the market, determining the market penetration of ENERGY STAR windows in the Northwest, and estimating the expected energy savings due to reductions in the use of HVAC equipment caused by windows that are more efficient. More recent efforts involved updating both the national and regional data using market reports published by the Window and Door Manufacturers Association (WDMA) and the American Architectural Manufacturers Association (AAMA).

The primary improvement for the 2011 LTMT effort has been to update the national market penetration figures using the latest comprehensive statistical analysis of the windows and doors report published by the WDMA/AAMA. Reports published by the WDMA/AAMA in odd years include nationally aggregated data, whereas reports published in even years have detailed regional data along with national market penetrations of ENERGY STAR windows. The latest report, published in March 2011, provides aggregated data at a national level putting this year's LTMT assessment in an "off track" year due to the lack regional data and market penetration. The 2011 LTMT analysis utilized this supplemental report to update national sales figures.

5.1 Assumptions and Indicators for Review

The energy savings impact analysis of the ENERGY STAR windows initiative is broadly based on the market penetration and baseline of ENERGY STAR windows, as measured by the energy savings per unit of installed window area. The energy savings further depend on home type and vintage and the types of heating and cooling systems in the home. At a high level, Navigant calculates incremental energy savings for a given calendar year as follows:

Energy Savings =

(1) Windows shipped in the Northwest
x (2) Average area per window
x (3) Market penetration of ENERGY STAR windows
x (4) Market penetration of heating and cooling system types
x (5) Savings per unit of window area (stratified by heating and cooling types)

where

1. **Windows shipped in the Northwest** is the number of windows shipped by manufacturers in the Northwest each year based on data found in market research studies published by Ducker Research Company and the WDMA/AAMA.

2. **Average area per window** is the number of square feet for an average product, which varies by window type (e.g., windows, doors, and skylights).

3. **Market penetration of ENERGY STAR windows** is the percentage of residential windows shipped in the region that are ENERGY STAR.

4. **Market penetration of heating and cooling system types** comes from data supplied by the Northwest Power and Conservation Council (NW Council). The appropriate market penetration value used in the savings calculation depends on home type, home vintage, and the type of savings being calculated (e.g., electric or gas, heating or cooling).

5. **Savings per unit of window area** is the annual energy savings due to reduced HVAC energy consumption per unit of window area. Navigant uses values taken directly from analysis conducted by the NW Council; savings vary based on home type, vintage, fuel type, and the HVAC system component demonstrating reduced energy usage. The LTMT analysis includes:

    - Electricity savings due to reduced electric-heating usage
    - Electricity savings due to reduced central air conditioner usage
    - Gas savings due to reduced gas-heating usage
    - Electricity savings due to reduced gas furnace-fan operation

5.2 Methodology

The 2011 LTMT effort for the ENERGY STAR Windows initiative provides an update to the market activity and baseline for ENERGY STAR residential windows. Specifically, Navigant conducted the following data collection and analysis activities.

1. **Purchased the 2010-2011 WDMA/AAMA U.S. Industry Statistical Review & Forecast.** This supplemental report contains annual updates and projections for windows, doors, and skylight at a national level.
2. **Updated estimates.** Updated market penetration and baseline estimates using the approach applied in the 2007 LTMT assessment.
3. **Calculated savings.** Applied the per-unit savings to the updated market penetration and baseline estimates to calculate the implied energy savings related to NEEA's involvement in this market.

5.3 Findings

Navigant focused on validating assumptions inputs to the ACE model, NEEA's tool for tracking energy savings associated with this initiative. The information and data collected created a

framework for understanding the current state of the market for ENERGY STAR windows and trends in that market; Section 5.3.1 discusses this "market activity." Establishing the role of the NEEA initiative in the evolution of the market requires understanding the scenario that would have ensued in the absence of the initiative; section 5.3.2 discusses this "baseline activity." Establishing the energy savings associated with each square foot of ENERGY STAR windows sold provides the final input needed to calculate the energy savings associated with NEEA's initiative; section 5.3.3 includes this discussion on "per-unit energy savings."

5.3.1 Market Activity

Navigant estimated the number and total area of windows shipped in the Northwest from 2001 to 2011, the market penetration of ENERGY STAR windows, and the penetration of different HVAC systems, including electric space heating, gas space heating, and central air conditioning.

WINDOWS SHIPPED IN THE NORTHWEST

The analysis of ENERGY STAR windows market activity has used window shipments as a proxy for sales since the first LTMT assessment of NEEA's ENERGY STAR windows initiative in 2004. Navigant uses market research reports published by Ducker Research Company and the WDMA/AAMA to document the number of windows shipped in the Northwest from 2001 to 2011. Ducker publishes complete reports with data disaggregated by region once every two years and summary reports with data aggregated at the national level for the in-between years. As a part of this year's evaluation efforts, NEEA purchased the supplemental report that updated only national data. The project team utilized the national data to establish a nationwide growth rate for windows, skylights, and patio doors. Navigant applied these growth rates to the regional data found during the 2010 LTMT efforts to aggregate the number of windows shipped to the Northwest.

For the 2010 LTMT Navigant utilized the regional data which only included a portion of the Pacific Northwest by covering solely Washington and Oregon as part of the Northwest region; Idaho and Montana are part of the Mountain region, which includes eight other states. The Northwest region's data is a starting point for assessing market activity in Idaho and Montana because the states in the Mountain region represent a much more diverse group of consumers than the Northwest. Navigant uses population data from the U.S. Census Bureau for Washington, Oregon, Idaho, and Montana to determine a population ratio between the states included in the Pacific Northwest. The population ratio is a proxy applied to the regional shipment data for Washington and Oregon that estimates the market size and the number of windows shipped to Idaho and Montana.

Table 5-1 shows the number of fenestration products shipped in the Northwest from 2008–2011. Navigant finds that the gross window shipments steadily declined from 2005-2009, but the WDMA/AAMA reports an increase in 2010 and forecasts the same for 2011. A more detailed table that shows window shipments starting from 2001-2011 is located in Appendix D.

Table 5-1: Fenestration Products Shipped in the Northwest from 2008-2011 (Thousands)

Year	New Construction			Existing Homes		
	Windows	*Skylights*	*Patio Doors*	*Windows*	*Skylights*	*Patio Doors*
2008	770	23	54	1,024	26	76
2009	729	18	59	1,050	21	68
2010	782	24	64	1,126	27	73
2011	805	25	66	1,159	28	76

Note: Ducker's report of actual market activity informs the data presented for 2008–2010; Ducker's forecast for 2011 informs data for that year.
Source: Navigant analysis of Ducker Research and WDMA/AAMA market reports 2009, 2010 and 2011.

The average area per window varies by window type established as a part of the 2007 LTMT effort:

- Windows – 16 square feet per unit shipped
- Skylights – 6 square feet per unit shipped
- Patio Doors – 40 square feet per unit shipped

Table 5-2 shows the total area of windows shipped in the Northwest from 2008 to 2011. A more detailed table with data starting from 2001 is located in Appendix D.

Table 5-2: Total Area of Windows Shipped in the Northwest from 2008–2011 (Thousand ft^2)

	New Construction	Existing Homes	Total
2008	14,624	19,582	34,206
2009	14,147	19,648	33,795
2010	15,213	21,117	36,330
2011	15,659	21,736	37,395

Note: (1) Ducker's report of actual market activity informs the data presented for 2008–2010; Ducker's forecast for 2011 informs data for that year.

(2) Reported numbers may not reflect the exact values listed in previous tables due to rounding.

Source: Navigant analysis of data in Table 1-2 and assumptions regarding average area per window.

MARKET PENETRATION OF ENERGY STAR WINDOWS

Based on research conducted for the 2007 LTMT effort, Navigant found that the ENERGY STAR market penetration for windows continued to grow after NEEA ceased funding. By 2007, the market penetration had risen to 95 percent. This growth proceeded as follows:

- Market penetration of ENERGY STAR in windows shipments had grown from just 13 percent in 1997 to 57 percent by the end of 2000, and to 66 percent by the second quarter of 2001[56].
- In the research conducted for the 2004 LTMT effort, Navigant found that ENERGY STAR market penetration continued to grow after NEEA ceased funding. By 2004, it had risen to 89 percent.
- By the end of 2007, market penetration for ENERGY STAR windows had increased to approximately 95 percent[57].
- In 2008, NEEA shared with ENERGY STAR the findings from the 2007 LTMT report, which showed that the penetration of ENERGY STAR windows in the Northwest was nearing 100 percent.

NEEA urged ENERGY STAR to revise the qualification for windows from a U-Factor of 0.35 Btu/h. ft^2 ºF to a U-Factor of 0.30 Btu/h. ft^2 ºF. As of January 4, 2010, ENERGY STAR revised the qualification for windows accordingly.

For determining market penetration, the 2011 LTMT effort originally focused on researching the potential savings that could be attributable to NEEA's windows initiative. However, due to the lack of information available for market penetration of the new standards, NEEA chose not to claim savings resulting from the specification change. This specification change may lower the market penetration of ENERGY STAR windows overall, and therefore may reduce the savings that NEEA would otherwise have been able to attribute to its efforts. In any case, this LTMT report identifies only the savings for windows with a U-Factor of 0.35.

Navigant proposes that the market penetration of residential windows for which NEEA counts savings stay constant at 95 percent. Market penetration of ENERGY STAR windows has already reached a very high level. In the absence of a detailed market penetration study, it is reasonable

[56] Navigant based its estimates on interviews with window manufacturers, retailers, wholesalers, distributors, and builders. For more details see the 2004 LTMT report for more details. Summit Blue Consulting, LLC. *NW Alliance Residential ENERGY STAR Windows Program – Draft M&T Findings.* March 11, 2005. Prepared for the Northwest Energy Efficiency Alliance.

[57] As a part of the 2007 effort, Navigant updated and confirmed the high level of market penetration through informal discussions with a group of reginal manufacturers. For more details see the 2007 LTMT report for more details. Summit Blue Consulting, LLC. *NEEA 2007 Long Term M&T Final Repport.* May 28, 2008. Prepared for the Northwest Energy Efficiency Alliance.

to assume that the market penetration stays at 95 percent. This recommendation is consistent with the current inputs in the ACE model for the ENERGY STAR residential windows initiative.

Table 5-3 shows the market penetration of ENERGY STAR windows as a percentage of all windows shipped and as total window area from 2008 through 2011. A detailed table with data from 1997 through 2011 is located in Appendix D.

Table 5-3: Market Penetration of ENERGY STAR Windows Shipped in the Northwest from 2008-2011

	ENERGY STAR Market Penetration (%)	New Construction (ft^2 x 1,000)	Existing Homes (ft^2 x 1,000)	Total (ft^2 x 1,000)
2008	95%	13,892	18,603	32,496
2009	95%	13,440	18,665	32,105
2010	95%	14,452	20,061	34,513
2011	95%	14,876	20,649	35,525

Note: Ducker's report of actual market activity informs the data presented for 2008-2010; Ducker's forecast for 2011 informs data for that year.
Source: Navigant analysis of interview data applied to gross window areas from
.

Market Penetration of Heating and Cooling System Types

All of the assumptions regarding the market penetration of heating and cooling system types come directly from data supplied by the NW Council. The 2007 LTMT effort validated these estimates and detailed the approach to calculating them; the 2007 LTMT report provides additional details. The NW Council updated these estimates for the Sixth Power Plan, and the LTMT for 2011 reflects those updated values. Table 5-4 shows the breakout of heating system fuel and home type by vintage.

Table 5-4: Market Penetration of Heating Fuel and Home Type by Vintage

Heating Fuel	Home Type	New Construction	Existing Homes
Electric Heat	Single Family	9%	30%
	Multi-Family	15%	13%
	Manufactured	7%	9%
Gas Heat	Single Family	60%	36%
	Multi-Family	7%	2%
	Manufactured	1%	1%
All Other Heating	All Home Types	1%	10%
Total		**100%**	**100%**

Note: Reported numbers may not sum correctly due to rounding.
Source: Navigant analysis of NW Council's Conservation Supply Curves[58] updated December 4, 2009.

Table 5-5 shows the presence of central air conditioning in the Northwest by home type and vintage. According to the data from the NW Council, new homes are just as likely to have central air conditioning as existing homes.

Table 5-5: Market Penetration of Central Air Conditioning by Home Type and Vintage

Home Type	New Construction	Existing Homes
Single Family	40%	38%
Multi-Family	5%	8%
Manufactured	5%	5%
Total	**49%**	**51%**

Note: Reported numbers may not reflect the exact values listed in previous tables due to rounding.
Source: Navigant analysis of NW Council's Conservation Supply Curves updated December 4, 2009.

Navigant applied the percentages from Table 5-4 to the window area shipment data as presented in Table 5-3 to get the area of ENERGY STAR windows shipped to homes with electric and gas heat for 2011. Table 5-6 shows the ENERGY STAR window area for homes with electric heat, while Table 5-7 shows the ENERGY STAR window area for homes with gas heat.[59] This same

[58] NW Council, *Residential Supply Curve Housing and Appliance Units*, available at http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm

[59] This analysis assumes that window shipments are in the same proportion as the market share percentages of heating and cooling system types by home type and vintage. In reality, this assumed relationship between shipments and residential building stock may not be exactly proportional. Although Navigant finds this to be a reasonable assumption for this analysis, it may be prudent to explore this further in future efforts.

method applies for homes with central air conditioning; Table 5-8 summarizes the results.[60] These tables present data from 2008 through 2011. Appendix D includes detailed tables.

Table 5-6: Area of ENERGY STAR Windows Shipped to Homes with Electric Space Heating from 2008–2011 (Thousand ft^2)

Year	New Construction			Existing Homes		
	Single Family	Multi-Family	Manufactured	Single Family	Multi-Family	Manufactured
2008	1,270	2,096	1,260	4,663	2,228	1,229
2009	1,229	2,027	1,219	4,678	2,235	1,233
2010	1,341	2,124	968	5,978	2,604	1,774
2011	1,381	2,186	997	6,153	2,680	1,826

Note: (1) Ducker's report of actual market activity informs the data presented for 2008–2010; Ducker's forecast for 2011 informs data for that year.
(2) Reported numbers may not reflect the exact values listed in previous tables due to rounding.
Source: Navigant analysis of Ducker Research market reports (2004, 2007, 2009, 2010, and 2011) and data from the NW Council received March 24, 2011.

Table 5-7: Area of ENERGY STAR Windows Shipped to Homes with Gas Space Heating from 2008–2011 (Thousand ft^2)

Year	New Construction			Existing Homes		
	Single Family	Multi-Family	Manufactured	Single Family	Multi-Family	Manufactured
2008	7,451	1,412	210	7,630	271	132
2009	7,208	1,366	203	7,655	272	132
2010	8,719	1,013	161	7,179	317	190
2011	8,975	1,043	166	7,390	326	196

Note: (1) Ducker's report of actual market activity informs the data presented for 2008–2010; Ducker's forecast for 2011 informs data for that year.
(2) Reported numbers may not reflect the exact values listed in previous tables due to rounding.
Source: Navigant analysis of Ducker Research market reports (2004, 2007, 2009, 2010, and 2011) and data from the NW Council received March 24, 2011.

[60] The window area values presented in the heating and cooling end-use tables are not additive to the values in previous tables because a) not all heating end-uses are represented in the heating end-use tables, and b) the values in the previous tables are actually a subset of the heating end-use tables; some window shipments that affect heating consumption also affect air-conditioning consumption.

Table 5-8: Area of ENERGY STAR Windows Shipped to Homes with Central Air Conditioning from 2008–2011 (Thousand ft^2)

Year	New Construction			Existing Homes		
	Single Family	Multi-Family	Manufactured	Single Family	Multi-Family	Manufactured
2008	3,700	932	625	3,195	301	365
2009	3,579	902	605	3,205	302	366
2010	5,794	655	657	7,541	1,601	1,095
2011	5,964	674	676	7,762	1,648	1,127

Note: (1) Ducker's report of actual market activity informs the data presented for 2008–2010; Ducker's forecast for 2011 informs data for that year.
(2) Reported numbers may not reflect the exact values listed in previous tables due to rounding.
Source: Navigant analysis of Ducker Research market reports (2004, 2007, 2009, 2010, and 2011) and data from the NW Council received March 24, 2011.

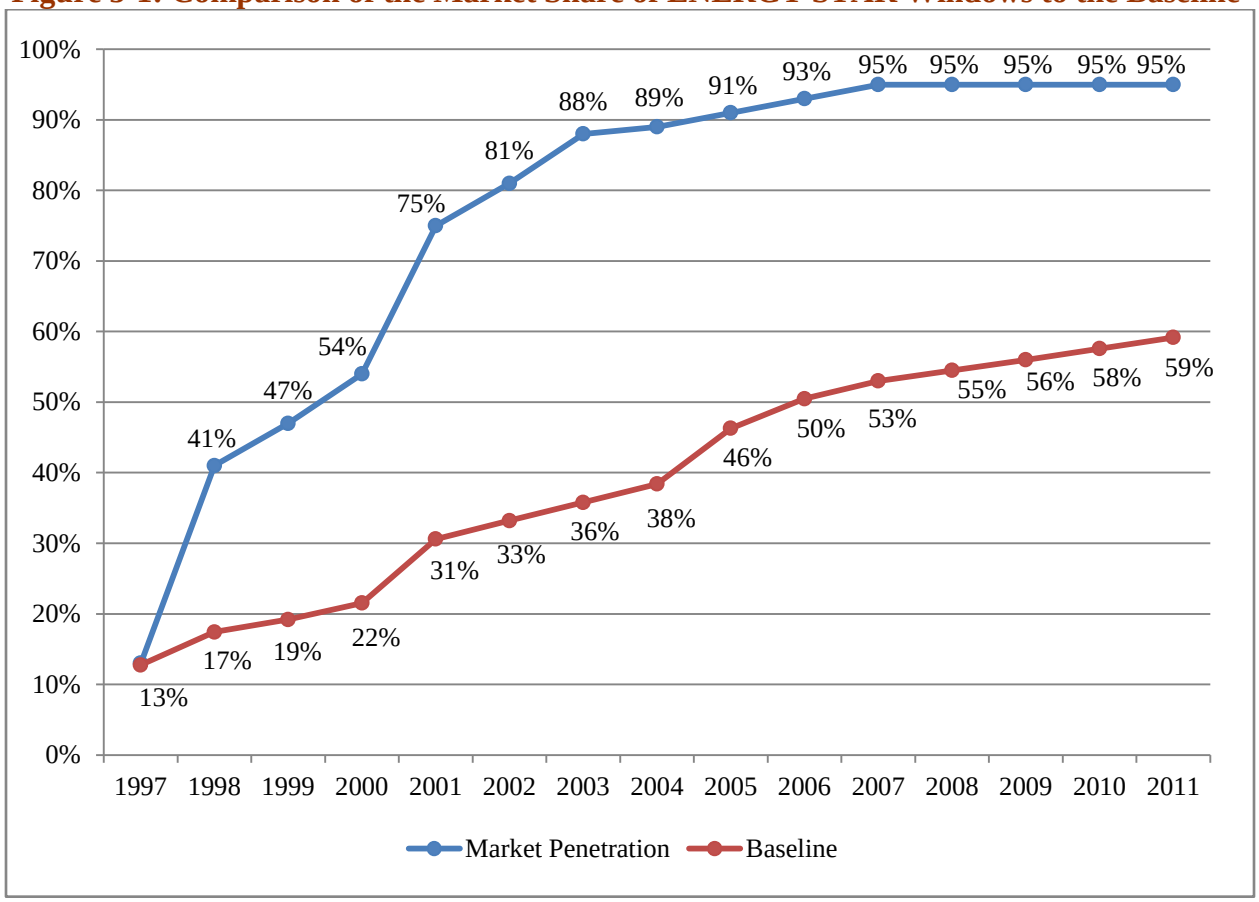
5.3.2 Baseline Activity

Past efforts to determine baseline activity utilized NEEA's methodology that compared the analysis of regions with active promotions of ENERGY STAR windows ("active regions") to those regions of the country without active promotions ("inactive regions"). According to this analysis, the market penetration of ENERGY STAR windows in inactive regions would be a reasonable proxy for the baseline if there had not been such a drastic change in economic conditions.

As a part of the 2011 LTMT effort, Navigant updated the methodology utilized in the 2010 evaluation effort, which obtained baseline estimates from the WDMA/AAMA report. The current supplemental report did not contain updated baseline figures so the project team applied the average growth rate to the calculated value for 2010 to determine 2011 baseline percentage. This approach enables the analysis to consider the fundamental change in the market caused by the economic downturn of 2008–2011. NEEA's original S-curve would not have been able to do so since it is based on population density and market penetration rates prior to the downturn and expected rates of growth consistent with "business as usual" conditions.

Figure 5-1 shows the market penetration of ENERGY STAR windows in the Northwest compared to the baseline from 1997–2011.

Figure 5-1: Comparison of the Market Share of ENERGY STAR Windows to the Baseline



Source: 2011 LTMT analyses.

5.3.3 Per-Unit Energy Savings

The savings per unit of window area is the annual energy savings due to reduced HVAC energy consumption per unit of window area. HVAC savings comes in several forms:

- Electricity savings due to reduced electric-heating usage
- Electricity savings due to reduced central air conditioner usage
- Electricity savings due to reduced gas furnace-fan operation

Per-unit savings remain unchanged from those calculated as a part of the 2010 LTMT effort. Navigant weights the average per-unit savings by the market share of heating and cooling system types as presented in Table 5-9. The project team utilizes the weighted average values to calculate energy savings from the total area of ENERGY STAR windows alone. The final weighted average electricity savings due to the ENERGY STAR windows is 0.53 kWh/ ft^2-yr, Table 5-9 summarizes the updated per-unit savings based on the weighted average savings values by end use and vintage type.

Table 5-9: Comparison of Electric Weighted Average Per-Unit Savings for 2011 Sales

Savings End Use	New Construction	Existing Homes	Weighted Average
Electric Heating (kWh/ ft^2 - yr)	0.36	0.57	0.49
Central Air Conditioning (kWh/ ft^2 -yr)	0.02	0.02	0.02
Reduced Furnace Fan Operation (kWh/ft^2 - yr)	0.02	0.02	0.02
Total Electricity Savings (kWh/ ft^2-yr)	**0.40**	**0.62**	**0.53**

Source: Navigant analysis of per-unit savings values and heating and cooling system market shares based on NW Council's Conservation Supply Curve updated December 4, 2009.

5.4 Conclusions

NEEA's ENERGY STAR Windows market transformation initiative continues to achieve significant energy savings in 2011. Although total window shipments in the Northwest receded after 2005, WDMA reports an increase in window shipments starting in 2010. In addition, the market penetration of those windows with an efficiency level affected by NEEA's initiative continues to approach 100 percent and will likely remain constant for the savings claimed with the 0.35 U-value specification. Specific findings from the 2011 LTMT effort are as follows:

- The number of ENERGY STAR windows shipped in the Northwest increased in 2010 and anticipated to rise in 2011. Although the total area of ENERGY STAR windows dropped from just over 45 million square feet in 2005 to under 33 million square feet in 2009, market experts expect an increase to more than 35 million square feet in 2011.

- Navigant recommends maintaining the 95 percent market penetration for windows with an efficiency level affected by NEEA's initiative. The market penetration remains unchanged from the last LTMT effort, given the absence of a detailed study or evidence to the contrary.

- Baseline activity represents 58 percent of the market in 2010 and 59 percent in 2011. Although the 2007 LTMT evaluation validated NEEA's innovation curve, Navigant utilized the market penetration figures reported in the 2010 LTMT and applied a growth ratio to determine the 2011 baseline.

Table 5-10 summarizes recommendations for the values of key indicators, characterized for ENERGY STAR windows sales in the Northwest. Baseline sales account for roughly two-thirds of the total market activity, yielding incremental savings of approximately 0.8 aMW in 2011.

Table 5-10: LTMT Recommendations for Key Indicators

Key Indicators Reviewed	2011 Incremental (Due to new activity occurring in 2011)	2011 Cumulative (Calendar year 2011 values due to all activity since initiative inception)	Source
Current Market Activity			
ENERGY STAR Windows sold in the Northwest (ft^2 x 1,000)	35,525	506,665	Section 5.3.1
Current Baseline Activity			
ENERGY STAR Windows sold in the Northwest (ft^2 x 1,000)	22,127	233,605	Section 5.3.2
Per-Unit Energy Savings			
kWh/ ft^2/year	0.5	0.6	Section 5.3.3
Implied Energy Savings (aMW)*			
New ENERGY STAR Windows sold in the Northwest (aMW)	0.8	19.2	Market activity minus baseline activity, times per-unit savings, divided by 8,760 hours, divided by 1,000

* Implied Energy Savings represent estimated savings from market activity less estimated savings from baseline activity. NEEA's reported values might not match those presented here because NEEA adjusts for the effect of utility incentives and other factors not taken into account in this LTMT analysis.

Source: Navigant analysis 2011

NEEA's ENERGY STAR Windows market transformation initiative has proven through the LTMT reports to shape the penetration of efficient windows into the Pacific Northwest market place. Although NEEA will claim savings attributable to the window initiative for 2011, NEEA plans to discontinue future entitlement due to a lack of current involvement within the windows market.

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6 PC Power Management Solutions (Verdiem)

From 2001 until December 2003, the Northwest Energy Efficiency Alliance (NEEA) provided funding to Verdiem to introduce a software product that manages energy in computer network environments. The market refers to this class of products as networked personal computer (PC) power management solutions eor networked energy management solutions (NEMS). Networked PC power management solutions enable network administrators to remotely control the power management functions of PCs linked to the central network. NEEA designed the initiative to lower the projected growth in energy consumption caused by the rapid expansion of computers and associated technology in the workplace. The NEEA-Verdiem partnership sought to sell at least 18,000 licenses in NEEA's territory by the end of 2003 by creating brand awareness of a product that could create energy savings and by identifying strategies to overcome network administrators' reluctance to introduce additional software into their networks. As of mid-2004, Verdiem had outpaced that target by over 50 percent, with 27,263 licenses sold in the Pacific Northwest.[61]

Prior to the last long-term monitoring and tracking (LTMT) effort in 2009-2010, the market for this class of products experienced significant growth throughout the country. Verdiem announced that it deployed license number one million (on a national level) in August 2009, following a 12-month period during which the company doubled its customer base. Private investors contributed more than $31.7 million to Verdiem between its founding in 2001 and early 2010.[62] By comparison, NEEA invested about $1 million in the effort through its investment in Verdiem, associated evaluation studies, and general administration of the program.

This is the fourth LTMT effort undertaken to examine the development of the market for networked PC power management software in the Northwest. Previous LTMT projects have covered the following range of topics:

- The initial LTMT project began in 2005 to address questions about the per-unit energy savings and sales data.
- The second LTMT effort in 2007 revised those data for Verdiem's updated products. It also dug deeper into the extent to which the NEEA-Verdiem partnership spurred innovation by additional companies and created broader market transformation.
- The third LTMT effort in 2009 updated the per-unit energy savings assumptions and Verdiem sales in the region, and it addressed the baseline activity that would have occurred in the market at that time in the absence of the NEEA-Verdiem partnership.

This fourth LTMT effort focused on assessing Verdiem's role in the early development of the market for PC power management solutions. This research led to updates to the Market Activity and Baseline Activity sections of the report. In addition, Navigant calculated incremental energy

[61] Quantec, LLC, January 15, 2005, "Market Progress Evaluation Report 2: Surveyor Software." Prepared for NEEA.
[62] John Cook, January 5, 2010, "Verdiem Powers up with Cash." TechFlash: John Cook's Venture Blog. Available: http://www.techflash.com/seattle/2010/01/verdiem_powers_up_with_cash.html.

savings from Verdiem sales in 2010 and 2011 using updated sales figures and baseline assumptions.

6.1 Assumptions and Indicators for Review

In assessing the energy savings related to the NEEA-Verdiem partnership, Navigant took a bottom-up approach, using Verdiem's sales data and input from its competitors to determine the current energy savings in the market. NEEA's Cost-Effectiveness (ACE) model served as a foundation for conducting this assessment. Together, the LTMT efforts have focused on verifying the ACE model's assumptions about the following inputs:

- Sales data for Surveyor
- Baseline activity
- Per-unit energy savings

A more formal equation for the networked PC power management software's energy savings calculation is as follows:

Annual Energy Savings (kWh/year) =

(1) Number of licenses in use

x (2) Per-unit energy savings (kWh/year)

where:

- **Number of licenses in use** is the number of Verdiem networked PC power management software licenses in use in the Northwest – the cumulative unit sales, adjusted downward for anticipated retirements;[63] and

- **Per-unit capacity energy savings** is the annual energy savings per computer with networked PC power management software installed.

Other indicators of success will reflect the broader market impacts of the NEEA-Verdiem partnership. Other indicators include the entrance of additional networked PC power management software firms into the market. These market effects factor into this analysis.

[63] In January 2011, the Regional Technical Forum (RTF) adjusted its measure-life assumption for PC power management from five years to four years. Navigant used the five-year lifetime for units installed before January 2011, and the four-year lifetime for those installed from January 2011 onward. (http://www.nwcouncil.org/energy/rtf/measures/measure.asp?id=95)

6.2 Methodology

Previous LTMT efforts for the NEEA-Verdiem partnership focused on updating market activity, including regional sales, reviewing per-unit energy savings estimates, and assessing baseline activity in the recent market. The 2011 LTMT effort attempted to determine the market effects of NEEA's early support of Verdiem and the related baseline activity. Specifically, Navigant aimed to understand Verdiem's role in the evolution of the networked PC power management solutions market. Based on its findings, the team subsequently updated its calculation of energy savings from Verdiem sales in the Northwest through 2011.

To determine Verdiem's impact on the networked PC power management market, Navigant worked with NEEA to identify key competitors and experts in the current market. Through Google and LinkedIn searches and by contacting competitors' public relations staff, Navigant located key contacts at each company who participated in or, at a minimum could speak to, the product conception, development, and early marketing stages. Navigant also contacted two market analysts who track the development of PC power management software (among other green information technology [IT] initiatives and solutions) to discuss the evolution of the market and their perception of key trends.

The 2011 LTMT effort involved the following steps:

- Review of the 2009 LTMT findings
- Review of past LTMT competitor interview findings
- Phone interview with Chris Baker, Verdiem's Vice President of Marketing and Strategy, to understand the company's perspectives on recent market trends and Verdiem sales in the Northwest
- Hour-long phone interviews with five of Verdiem's competitors to determine the main influences on their decisions to develop networked PC power management software at the time they did (see Appendix E.1 for the competitor interview guide).
- Hour-long phone interviews with two market analysts to understand their perception of the main players in and drivers of the market in its early stages (see Appendix E.2 for the market analyst interview guide).
- Updates to the ACE model to calculate incremental and cumulative savings from Verdiem sales in the Northwest through October 2011

Together, these steps provided the LTMT team with the information needed to assess Verdiem's influence in the evolution of the market for networked PC power management software. A summary of primary data collection activities is included in Table 6-1.

Table 6-1: Primary Data Collection

	Number of Interviews / Surveys	Topic Issues
Verdiem's Competitors	5 phone interviews	Key drivers that influenced the launch of competitor product/solution, perceived key competitors at time of product launch, key geographic sales markets with a focus on Pacific Northwest
Verdiem Staff	1 phone interview	Verification of assumptions about market activity and product sales
Market Analysts	2 phone interviews	Evolution of the market and key contributors to market change; current status of market

Source: Navigant analysis, 2011.

The interviews with competitors and market actors included some internationally based firms that do business in the U.S.

Four out of five competitor interviewees had some degree of involvement in the early stages of their product's development. To protect respondent confidentiality, Table 6-2 lists the role that each respondent played during product development and launch.

Table 6-2: Competitor Roles during Launch of Product

Roles
Business management/development
Marketing consultant
Technical development
CEO
Did not work for company at the time of product launch

The market analysts spoke both to their perception of the market's early evolution and their understandings of the market's current status and growth. Competitors responded to questions regarding the historical development of their respective products: key drivers that influenced its conception, primary competitors at the time of product launch, and the geographical regions in which they focused their initial marketing efforts.

6.3 Findings

This section presents findings of the 2011 LTMT efforts for the PC Power Management initiative. Section 6.3.1 discusses related market activity for Verdiem. Section 6.3.2 outlines the results of the baseline activity research and recommends an updated baseline assumption for the ACE model. Section 6.3.3 recommends changes to the per-unit energy savings associated with networked PC power management solutions.

6.3.1 Market Activity

According to interviewees, the market for networked PC power management has continued to grow in the past two years and will continue to do so. Respondents did not provide specific estimates of the extent of past growth; however, two firms discussed analyst reports that forecasted the market's expected annual growth rate at anywhere between 6 percent and 30 percent. Solution providers (including Verdiem) cited a great deal of untapped customer demand, including many "greenfield" sites (i.e., organizations without any existing networked PC power management solutions). Several offered the continuing increase in the number of competing firms as additional evidence that such demand exists. All of the market analysts interviewed agreed that the economic slowdown has provided a boost to the market as organizations seek out and implement cost-cutting measures.

Importantly, half of the interviewed firms and both of the market analysts discussed the decreasing opportunity for stand-alone networked PC power management solutions. These respondents agreed that customers would increasingly look for networked PC power management solutions as part of a broader suite of IT services rather than a stand-alone product. This might include network solutions that manage multiple PC functions (e.g., power settings, software updates) and/or applying the PC power management and other endpoint management functions to a broader array of IT equipment (e.g., servers, routers, and switches).

In terms of market segmentation, none of the interviewed firms pursues a regional geographic focus. Most firms deploy their products electronically and sell to large customers whose operations span several geographies. These product and market characteristics enable firms to take a national or even international marketing approach. On the other hand, some firms did mention focusing their efforts on particular sectors such as education, the public sector (e.g., state and local government), or small businesses.

VERDIEM SALES DATA

For this LTMT effort, Verdiem sales during 2010 and 2011 serve as the basis for market activity estimates (Table 6-3). As discussed later in this section, NEEA's efforts spurred sales of Verdiem licenses in the Northwest but did not generate additional sales activity by other competitors. As such, sales of Verdiem licenses in the Northwest best reflect market activity associated with the Verdiem-NEEA partnership.

Table 6-3: Sales of Verdiem's Surveyor, 2010

Year	Reported Sales in the Northwest	Anticipated Retirements in the Northwest
2010	[redacted]	[redacted]
2011	[redacted]	[redacted]

Source: Sales data provided by Verdiem.

Note: Sales numbers redacted for public consumption.

6.3.2 Baseline Activity

Understanding the level of market activity that would have occurred in the absence of the NEEA-Verdiem partnership requires understanding the drivers in the marketplace, from both the customer and the competitor perspective. The 2009 LTMT findings explored the degree to which the NEEA-Verdiem partnership could have influenced the various drivers for customers to purchase a networked PC power management solution in the 2008-2009 time frame. This year's evaluation focused on competitors and sought to identify specific influences on their decisions to enter or increase their attention on the networked PC power management market in the Northwest. This section summarizes two elements of competitor activity:

- Competitor motivations for product launch
- Geographic focus of sales activities

The section concludes with Navigant's recommended update to the baseline activity assumption used in the ACE model.

COMPETITOR MOTIVATIONS FOR PRODUCT LAUNCH

Each of the five interviewed companies described entering the PC power management market due primarily to specific customer requests. In several cases, this involved improvements to an existing end-point IT management product. In three cases, the company initially developed the networked PC power management capability as an additional feature to an existing solution in order to save customers money. In addition, four competitors mentioned various secondary drivers of customer demand, including energy conservation, increased interest in green IT initiatives, or rebates from utility companies.

The majority (four out of five) of the competitors' existing products helped IT administrators remotely manage multiple end-points within the customers' organization. Most of these solutions included a feature that turned on computers remotely so as to "patch in" updates at night. These competitors' customers requested that they add a feature that would shut down those computers after completing updates or after a certain time of night in order to save money. For the other two companies, customers approached them to specifically create networked PC power management solutions. One company stated that it only had to create a reporting functionality to help its client determine energy savings since its software already shut computers down after updates completed.

When asked about the firms they viewed as first to market networked PC power management solutions, three companies specifically mentioned Verdiem along with other firms like Faronics and 1E with stand-alone networked PC power management products. Three respondents also mentioned that firms with other PC life-cycle management solutions added (or began to better market existing) networked PC power management features to their products around the same time.

Each company maintained, however, that customer demand was the sole or primary driver for their product's development. The presence of firms with similar products only slightly influenced their decisions to enter the market for PC power management solutions. Specifically, two of these companies acknowledged that (as with any such decision) competitors' actions would have influenced their approach to product development, albeit in a minor way. One of these two respondents stated that his company developed the product with the knowledge that other companies "weren't serving the [power management] function properly." The other respondent maintained that while "competitors offering similar services and features are always influences for decision… [competitor presence] wasn't a driving factor."

The interviewed market analysts confirmed the timing of product introduction by the interviewed competitors. In addition, the U.S.-based market analysts added that the U.S. Department of Energy first distributed two freeware products, EZ SAVE and EZ GPO, at about the same time as Verdiem and 1E. All of the analysts further indicated that, despite this early activity, the market for networked PC power management did not take off until the later integration of those capabilities with operating systems (e.g., Microsoft Windows) and other desktop management solutions (e.g., BigFix). Specifically, the analysts credited companies like Microsoft with mainstreaming and standardizing PC power management functionalities in a way that smaller stand-alone companies would not have been able to achieve. These comments mirrored those of the interviewed competitors that discussed such integrated approaches to the market.

GEOGRAPHIC FOCUS OF SALES ACTIVITIES

Regarding the geographic focus of sales activities, each competitor stated that the U.S. represents its strongest market. Most of these competitors focused their launch and initial sales efforts in the U.S., but their initial marketing efforts did not focus on any particular region of the country. Instead, most respondents reported that they followed business opportunities based on their target customers (often-larger organizations whose operations spanned several regions). As a result, competitors tended to enter specific regions in response to requests from existing customers that had office locations there. In fact, only one respondent mentioned targeting its initial sales in one region (California) due to the availability of utility company rebates that could help drive sales of its product.

While most respondents reported having followed customer demand to the Northwest over time, two of the five companies did mention such utility rebates as an additional contributor to the attractiveness of the region. The timeframes for each company's entry to the Northwest market vary as widely as the timing of their initial product launches. Some entered the region as early as 2004, with others entering as late as 2010.

Three respondents stated that Verdiem's experience did not influence their decision to enter the market. Despite this claimed lack of influence, they did recognize Verdiem as a primary competitor when they launched in the Northwest; one also cited 1E in a similar role. One respondent went on to clarify that early on they only considered Verdiem as a competitor in the Northwest but not in the rest of the country. Similarly, another respondent that offers networked PC power management within a broader suite of services mentioned that their company

considered Verdiem on the "periphery" of their competition because Verdiem only focused on the power consumption analysis function.

UPDATED BASELINE ASSUMPTION FOR ACE MODEL

The analysis undertaken as part of this year's LTMT efforts reinforces the 2009 LTMT finding that other networked PC power management software solutions would have evolved in the absence of the NEEA-Verdiem partnership. As evidenced in the above interview findings, competitors maintain that customer demand solely or primarily drove product development. Market analysts added that larger companies have contributed to the "mainstreaming" of PC power management software by integrating it into larger PC life-cycle management software. In addition, a contact with the Regional Technical Forum (RTF) noted that they expect an increase in the number of computers sold with networked PC power management solutions pre-installed.[64]

Navigant recommends updating the baseline assumption in the ACE model to more accurately reflect the above factors and the rapidly changing pace of the computer industry. The combined input of competitors, analysts and the RTF suggests that within the next few years, most NEMS will come pre-installed on new computers and/or as part of a larger suite of enterprise management solutions. Therefore, the team recommends increasing the 2009 baseline activity assumption each year in 10 percent increments beginning in 2010. For example, the 50 percent baseline in 2009 will increase to 60 percent in 2010, and so on until it reaches 100 percent in 2014. This assumption implies that baseline activity arising from other market forces will effectively overshadow any underlying influence from the Verdiem-NEEA partnership by 2014.

As noted in the 2009 LTMT findings, Navigant's approach to baseline does not differentiate between NEMS licenses that received a utility-funded incentive and those that did not. Rather, NEEA's assumed role in influencing utilities' initial decision to offer incentives for NEMS led Navigant to estimate a lower baseline in 2009 (i.e., 50 percent) than it would have absent that influence.[65] While Navigant acknowledges that NEEA (either through direct influence or through its investment in Verdiem) may have influenced utilities' decisions to offer NEMS incentives, this study did not include an analysis of the degree of that influence. Therefore, Navigant continues to assume that licenses obtained with utility incentives have the same level of baseline as those obtained without incentives.

6.3.3 Per-Unit Energy Savings

As discussed in previous LTMT reports, per-unit energy savings for networked PC power management software depend on many factors, making it difficult to develop an "average" per-unit energy savings estimate.[66] Variability in the per-unit energy savings estimate reflects the significant differences in potential savings based on: the type of technology used (e.g., CRT vs.

[64] Email correspondence with Charlie Grist, Northwest Power and Conservation Council, December 20, 2011.
[65] Navigant. October 26, 2010. *Long-Term Monitoring and Tracking Report on 2009 Activities.* Prepared for NEEA. Report #E10-218.
[66] Navigant. October 26, 2010. *Long-Term Monitoring and Tracking Report on 2009 Activities.* Prepared for NEEA. Report #E10-218.

LCD monitors, desktops vs. laptops); baseline user habits and company policies; and aggressiveness of the PC power management savings applied.

Navigant recommends using a revised per-unit energy savings rate for 2010 and subsequent years that is consistent with the Regional Technical Forum's recent update. This revision responds to a recommendation made in the 2009 LTMT report, in which Navigant suggested that "NEEA continue to use per-unit energy savings based on Verdiem's M&V efforts until more widespread evaluation studies are conducted on utility incentive programs."[67] For the 2011-2012 LTMT effort, Navigant updated its per-unit energy savings assumption to reflect the RTF's provisionally approved per-unit savings rate: 115 kWh per license per year.[68]

In addition, Navigant recommends that NEEA adjust the measure-life assumption starting in 2011. In January 2011, the RTF adjusted its measure-life assumption for PC power management from five years to four years. Navigant recommends that NEEA use the five-year lifetime for units installed before January 2011, but adopt the four-year lifetime for those installed from January 2011 onward.[69] Navigant inquired with Verdiem for any data that would suggest a different effective lifetime for each purchased license; however, the company has not historically tracked the ongoing use and application of the software by its customers.

6.4 Conclusions and Recommendations

Interviews with market analysts and Verdiem's competitors suggest that Verdiem only played a minor role in its competitors' development or launch of products into the networked PC power management market. Instead, all five companies credited their product development and launch decisions primarily to demand for cost savings and energy conservation from customers in other geographic regions. Some competitors entered the Northwest market unintentionally when existing customers in other geographic regions installed the technology in their locations in the Northwest.

Competitors had mixed feedback regarding the nature of their competition with Verdiem. While each company expressed some level of awareness of Verdiem, only two considered Verdiem a primary competitor in the U.S., while three considered them a competitor in the Northwest region. Only one competitor reported any awareness of the NEEA-Verdiem partnership; however, that company discussed targeting a different base of customers than Verdiem altogether. As such, the NEEA-Verdiem partnership does not appear to have substantially influenced that company.

In addition to these market and baseline activity findings, Navigant also updated its estimate of energy savings implied from NEEA's partnership with Verdiem. Table 6-4 summarizes these

[67] Navigant. October 26, 2010. *Long-Term Monitoring and Tracking Report on 2009 Activities.* Prepared for NEEA. Report #E10-218.

[68] On July 12, 2011, the RTF published a "v3.0 savings worksheet" with calculations supporting a per-unit energy savings rate of 115 kWh/license-year based on ENERGY STAR baseline assumptions and the weighted average of laptops and desktops currently available in the market. The spreadsheet can be found at http://www.nwcouncil.org/energy/rtf/measures/measure.asp?id=95. The per-unit energy savings is calculated in a tab titled "RTF Compare".

[69] http://www.nwcouncil.org/energy/rtf/measures/measure.asp?id=95

energy savings using Verdiem sales data from January 2010 through October 2011. These calculations used the updated baseline activity and per-unit energy savings assumptions discussed in the earlier sections. The lower per-unit energy savings rate of 115 kWh per year and the baseline assumptions of 60 percent in 2010 and 70 percent in 2011 decrease the incremental energy savings for these years relative to prior years' estimates.

Other recommendations from this LTMT evaluation include the following:

- Increase the baseline activity assumption 10 percent annually beginning in 2010
- Lower the energy savings rate to the RTF-approved 115 kWh per unit
- Adjust the measure life to four years for units installed beginning in 2011

Table 6-4: Recommended Values for Verdiem Surveyor

Key Indicators Reviewed	**2010 Incremental** (Due to *new* activity occurring in 2010)	**2011 Incremental** (Due to *new* activity occurring in 2011 through October)	**2011 Cumulative** (Calendar year 2011 [through October] values due to all activity since program inception)	Source
Market Activity				
Networked PC Power Management Unit Sales in the Northwest	[redacted]	[redacted]	141,068	Section 6.3.1
Baseline Activity				
Networked PC Power Management Sales in the Northwest	(60%) [redacted]	(70%) [redacted]	70,875	Section 6.3.2
Per-Unit Energy Savings				
Installing Networked PC Power Management on Workstation (kWh/year)	115	115	171**	Section 6.3.3
Implied Energy Savings (aMW)*				
Installing Networked PC Power Management on Workstation	[redacted]	[redacted]	1.37	

* Implied Energy Savings represent estimated savings from market activity less estimated savings from baseline activity. NEEA's reported values might not match those presented here since NEEA adjusts for the effect of utility incentives and other factors not taken into account in this analysis.

** Cumulative Per-Unit Energy Savings reflects the balance of products in the market (net market effects) that count toward NEEA savings in a given year.

Source: Navigant Analysis 2011.

Navigant recommends that NEEA carefully consider its next LTMT effort for networked PC power management software solutions. NEEA may consider discontinuing LTMT of Verdiem in the future due to the relatively small levels of incremental savings when compared to other NEEA initiatives. These relatively low levels of incremental savings mainly stem from two key trends:

- This LTMT effort suggests that NEEA only claim savings created by sales of Verdiem licenses in the Northwest; sales of other networked PC power management solutions do not appear to have stemmed from the NEEA-Verdiem partnership, meaning that NEEA should not count savings generated by sales of those products in the Northwest.

- RTF anticipates that the baseline for networked PC power management solutions will increase significantly in the near term. This further reduces the amount of implied energy savings that NEEA can claim from this initiative.

NEEA should reassess the need for LTMT of Verdiem in late 2013 after the RTF has revisited its deemed savings estimate for networked PC power management software in the Northwest.

6.5 Bibliography

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Navigant interviews with five providers of networked PC power management solutions. November 2011. These individuals requested to remain unidentified in the report.

Navigant interviews with two market analysts. November 2011. These individuals requested to remain unidentified in the report.

Navigant interviews with Chris Baker, Vice President of Marketing and Sales, Verdiem. November-December 2011.

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Appendix A. BOC Supplemental Information

A.1 Methodology for Estimating Per Unit Energy Savings

As part of the 2010 LTMT efforts, Navigant developed an extensive questionnaire for participating building operators and a related savings estimate tool for future project years. These tools refined and improved upon an engineering-based impact assessment of energy savings that Navigant developed for the Building Operator Certification (BOC) program of the Midwest Energy Efficiency Alliance (MEEA), which is predicated on the Northwest Energy Efficiency Alliance's (NEEA's) BOC initiative. This improved impact assessment approach incorporates topics covered in the Northwest Energy Efficiency Council (NEEC) BOC curriculum. The improved methodology sought to achieve two goals:

1. To increase the accuracy of per-unit energy savings assumed for the program
2. To assess the savings associated with the 2009 and 2010 investments in BOC by NEEA

Additionally, Navigant used the questionnaire-based interviews with certified building operators along with secondary literature to assess the possible need for other adjustments to the baseline and per-unit savings assumptions.

This memo provides a brief overview of the approach used to develop (1) the survey questionnaire and (2) the related scoring tool.

Redesigned Questionnaire

Navigant developed the BOC participant questionnaire to evaluate the practices of certified building operators in the Northwest. Specifically, the questionnaire collects the data needed to assesses the energy-saving measures implemented by certified building operators and to quantify the level of influence that the BOC program had in driving these practices. The questionnaire topics cover material directly from the NEEC's BOC curriculum to address its effectiveness and to avoid omitting any potential sources of savings.

The following bullet points highlight the focus of the questionnaire guide:

- Establish participant practices related to O&M and equipment installations *before* BOC training.
- Evaluate participant practices related to O&M and equipment installations *since* BOC training.
- Determine how influential BOC training was on changes in O&M practices and equipment installations.

The difference between O&M practices and equipment installations from before and after BOC training contains the fundamental information needed to estimate energy savings from the BOC initiative. However, as discussed in previous long-term monitoring and tracking (LTMT) reports, BOC training does not necessarily drive all of these changes. The questionnaire addresses this by using a zero-to-ten scale to quantify the level of influence the BOC training had on the changes,

as well as asking about other sources from which BOC participants learned about energy-efficient building operations.

Navigant assessed NEEA's recent investments in BOC promotion by applying responses for targeted questions to the participant sample in order to estimate the extent of impacts related to these efforts. For example, a percentage of respondents who indicate that NEEA's investments influenced their BOC program enrollment can translate to a quantifiable impact. Navigant only applied this analysis to participants who certified since NEEA's investments began.

ADMINISTRATION OF QUESTIONNAIRE

Navigant administered the questionnaires to a sample of certified building operators that were (1) representative of the population of building types and locations and (2) placed more weight on participants with recent certification years.

Navigant utilized the following approach to draw a sample for the BOC participant survey:

- Navigant created Pivot Tables from the 2010 NEEC database that displayed participant numbers by state, building type, and certification year.
- Based on the stratification of participants across location, certification year, and building type, Navigant determined the targeted number of survey participants from each category from the Pivot Tables.
- Navigant filtered the 2010 NEEC database separately for each of these categories.
- NEEC emailed the first sample of approximately 30 BOC participants, alerting them to Navigant's desire to conduct an interview. In order to get a sample that included email addresses, the team removed about one-third of the participants from the sample due to lack of email addresses in the database, resulting in a pool of 1,262 participants from which to pull the sample.
- Navigant used the random number generator function in MATLAB to select the participants based on their row within the database.
- Navigant selected 52 participants to ensure that 20 participants were reachable.

Navigant did not sample the International Building Operators Association (IBOA) database because an updated version of the database was not available at the time of the interviews.

Of the 2,145 records in the NEEC database, only 15 participants are from Idaho and only 4 from Montana. Due to these limited numbers, no participants from either of these states appeared in the random sample. Table A-1 shows the distribution of participants interviewed by Navigant staff.

Table A-1: Completed Interviews by Category

Building Type	Oregon	Washington
Government	2 (2008)	2 (2009, 2010)
Manufacturing	1 (2010)	1 (2008)
Municipality	2 (2006 Prior)	4 (2008)
College		1 (2010)
Healthcare		1 (2010)
K-12 School		3 (2007, 2008, 2010)
Property Management		3 (2009, 2010, 2010)

Source: Navigant survey of participating building operators, 2011.

ENERGY SAVINGS SCORING TOOL

Navigant redesigned the scoring tool used for the MEEA effort to incorporate the comprehensive BOC participant questionnaire described above. The scoring tool is an engineering-based algorithm used to convert questionnaire responses to energy savings.

As noted above, BOC training can influence both the capital acquisition decisions and operations and maintenance (O&M) of that capital investment in equipment installations. Navigant's impact methodology and questionnaire address both of these situations:

The questionnaire inquires about the efficiency of equipment acquired before and after participation in the BOC training and asks respondents to rate, on a scale of zero to ten, the influence of the BOC training on each action taken. Navigant assumes that BOC training only marginally influences actions with an influence rating of less than three, and therefore no savings accrue to the program for these actions. When questionnaire responses indicate that the BOC program influenced the efficiency improvements, Navigant estimates the savings based on energy use intensities (EUIs) from a 2009 NorthWestern Energy End Use and Load Profile Study.[70]

Navigant captures savings from changes in O&M practices in a similar manner. Instead of applying an efficiency multiplier to end-use energy intensity, however, O&M savings reflect savings potential by end use modified by reported behavior changes. Maximum savings potential from O&M practices reflect a review of literature and primary research including simulation modeling and retro-commissioning studies. Table A-2 shows Navigant's conservative estimates potential savings from O&M.

[70] "Energy End Use and Load Profile Study," prepared for NorthWestern Energy by Nexant and Cadmus, 2009. http://www.northwesternenergy.com/documents/defaultsupply/plan09/volume2/Chapter2-EndUseLoadProfile.pdf.

Table A-2: O&M Savings Ratios by End Use

End Use	Maximum O&M Savings Ratio
Cooling[1]	5%
Economizer/Ventilation[1]	5%
Electrical PM[1]	0.5%
Heating[1]	5%
Lighting	3%
Drive Power[2]	1%
Building Shell[3]	2%

Source:
Notes:

1. Navigant estimates based on questionnaire responses and conservative estimates based on Piper, J., "HVAC Maintenance and Energy Savings," Building Operating Management, March 2009. http://www.facilitiesnet.com/hvac/article/HVAC-Maintenance-and-Energy-Savings--10680. The paper notes, "Facilities in which proper HVAC maintenance is completed will use at least 15 to 20 percent less energy than those where systems are allowed to deteriorate." Navigant chose conservative estimates of HVAC maintenance savings, not knowing the existing state of facility maintenance.
2. Drivepower Technology Atlas (Volume IV), Esource. This reference indicates that optimal operations and maintenance practices can save 3 to 10 percent of all drive power, compared to very poor maintenance practices. Navigant assumes a conservative 1 percent improvement over existing practices.
3. Navigant building simulation analysis.

Navigant then modifies the savings ratios above based on an estimate of the rigor with which the building operator applied them. Rigor has two elements—frequency and content. Navigant considered each of these elements individually and made the modification according to the following formula:

Net Savings Ratio = Max Savings Ratio x (frequency factor + content factor)

The remainder of this appendix explains how Navigant developed the frequency factor and the content factor.

1. **Frequency**. The more frequently that additional O&M tasks are applied, the more savings accrue. Increased frequency of O&M activities will create additional savings, though with diminishing returns. Navigant assigned a factor between 0 and 0.3, depending on whether the participant reported *increased* O&M frequency for the end use as a result of the BOC training.

   The frequency factor for O&M rigor recognizes both increased frequency of existing O&M tasks and addition of new O&M tasks (prior frequency = never). Full credit for the

frequency factor (= 0.3) is given if the respondent has increased the frequency of any previously implemented O&M task or if the number of new O&M tasks is at least one more than is required for the full content-based rigor score. If an operator performs fewer O&M tasks, the scoring algorithm reduces the frequency factor proportionally to the number required for full credit.

2. **Content.** Navigant assigned a factor between 0 and 0.7 to the content of O&M activities based on the number of *new* O&M activities performed for each end use as a result of the BOC training. The content-based measure of O&M rigor depends on the end use affected. Table A-3 shows end uses discussed in the survey and the number of equipment retrofit and standard O&M practices included in the BOC curriculum for each.

   Content of O&M improves if an operator performs more O&M tasks or if they implement the tasks more effectively; however, some O&M tasks are degrees of the same measure or are m*utually e*xclusive. For example, steam trap maintenance does not apply to hot-water boilers.

   Table A-3 also shows the minimum number of O&M practices that must be employed to receive full credit (content factor = 0.7) for content factor used for the net savings ratio. If an operator performs fewer O&M tasks, the scoring algorithm reduces the content factor proportionally to the number required for full credit. For example, if the respondent performed five or more O&M measures for Cooling, they will receive the full score of 0.7. However, if the respondent performed only 4 of the 11 O&M measures for Cooling, they will receive a content score of 0.56 (i.e., 0.7 x 4/5).

Table A-3: Retrofit and O&M Measures Assessed in Questionnaire

End Use	Retrofit Measures Assessed	O&M Measures Assessed	Measures Required for Full Content Score
Lighting Control	5	2	1
Lighting Equipment	8		
Motors	1	6	3
VFDs	1		
Heating	5	11	4
Cooling	6	11	5
HVAC Energy Management	9	19	8
Water Heating	6	0	0
Economizer/Ventilation	2	11	5
Electrical PM	0	2	1
Building Shell	0	3	2

Source: Navigant BOC Participant Questionnaire, 2011.

Navigant will generate the final savings estimates by combining credit from equipment upgrades and changes in O&M practice, and applying these to end-use energy intensities by building type.

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A.2 Memorandum on BOC Market Size

To: Rita Siong, Northwest Energy Efficiency Alliance (NEEA)

From: Jennifer Hampton, Christian Douglass, Stuart Schare, Jane Pater Salmon

Date: March 8, 2012

Re: Market size for Building Operator Certification training in the Northwest

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This memo provides an estimate of the maximum potential number of certified building operators in the Northwest as well as an estimate of the likely number of building operators that might participate (achievable potential) in Building Operator Certification (BOC). The research includes an analysis of secondary research, BOC participant data, and several expert interviews.

This memo's organization is as follows:

- Section 1 provides an estimate of the maximum potential number of building operators in the Northwest.
- Section 2 provides an estimate of the *achievable* potential number of BOC program participants in the Northwest based on previous NW studies and Roger's Theory of Innovation Diffusion.
- Section 3 includes recommendations for future research on this subject.

Section 1. Estimate of Maximum Potential Market for Certified Building Operators

Navigant calculated an estimate of the maximum potential number of building operators in the Pacific Northwest using two sources of data:

1. First, the team reviewed the 2009 *Northwest Commercial Building Stock Assessment*[71] to identify building area (by square feet) for commercial buildings in NEEA's territory. Table C-GB1 in Appendix C of the CBSA report summarizes building area by sector and then distributes the building area by percentage across building size tiers in Table C-GB2. Navigant used this information to determine the number of square feet across building size tiers and sectors. Specifically, Navigant calculated the amount of floor space per sector in each building size tier in the Northwest as the product of two factors:

    - A = Total floor area per sector (Million [MM] square feet)

[71] The Cadmus Group. 2009. *Northwest Commercial Building Stock Assessment.* Prepared for Northwest Energy Efficiency Alliance. http://neea.org/research/reports/10-211CBSA.pdf

- » B = Percent of floor area by sector and building size tier
- » C = B*A = Floor area (MM square feet) by sector and building size tier

Table A-4 shows the results of this calculation: the breakdown of floor area by sector and building size tier.

2. Next, the team identified an estimate of the average amount of building area under management by individual operators. The 2008 Long-Term Monitoring and Tracking (LTMT) team performed an assessment of the square footage for which an average building operator is responsible.[72] This analysis resulted in a value of 286,000 square feet per operator. This assumption remained in the 2010 report.[73] The 2011 LTMT effort reviewed this assumption by interviewing BOC participants and non-participants. While the completed interviews provide a starting point for understanding the average square footage overseen by a BOC operator, the 2011 data collection does not provide sufficient information to recommend a change to this assumption. Therefore, the team chose to use the existing estimate of 286,000 square feet per operator because it represents the most current and best-documented knowledge for this input. Navigant used a simple formula to calculate total number of building operators in the Northwest:

   - » C = floor area in sector and building size tier (MM square feet)
   - » C / 286,000 = number of building operators

   Table A-5 shows the results of this calculation: an estimate of the maximum potential number of building operators in the Northwest by building type.

Based on this analysis, Navigant projected the maximum potential building operators in NEEA territory to be about 7,900. About two thirds of those (67 percent) fall within the Office, Other, Retail, and Schools sector categories. At the current level of actively certified building operators as defined in the report (1196), BOC has a 15 percent market penetration of the maximum potential.

[72] Summit Blue. 2009. "Long-Term Monitoring and Tracking Report on 2008 Activities." Prepared for Northwest Energy Efficiency Alliance. Available: http://neea.org/research/reports/E09-207.pdf. Detailed documentation of the methodology and findings related to square footage per building operator found on pages 13 – 15.

[73] Navigant. 2011. "Long-Term Monitoring and Tracking Report on 2010 Activities." Prepared for Northwest Energy Efficiency Alliance. Statement regarding square footage per building operator found on page 28. http://neea.org/research/reports/E11-223_LTMT.pdf

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Table A-4: Floor Area by Sector and Building Size Tier - Square Feet (MM)

Bldg Size (1,000 ft²)	Office	Other	Dry Good Retail	Schools	Warehouse	Hotel/ Motel	Other Health	University	Hospital	Grocery	Vacant	Restaurant	Totals
< 5 - 99	245	325	251	171	113	65	106	66	13	81	37	42	**1,515**
100 - 499	158	90	125	92	50	38	28	26	30	4	3	0	**644**
> = 500	53	0	12	0	10	15	1	0	9	0	0	0	**101**
	456	**415**	**388**	**263**	**173**	**118**	**135**	**92**	**52**	**85**	**40**	**42**	**2,260**

Source: Navigant analysis of 2009 CBSA.

Table A-5:. Estimate of the Maximum Potential Number of Building Operators in the Northwest by Building Type

Bldg Size (1,000 ft²)	Office	Other	Dry Good Retail	Schools	Warehouse	Hotel/ Motel	Other Health	University	Hospital	Grocery	Vacant	Restaurant	Totals
< 5 - 99	855	1,137	877	598	397	227	370	233	45	282	130	148	**5,298**
100 - 499	554	315	438	322	174	133	97	90	105	14	11	0	**2,252**
> = 500	187	0	42	0	34	51	5	0	33	0	0	0	**352**
Totals	**1,596**	**1,452**	**1,357**	**919**	**605**	**412**	**472**	**322**	**183**	**296**	**141**	**148**	**7,902**

Source: Navigant analysis of CBSA 2009

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Section 2. Estimate of Achievable Potential Market for Certified Building Operators

In order to estimate an achievable potential, Navigant pursued a two part top-down methodology. First, the assessment allocated no certified building operators to the "Vacant" category in Table A-5 since it seems unlikely that building owners would task certified operators to maintain buildings that produced no revenue. Second, Navigant applied the maximum saturation rate from the 1981 Hood River Conservation Project (85 percent) as an upper limit to the number of certified building operators in the four Northwest states. The Hood River Project's maximum saturation is a standard assumption used by the Northwest Power and Conservation Council as well as many utilities in Oregon, Washington, Idaho and Montana as an upper limit for market penetration of non-lost opportunity measures. In addition, this upper limit of market penetration correlates to that of Rogers Theory of Innovation Diffusion which estimates 12 – 15 percent of any population are "laggards" and will not adopt a new innovation (in this case BOC) unless compelled to do so by regulation or statute. Table A-6 shows the results of these two steps, with an assumed maximum saturation of 85 percent for all occupied buildings.

Earlier iterations of this memo applied a 50 percent reduction to the achievable potential in the small building size category (< 5 – 99,000 ft^2), based on the hypothesis that smaller buildings may be less likely to hire full-time building operators. Since then, Navigant conducted interviews with a sample of BOC participants and non-participants, collecting square footage data from the sample. Table A-7 shows the results of the data collection. Respondents provided the total square footage under their supervision, in addition to the total number of buildings represented by the square footage. Navigant then calculated the average square footage per building by dividing the total square footage by the total buildings reported. Of the total sample of 25 participants and non-participants, 52 percent of respondents reported supervising buildings in the small building size category. These results did not support Navigant's earlier hypothesis; therefore, Navigant did not apply additional adjustments to the building size tiers.

Table A-6: Estimate of the Achievable Potential Number of Building Operators in the Northwest by Building Type

Bldg Size (1,000 ft²)	Office	Other	Dry Good Retail	Schools	Warehouse	Hotel/ Motel	Other Health	University	Hospital	Grocery	Vacant*	Restaurant	Totals
< 5 - 99	727	966	745	508	337	193	315	198	39	240	0	126	**4,393**
100 - 499	471	268	372	273	148	113	82	76	89	12	0	0	**1,905**
> = 500	159	0	36	0	29	44	4	0	28	0	0	0	**299**
Totals	**1,356**	**1,234**	**1,153**	**781**	**514**	**350**	**401**	**274**	**156**	**252**	**0**	**126**	**6,597**

* Navigant assumes that vacant buildings have a zero achievable potential for BOC participants.
Note: Navigant recommends a maximum saturation factor of 85 percent.
Source: Navigant analysis of CBSA 2009

Table A-7: Total Square Footage and Total Number of Buildings Overseen by a Sample of BOC Participant and Non-Participant Building Operators

Respondent #	Respondent Type	Total ft² Reported	Total Buildings Reported	Average ft² Per Building	Sector
1	Participant	1,200,000	1	1,200,000	Healthcare
2	Participant	1,200,000	32	37,500	Property Management
3	Participant	1,300,000	40	32,500	College
4	Participant	6,500	1	6,500	Miscellaneous
5	Participant	1,000,000	1	1,000,000	Office
6	Participant	900,000	1	900,000	Miscellaneous
7	Participant	177,000	1	177,000	School/University
8	Participant	750,000	1	750,000	Manufacturing
9	Participant	1,500,000	1	1,500,000	Healthcare
10	Participant	18,000,000	950	18,947	Miscellaneous
11	Participant	100,000	1	100,000	Government
12	Non-Participant	220,000	5	44,000	K-12 School
13	Non-Participant	174,000	2	87,000	Property Management
14	Non-Participant	150,000	5	30,000	K-12 School
15	Non-Participant	185,000	30	6,167	K-12 School
16	Non-Participant	2,200,000	96	22,917	Government
17	Non-Participant	1,130,000	21	53,810	K-12 School
18	Non-Participant	499,000	5	99,800	K-12 School
19	Non-Participant	1,500,000	3	500,000	Healthcare
20	Non-Participant	30,000	13	2,308	Municipality
21	Non-Participant	2,500,000	27	92,593	K-12 School
22	Non-Participant	1,300,000	12	108,333	Manufacturing
23	Non-Participant	175,000	4	43,750	Office
24	Non-Participant	375,000	1	375,000	Office
25	Non-Participant	310,000	1	310,000	Miscellaneous

Source: Navigant analysis of 2011 survey data.

Section 3. Recommendations & Future Research Needs

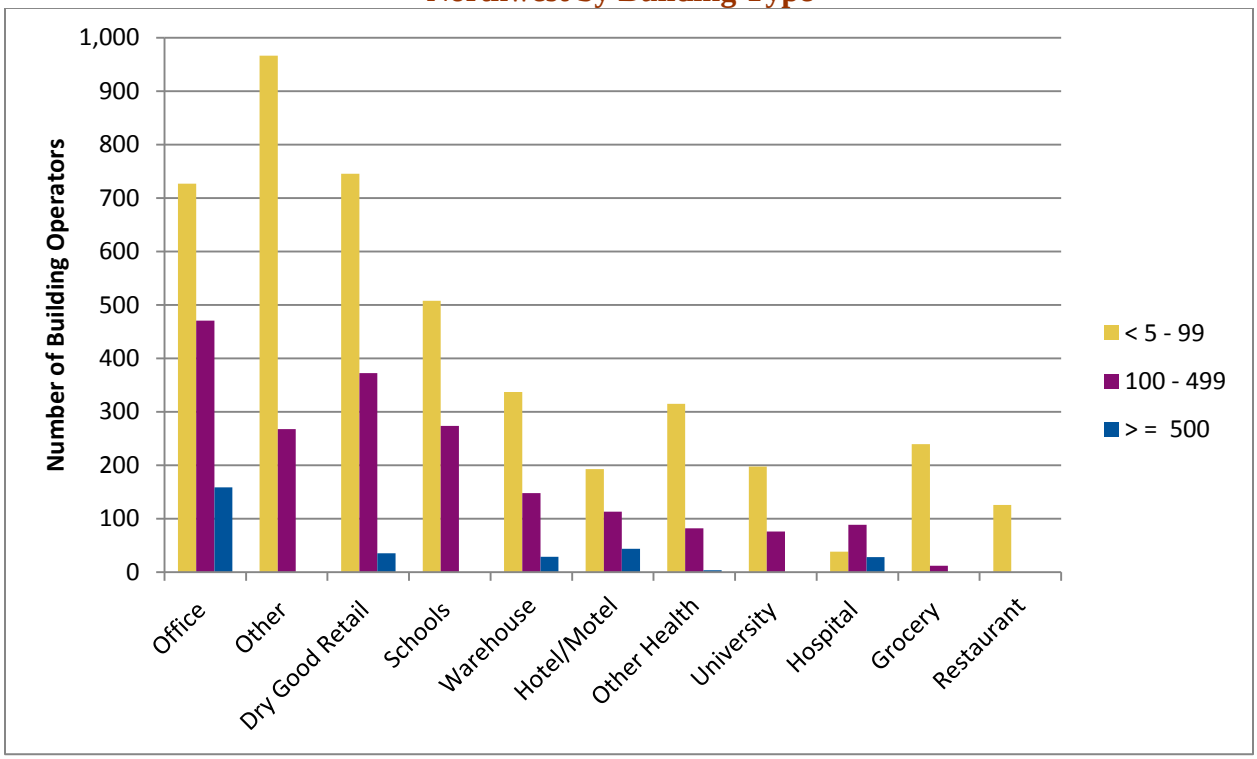
In order for NEEA to further refine the potential number of building operators with a higher amount of accuracy than this memo and the LTMT scope allows, Navigant recommends a more in-depth study that includes a thorough process evaluation and/or marketing assessment similar to a 2002 evaluation done for the Northeast Energy Efficiency Partnership's (NEEP) BOC program[74]. To provide guidance for future studies on this topic, Navigant recommends considering the following research questions:

1. How many building square feet do BOC participants oversee? Navigant recommends that NEEA's implementation partners (NEEC and IBOA) gather square footage information from participants on a consistent basis moving forward.
2. How many buildings do BOC participants oversee? As noted in the previous point, the implementation partners should capture this information on a consistent basis so NEEA can access it on a regular basis.
3. What is the number of buildings within each sector in the Northwest's territory? The next iteration of CBSA will likely provide this information, but NEEA should ensure that this data collection be part of the overall regional study design.
4. How many BOC program participants are in each building size category? Per the first and second point on this list, NEEA's implementation partners should gather this information on a consistent basis and make it regularly available to NEEA.
5. How are building operation and maintenance staffed in each sector? If outsourced, is it parsed out by equipment type (e.g., mechanical contractor for HVAC, electrical contractor for lighting, etc.) or by building engineering service firm?
6. Are there staffing benchmarks (e.g. FTE/ ft^2) or credentialing benchmarks (e.g. hours of training per year) within different building sectors?

Furthermore, NEEA may consider learning more about the composition of the "Other" sector outlined in the 2009 CBSA study. The "Other" sector is twice the achievable potential as the Schools sector in the 5,000 – 99,999 square feet tier, and represents over 18 percent of the total CBSA building stock (see Figure A-1). Yet, the CBSA did not define which market segments it included in the "Other" sector. It may be that the "Other" sector comprises many sectors that are too small to justify additional attention, but there is a possibility that some combination of these smaller sectors could represent an opportunity for building operator certification.

[74] *Evaluation of the Building Operator Training and Certification (BOC) Program in the Northeast;* Northeast Energy Efficiency Partnerships, September 2002, Research into Action

Figure A-1: Estimate of the Achievable Potential Number of Building Operators in the Northwest by Building Type



Source: Navigant analysis of CBSA 2009 data. Navigant assumes that vacant buildings have a zero achievable potential for BOC participants. N = 6597

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Appendix B. Commissioning – Online Survey Guide Cx/RCx Providers

Objective
To obtain industry activity estimates and trends that inform a summary of the amount of commissioning (of new buildings), re-commissioning (of previously commissioned buildings), and retro-commissioning (of existing buildings) conducted and anticipated in the Northwest.

Survey Targets:
Complete twenty (20) online surveys with Cx and RCx service providers based in the Northwest.

Introduction

This confidential survey is being conducted by Navigant Consulting on behalf of the Northwest Energy Efficiency Alliance (NEEA), a non-profit organization funded by Northwest utilities, Bonneville Power Administration, and the Energy Trust of Oregon. NEEA works to accelerate the market adoption of energy-efficient products, technologies and practices within homes, business and industry. This survey will inform NEEA about how building commissioning has grown over the past few years and how commissioning practices have evolved. As a member of the Building Commissioning Association, you are part of a select group of people knowledgeable about this market. Your participation in this survey will help NEEA determine the overall energy efficiency benefits associated with commissioning, which NEEA has promoted in the past. **Your information will be treated confidentially and your responses will not be associated with you or your organization in any way. You will not be contacted for any commercial purposes as a result of responding to this survey. For more information about NEEA, please visit our website: www.NEEA.org**

This survey should take no more than 10 minutes.

We greatly appreciate your time and consideration.

Definition of "Commissioning"

The term “commissioning” is often used loosely to describe a variety of activities related to preparing new buildings for occupancy and adjusting systems in existing buildings to improve performance and efficiency. As a general guideline, please consider “commissioning” to refer to the following:

Commissioning (Cx) *is an intensive quality assurance process that begins during design and continues through construction, occupancy, and operations. Commissioning ensures that the new buildings operates as the owner intended and that building staff are prepared to operate and maintain its systems and equipment.* ***Retro-commissioning (RCx)*** *is a subset of commissioning and is the application of the same process to existing buildings to improve a building’s operations and maintenance (O&M) procedures to enhance overall building performance.*

Source: California Commissioning Collaborative. California Commissioning Guide: New Buildings. 2006

*Related to retro-commissioning is **re-commissioning**, which is when an existing building that was commissioned earlier in its existence undergoes the same procedures again to maintain the effectiveness of commissioning measures.*

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Survey Questions

Background Questions

1. What type of organization are you affiliated with? Please choose the response that most closely matches your organization.

- ☐ Energy service company (ESCO)
- ☐ Engineering firm
- ☐ Consulting firm
- ☐ Private commissioning provider
- ☐ Building owner
- ☐ General contractor
- ☐ Governmental entity
- ☐ Non-profit organization
- ☐ Other (please specify)

2. What is your organization's typical role on commissioning projects?

- ☐ Commissioning Lead
- ☐ Building Owner or Owner Representative
- ☐ Building Manager or Staff
- ☐ System Specialist
- ☐ Design Professional
- ☐ LEED Consultant
- ☐ Installing Contractor
- ☐ Controls Contractor
- ☐ Maintenance Service Contractor
- ☐ Other (please specify)

3. How long has your organization been providing professional commissioning services?

- ☐ Less than 2 years
- ☐ 2-5 years
- ☐ 6-10 years
- ☐ More than 10 years
- ☐ Not applicable

Cx and RCx Activity in the Northwest

4. **In your opinion, how has the quantity of new building commissioning activity in the Pacific Northwest market (Washington, Oregon, Montana, Idaho) changed in the past two years? Please think in terms of the percentage of new building square footage that is commissioned.**

   ☐ Increased
   ☐ Decreased
   ☐ Stayed the same
   ☐ Don't know

5. **If you answered either "increased" or "decreased" to the question above: By about what percent has new building commissioning activity changed between 2009 and 2011 (as measured in percent change in square footage of building space)?**

   %: [Please enter a number between 0 and 100.]

6. **In your opinion, what share of new construction projects completed in the last year in the Northwest are commissioned? Again, please think in terms of the percentage of new building square footage that is commissioned.**

   %: [Please enter a number between 0 and 100.]

7. **In your opinion, what share of major existing building retrofit/renovation projects completed in the last two years in the Northwest are commissioned?**

   %: [Please enter a number between 0 and 100.]

8. **In your opinion, how has the quantity of existing building retro-commissioning activity changed in the past two years? Please think in terms of the percentage of existing building square footage that is retrocommissioned.**

   ☐ Increased
   ☐ Decreased
   ☐ Stayed the same
   ☐ Don't know

9. **If you answered either "increased" or "decreased" to the question above: By about what percent has retro-commissioning activity changed between 2009 and 2011 (as measured in percent change in square footage of building space)?**

   %: [Please enter a number between 0 and 100.]

10. Have any of the following factors influenced the trends that you've observed? [Select as many as you'd like]

- ☐ The decline in the economy
- ☐ Availability of federal stimulus funds (American Recovery and Reinvestment Act)
- ☐ Utility programs/incentives available
- ☐ New state/local policies
- ☐ Others: Please describe [OPEN ENDED]

11. [If any of the factors in Q10 are selected] Please describe the influence of these factors:

[OPEN ENDED]

12. How do you foresee the quantity of commissioning activity, including retro-commissioning and re-commissioning, changing in the next two years? Please think in terms of percentage of total square footage.
[MATRIX with columns for Cx, ReCx, and RCx]

- ☐ Increasing
- ☐ Decreasing
- ☐ Staying the same
- ☐ Don't know

13. If you answered either "increasing" or "decreasing" to the question above: By about what percent do you predict commissioning activity will change between 2011 and 2013 (as measured in percent change in square footage of building space)?

Commissioning: %:	[Please enter a number between 0 and 100.]
Re-commissioning: %:	[Please enter a number between 0 and 100.]
Retro-commissioning: %:	[Please enter a number between 0 and 100.]

Link between Commissioning and Re-commissioning

14. How long do the energy savings created by commissioning last after the completion of commissioning activities?

- ☐ Less than 1 year
- ☐ 1 year – 3 years
- ☐ 3 years – 5 years
- ☐ More than 5 years

15. Based on your observations of the Pacific Northwest market, what share of commissioned buildings are re-commissioned after a period of time?

%: [Please enter a number between 0 and 100.]

16. How much time typically elapses between commissioning and re-commissioning?

#: [Please enter the number of years.]

17. For buildings that are re-commissioned, how frequently does the same firm typically perform both commissioning and re-commissioning activities?

- ☐ Less than 25% of the time
- ☐ 25-49% of the time
- ☐ 50-74% of the time
- ☐ 75-100 % of the time

Cx and RCx Quality

18. In your opinion, in what ways has the *quality and type* of commissioning activity in the Pacific Northwest (Oregon, Washington, Montana, and Idaho) changed in the past two years? What factors have influenced those changes in quality and type of commissioning activity that you've observed? Please describe.

[OPEN ENDED]

19. What changes do you foresee occurring in the next two years with respect to the *quality and type* of commissioning activity in the Northwest? What are the major drivers likely to influence those trends?

[OPEN ENDED]

Organizational Cx Activity

20. Approximately how many commissioning projects, including retro-commissioning, did your organization perform in the Pacific Northwest (OR, WA, MT, ID) in 2011? If possible, break out by type of commissioning. Rough estimates are fine.

[NUMERIC RESPONSES]
Total number of projects:
Commissioning (of new construction) projects:
Retro-commissioning (of existing buildings) projects:
Re-commissioning (of previously commissioned buildings) projects:

21. What is the average square footage of your commissioning projects? Again, rough estimates are fine.

[NUMERIC RESPONSES]
Average square footage of commissioning (of new construction) projects:

Average square footage of retro-commissioning (of existing buildings) projects:
Average square footage of re-commissioning (of previously commissioned buildings) projects:

22. What are the three major types of buildings that your organization performs commissioning services on? [Select up to 3]

- ☐ Offices (private)
- ☐ Hospitals
- ☐ Other Health
- ☐ K-12 Schools
- ☐ Universities
- ☐ Grocery Stores
- ☐ Other Retail
- ☐ Hospitality
- ☐ Restaurants
- ☐ Warehouse
- ☐ Government
- ☐ Other [Describe:]

23. What organizations have influenced your Cx or RCx business? Can you describe the impact they had on your commissioning business?

[OPEN ENDED]

24. If these organizations had *not* influenced you, do you think you would have done the same amount of commissioning work over the past two years?

- ☐ Yes, would have done the same amount of work
- ☐ No, would have done *less* commissioning work
- ☐ No, would have done *more* commissioning work

25. [IF Q23=No] About how much more/less commissioning work do you think you would have done? Think in terms of the percentage of total project square footage, if possible.

%: [Please enter a number between 0 and 100.]

26. Do you have any other comments you'd like to provide about your commissioning business or the market for commissioning services in the Northwest?

[OPEN ENDED]

27. Do you have any comments or questions for NEEA?

[OPEN ENDED]

May we re-contact you if we have additional questions? (Y/N)

Contact Details

Please provide the following information about yourself:

Name:
Company:
Email Address:
Phone Number:

Note: **All contact information and individual responses will be kept confidential, and responses will not be publicly associated with you or your organization in any way.** It is important that NEEA is aware of who the respondents are and that they represent real organizations in the Northwest. You will not be contacted for any commercial purposes as a result of participating in this survey.

May we contact you if we have questions about your responses, or for additional research?

- ☐ Yes
- ☐ No

Thank you for your time!

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Appendix C. Drive Power – Supplemental Information

C.1 Motor Shipment Data and Motor Sales Estimation Methods

Reported Motor Shipment Data, 2001-2007

Table C-1: Reported Shipments of NEMA Premium™ Motors, 2001–2004*

	2001	2002	2003	2004
Idaho				4,736
Montana				326
Washington		N/A		2,725
Oregon				2,834
Northwest				10,621
Nation	187,170	266,958	311,117	267,220

*Data on standard efficiency motors was not available prior to 2005. OEM motor shipment data were not available after 2003.

Source: NEMA motor shipment data as reported by the CEE.

Table C-2: Reported Shipments of NEMA Premium™ and Standard Efficiency Motors, 2005-2006*

	2005				2006			
	Premium	Non-Premium	Total	% Premium	Premium	Non-Premium	Total	% Premium
Idaho	8,677	8,223	16,900	**51%**	8,732	9,428	18,160	**48%**
Montana	**(Included in Idaho)**				**(Included in Idaho)**			
Washington	1,926	7,787	9,713	**20%**	4,048	9,975	14,023	**29%**
Oregon	1,801	10,020	11,821	**15%**	6,536	9,753	16,289	**40%**
Northwest	12,404	26,030	38,434	**32%**	19,316	29,156	48,472	**40%**
Nation	216,852	668,522	885,374	**24%**	238,098	807,795	1,045,893	**23%**

* One motor manufacturer stopped reporting shipments as of 2005.
Source: NEMA motor shipment data as reported by the CEE.

Table C-3: Reported Shipments of NEMA Premium™ and Standard Efficiency Motors, 2007

	Premium	Non Premium	Total	% Premium
Idaho	13,347	9,833	23,180	**58%**
Montana	**(Included in Idaho)**			
Washington	3,183	10,522	13,705	**23%**
Oregon	3,216	11,981	15,197	**21%**
Northwest	19,746	32,336	52,082	**38%**
Nation	217,604	838,621	1,056,225	**21%**

Source: NEMA motor shipment data as reported by the CEE.

METHOD OF ESTIMATING NATIONAL NEMA Premium™ Motor Shipments

Navigant estimated the total number of NEMA Premium™ units shipped in 2004 through 2009 from the available data. This estimation proceeded as follows (see for estimated shipments):

1. **2004 NEMA Premium™ shipments.** The estimate of 2004 national shipments assumed the average of annual growth rates from the year before and after 2004. Data sources remained consistent between 2002 and 2003 and yielded a 17 percent growth rate. A consistent set of sources reported data in 2005–2006, during which premium motor sales grew nationally by 10 percent. Navigant applied the average of these two growth rates to 2003 reported shipments to derive an estimate of more than 350,000 motors shipped in 2004.
2. **2005–2007 NEMA Premium™ shipments.** The estimate of 2005 shipments used the annual growth rate of *reported* shipments between 2005 and 2006 (the nearest period with consistent reporting data), as applied to the 2004 motor shipment estimate. Building on this 2005 estimate, annual growth rates from reported data for 2006 and 2007 yielded estimates for shipments in these years. The result is a peak of nearly 425,000 NEMA Premium™ motors shipped in 2006, declining to less than 390,000 in 2007.
3. **2008-2009 NEMA Premium™ shipments.** In 2008, the motor manufacturer that had dropped out of the survey in 2005 began reporting data to NEMA again. As a result, the reported data between 2007 and 2008 did not consist of a common set of companies, and any calculated growth rate would have little meaning. Instead, the LTMT analysis assumed that the ratio of actual shipments to reported shipments in 2008 was the same as in 2004—the last year for which all non-OEM motor manufacturers reported shipments. This ratio—which effectively adjusts for the missing OEM data—was 1.32 in 2004 and results in estimated shipments in 2008 of approximately 317,000.[75] In 2009, the number of reporting manufacturers remained constant, and thus Navigant used the same ratio of 1.32 to estimate the year's total NEMA Premium™ shipments of approximately 266,000 motors.

[75] According to interviews with GMPG, OEMs account for approximately 33 percent of total motor sales. If this were accurate, then the required adjustment factor to correct for the incomplete reporting data would be 1.5. The LTMT estimated resulted in an adjustment factor of 1.32.

4. **2010-2011 NEMA Premium™ shipments.** Due to market uncertainty, Navigant assumes that sales in 2010 and 2011 will remain flat.

METHOD OF ESTIMATING REGIONAL NEMA PREMIUM™ MOTOR SHIPMENTS

2001 NEMA Premium™ Sales: Navigant estimated NEMA Premium™ sales in the Northwest based on previous research. MPERs and previous LTMT reports indicated that NEEA's influence on the sale of NEMA Premium™ motors was minimal in 2001, the first year for which data is available.[76] Therefore, the baseline in 2001 includes all regional premium motor sales. Since regional motor shipment data was not available until 2004, the analysis assumed that premium motor shipments in the Northwest in 2001 could be estimated based on national premium motor shipment data and on the region's share of all motors (premium and non-premium) shipped nationally in that year. Navigant used the Northwest's share of the U.S. population in 2001 as a proxy for the ratio of total motors shipped in the Northwest to total motors shipped nationally. This ratio of 4.8 percent translates into an estimate of approximately 9,000 NEMA Premium ™ motors shipped and sold in the Northwest in 2001.[77]

2002–2004 NEMA Premium™ Sales: The assessment calculated sales based on linear interpolation between the 2001 and 2005 estimates.

2005–2007 NEMA Premium™ Sales: Regional shipment data for NEMA Premium™ motors is available back to 2004. However, similar to the national data, the regional data for these years does not include OEM motors (starting in 2004) or shipments from one of the major motor manufacturers (starting in 2005). Therefore, Navigant applied an adjustment factor to each year's data for Northwest premium motor shipments to convert from *reported* shipments to a projection of *actual* shipments. (See Table C-3 for regional data from 2005 through 2007.) This adjustment factor equals the ratio of projected *national* shipments to reported *national* shipments (see above). Since 2006 and 2007 projections reflected annual growth in reported shipments, the adjustment factor of approximately 1.8 is the same value for each year between 2005 and 2007. The result is an estimate of more than 22,000 NEMA Premium™ motors shipped in 2005, rising to more than 35,000 in 2007.[78]

2008-2009 NEMA Premium™ Sales: In 2008, one would expect the adjustment factor to be smaller than in previous years since the motor manufacturer that had dropped out of the survey in 2005 began reporting again. This change in reporting entities meant that the set of companies reporting in 2008 included all major motor manufacturers, but none of the OEMs—the same makeup of companies as in 2004 when the ratio of projected national shipments to reported national shipments was approximately 1.3 (see *National Motor Shipment Trends* above). Applying this adjustment factor to the 2008 reported data yields an estimate of approximately 20,600 motors sold in the Northwest in 2008 and 31,900 motors in 2009.

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[76] NEMA premium motor sales only started in 2001, as documented in the 2007 M&T report. Until that time, the initiative was in a planning stage, and fieldwork was actively conducted only late in the year.

[77] Navigant confirmed the appropriateness of using population as a proxy for motor sales by analyzing regional data for the first three years where it was available. Based on shipment data for 2005-2007, the Northwest accounted for 4.7 percent of total motor shipments nationally, compared to the proxy value of 4.8 percent used for 2001.

[78] The methodology used to determine adjustment factors implicitly assumes that the ratio of OEM to non-OEM motors is the same nationally and in the Northwest.

NEMA Premium™ motor shipments decreased by nearly half between 2007 and 2008, even though the market penetration of premium motors remained almost constant at just under 40 percent. Navigant learned from the BPA interview (corroborated by GMPG) that in 2008, due to the recession, large mills in the Northwest went out of business, resulting in inexpensive second- hand motors (including NEMA Premium™ motors) entering the market in the Northwest. As a result, new motor purchases decreased, effectively lowering sales of both standard and premium efficiency motors in the region. Although national shipments of NEMA Premium™ motors, *as reported by CEE,* dropped by 10 percent between 2004 and 2008 (owing to the factors discussed previously), reported shipments of premium motors in the Northwest increased by 47 percent. This suggests that premium motor sales in the Northwest have trended upward at a significantly higher rate than they have nationally. This trend continued in 2009. At the same time that NEMA Premium™ motor sales fell 16 percent nationally from 2008 to 2009, sales of these motors increased nearly 55 percent in the Northwest, from 15,646 motors in 2008 to 24,190 motors in 2009.

2010–2011 NEMA Premium™ Sales: As noted above, sales of premium motors in the Northwest declined in 2008 to below 2005 levels, likely due to the economic recession. The 2009 shipment data suggests a significant recovery from the 2008 level; however, due to market uncertainty, Navigant assumes that sales in 2010 and 2011 will remain flat.

C.2 INTERVIEW GUIDE FOR MARKET ACTORS

Hello, my name is _____, and I am calling on behalf of the Northwest Energy Efficiency Alliance (NEEA). NEEA hired my company, Navigant Consulting, for the purpose of updating information about the market for energy efficient motor rewinds in the Northwest.
I would like to ask a brief number of questions regarding the current state of the rewind market, and the long-term effects in the Northwest of NEEA's Drive Power Initiative (DPI), which ended in 2004. I greatly appreciate your participation in this effort as it significantly contributes to the long-term metering and tracking of NEEA's past initiatives. If possible, I would like to set up a short phone interview within the next week, at your convenience, to discuss your thoughts on the following questions.
[Note: These targeted respondents have participated in similar interviews in the past and are well versed in the LTMT of the DPI.]

Market Activity

1) In 2009, Navigant surveyed 18 motor service centers in the Northwest with the specific aim of a) determining how many motors are rewound annually and what percentage of these are EASA Tech Note 16-compliant rewinds, b) gaining insight into energy savings due to Tech Note 16 rewinds, and c) estimating the effect of the DPI on the prevalence of Tech Note 16 rewinds.

   Based on the 2009 survey sample, Navigant provided NEEA with the following estimates of *total* motor rewinds performed at motor service centers in the Northwest:

   - 4,500 rewinds for GMPG members
   - 5,800 rewinds for non-members
   - 10,300 total rewinds in the Northwest

   a) Based on your experience, do these numbers sound reasonable for the region? How certain are you, on a scale of 1 to 4 (with 1 being "not certain at all" and 4 being "very certain")?

   b) Have the number of *all* types of rewinds increased, decreased or remained the same in the last two years? [Probe for a range if respondent cannot give specific numbers, e.g. increased less than 10 percent, increased 10-49 percent, increased 50-90 percent, increased greater than 90 percent]

2) **(GMPG Only)** Are the GMPG tracking rewinds on motors larger than 500 HP?
   a) If so, what percentage of GMPG members conduct Tech Note 16-compliant rewinds on motors larger than 500 HP (less than 10 percent, 10-49 percent, 50-90 percent, greater than 90 percent)?

b) What percentage of non-GMPG members conduct Tech Note 16-compliant rewinds on motors larger than 500 HP (less than 10 percent, 10-49 percent, 50-90 percent, greater than 90 percent)?

3) In the 2009 LTMT study, 100 percent of GMPG members surveyed responded that they offered energy efficient rewinds fully compliant with the EASA Tech Note 16 guidelines, compared to about 25 percent for non-members. To what extent do you think that this is still true in the market today? How certain are you, on a scale of 1 to 4 (with 1 being "not certain at all" and 4 being "very certain")

4) The ten GMPG members surveyed in 2009 claimed that 82 percent of their total rewinds were EASA Tech Note 16 compliant, compared to about 5 percent for the eight non-members.

   a) Based on your professional experience, what percentage of total motor rewinds currently performed by GMPG members would you expect to be Tech Note 16-compliant (less than 10 percent, 10-49 percent, 50-90 percent, greater than 90 percent)?

   b) What percentage of total motor rewinds currently performed by *non*-GMPG members would you expect to be Tech Note 16-compliant (less than 10 percent, 10-49 percent, 50-90 percent, greater than 90 percent)?

5) Based on your professional experience, what percentage of Tech Note 16 compliant rewinds performed in the Northwest are currently incentivized (less than 10 percent, 10-49 percent, 50-90 percent, greater than 90 percent)?

   a) Does this number differ for motors larger than 500 HP?

   b) How can we access that information?

6) ***Testing equipment:*** In your experience, what percentage of service centers owns a core loss tester (less than 10 percent, 10-49 percent, 50-90 percent, greater than 90 percent)?

   a) How is testing equipment calibrated? [If more than one method, probe for how many service centers (less than 10 percent, 10-49 percent, 50-90 percent, greater than 90 percent) calibrate this way]

   b) To what extent is this done in-house (less than 10 percent, 10-49 percent, 50-90 percent, greater than 90 percent)?

   c) Do GMPG members and non-members follow different protocols to calibrate their core loss testers? [If members or non-members follow different protocols, probe for how many centers in each group (less than 10 percent, 10-49 percent, 50-90 percent, greater than 90 percent) follow each set of protocols.]

7) ***[BPA Only] NEEA Trainings:*** What percentage of program participating service centers have taken part in NEEA sponsored trainings on motors (less than 10 percent, 10-49 percent,

50-90 percent, greater than 90 percent)? [By participating center we mean a service center that claims incentives for performing Tech Note 16 compliant rewinds.]

8) What is your perception of trends in the motor repair industry of the Northwest market over the past three years? Would you say that the motor repair market in the Northwest has grown, stagnated, or shrunk? [Probe for why].

Baseline Activity

In the remainder of this interview, we will refer to the term "baseline" as the level of Tech Note 16 rewinds that would have occurred in the absence of NEEA's DPI.

9) ***[BPA Only]*** We are trying to assess the baseline of Tech Note 16-compliant motor rewinds in the Northwest. In 2007, GMPG stated that before NEEA formally started its efforts, fewer than 10 percent of service centers had the means to perform a Tech Note 16-compliant rewind. A 2007 Navigant report estimated the baseline at less than 5 percent, and since then, Navigant has assumed a flat 5 percent baseline.

   a) Based on your experience, what percentage of Northwest motor service centers would be providing Tech Note 16 compliant rewinds in 2012 if the region had not funded DPI or GMPG?

      a) What data or personal observation supports this percentage?

   b) Is the assumption of a flat baseline over time accurate, or do you think that the share of service centers offering Tech Note 16 rewinds would have naturally increased over time without NEEA influence?

If you think that the offering of Tech Note 16-compliant rewinds would have increased over time:

   a) To what extent do you think that it would have changed?

   b) Would it have increased at the same rate for all hp-classes of motors?

   c) in the past few years?

10) Do you have any other comments regarding NEEA's estimated baseline for efficient rewinds in the Northwest?

Per-Unit Savings

11) ***[BPA Only]*** Interviews with the GMPG indicated that most motor rewinds are for motors larger than 75 HP, whereas motors below 75 HP are replaced by new motors. To what extent is this practice consistent with what you have observed in the market? Please tell me more.

12) Feedback from the surveys suggested that the typical size of motors receiving an energy efficient rewind is between 75 HP and 200 HP. We used the conservative estimate of 75 HP

in 2009, which corresponded to annual savings of about 1,100 kWh per motor. From your experience, does this assumption sound reasonable? How certain are you on a scale of 1 to 4 (with 1 being "not certain at all" and 4 being "very certain")?

13) What motor range would you say is the most prevalent group to receive a Tech Note 16-compliant rewind (75 HP or less, 75-100 HP, 100-200 HP, 200 HP or more)?

14) Do you have any other thoughts as to how much energy is saved by rewinding per Tech Note 16 as opposed to any other way of rewinding?

Additional Motor Service Center Survey

[The following questions assess the need for conducting additional surveys with motor service centers. If the market actors report significant changes to the motor rewind industry in the past two years, or express significant uncertainty in the current practices of motor service centers, these centers will need to be surveyed to update current market assumptions.]

15) Navigant conducted its last round of detailed motor center surveys regarding motor rewind practices, in the Northwest, in 2009-10.

    a) Based on your experience, have motor rewind practices by GMPG non-members changed significantly in the past two years? If so, please tell me how?

    b) How certain are you of your knowledge of the current motor rewind practices of non-members on a scale of 1 to 4 (with 1 being "not certain at all" and 4 being "very certain")?

Concluding Statement

Thank you for your time. If I have any follow up questions would it be alright to contact you via phone or email?

Appendix D. ENERGY STAR Windows Supplemental Information

This appendix presents tables showing market activity for all years tracked. Section 5 above presents similar tables but only for activity in 2008 through 2011.

Table D-1: Fenestration Products Shipped in the Northwest from 2001-2011 (Thousands)

Year	New Construction			Existing Homes		
	Windows	*Skylights*	*Patio Doors*	*Windows*	*Skylights*	*Patio Doors*
1997-2000	Data Not Available[79]					
2001	1,199	37	73	1,372	42	96
2002	1,137	38	78	1,446	43	103
2003	1,087	40	85	1,520	47	111
2004	1,273	40	83	1,520	44	112
2005	1,124	38	79	1,495	43	111
2006	1,065	35	75	1,417	39	105
2007	944	31	66	1,256	35	93
2008	770	23	54	1,024	26	76
2009	729	18	59	1,050	21	68
2010	782	24	64	1,126	27	73
2011	805	25	66	1,159	28	76

Source: Summit Blue/Navigant analysis of Ducker Research market reports (2004, 2007, 2008, 2010 and 2011)

[79] NEEA tracked the total area of windows shipped in the Northwest between 1998 and 2000, but the number of units shipped was not available to the LTMT project team.

Table D-2: Total Area of Windows Shipped in the Northwest from 1997-2011 (Thousand Square Feet)

Year	New Construction	Existing Homes	Total
1997	*	*	48,709
1998	*	*	48,709
1999	*	*	48,709
2000	*	*	48,709
2001	22,318	26,055	48,372
2002	21,534	27,495	49,030
2003	21,046	29,048	50,094
2004	23,913	29,083	52,996
2005	21,385	28,631	50,015
2006	20,250	27,113	47,363
2007	17,929	24,004	41,933
2008	14,624	19,582	34,206
2009	14,147	19,648	33,795
2010	15,213	21,117	36,330
2011	15,659	21,736	37,395
Total	*****	*****	676,366

* Data disaggregated by vintage was not available to the LTMT project team for 1997-2000.

Source: Summit Blue/Navigant calculations and assumptions regarding average area per window.

Table D-3: Market Share of ENERGY STAR Windows Shipped in the Northwest from 1997-2011

	ENERGY STAR Market Share (%)	New Construction (ft^2 x 1,000)	Existing Homes (ft^2 x 1,000)	Total (ft^2 x 1,000)
1997	13%	*	*	6,218
1998	41%	*	*	19,971
1999	47%	*	*	22,893
2000	54%	*	*	26,303
2001	75%	16,738	19,541	36,279
2002	81%	17,443	22,271	39,714
2003	88%	18,521	25,562	44,083
2004	89%	21,282	25,884	47,166
2005	91%	19,460	26,054	45,514
2006	93%	18,833	25,215	44,048
2007	95%	17,032	22,804	39,836
2008	95%	13,892	18,603	32,496
2009	95%	13,440	18,665	32,105
2010	95%	14,452	20,061	34,513
2011	95%	14,876	20,649	35,525
Total		*****	*****	**506,665**

* Data broken out by vintage was not available to the LTMT project team for 1997-2000.
Source: Summit Blue/Navigant analysis of interview data applied to gross window areas.

Table D-4: Area of Windows Shipped to Homes with Electric Space Heating from 2001-2011 (Thousand Square Feet)

Year	New Construction			Existing Homes		
	Single Family	*Multi-Family*	*Manufactured*	*Single Family*	*Multi-Family*	*Manufactured*
1997-2000	Data Not Available*					
2001	1,530	2,525	1,519	4,898	2,340	1,291
2002	1,595	2,631	1,582	5,582	2,667	1,472
2003	1,693	2,794	1,680	6,407	3,061	1,689
2004	1,946	3,210	1,931	6,487	3,100	1,711
2005	1,779	2,935	1,765	6,530	3,120	1,722
2006	1,722	2,841	1,709	6,320	3,020	1,666
2007	1,557	2,569	1,545	5,715	2,731	1,507
2008	1,270	2,096	1,260	4,663	2,228	1,229
2009	1,229	2,027	1,219	4,678	2,235	1,233
2010	1,341	2,124	968	5,978	2,604	1,774
2011	1,381	2,186	997	6,153	2,680	1,826

* Data broken out by vintage was not available to the LTMT project team for 1997-2000.
Source: Summit Blue/Navigant analysis of Ducker Research market reports (2004, 2007, 2009, 2010, and 2011) and data from the NW Council.

Table D-5: Area of Windows Shipped to Homes with Gas Space Heating from 2001-2011 (Thousand Square Feet)

Year	New Construction			Existing Homes		
	Single Family	*Multi-Family*	*Manufactured*	*Single Family*	*Multi-Family*	*Manufactured*
1997-2000	Data Not Available*					
2001	8,977	1,702	253	8,014	285	138
2002	9,355	1,773	264	9,134	324	158
2003	9,933	1,883	280	10,484	372	181
2004	11,414	2,163	322	10,616	377	183
2005	10,437	1,978	294	10,685	379	184
2006	10,100	1,914	285	10,341	367	179
2007	9,135	1,731	258	9,353	332	161
2008	7,451	1,412	210	7,630	271	132
2009	7,208	1,366	203	7,655	272	132
2010	8,719	1,013	161	7,179	317	190
2011	8,975	1,043	166	7,390	326	196

* Data broken out by vintage was not available to the LTMT project team for 1997-2000.
Source: Summit Blue/Navigant analysis of Ducker Research market reports (2004,2007,2009, 2010, and 2011) and data from the NW Council

Table D-6. Area of Windows Shipped to Homes with Central Air Conditioning from 2001-2011 (Thousand Square Feet)

Year	New Construction			Existing Homes		
	Single Family	*Multi-Family*	*Manufactured*	*Single Family*	*Multi-Family*	*Manufactured*
1997-2000	Data Not Available*					
2001	4,458	1,123	753	3,356	316	384
2002	4,645	1,171	785	3,825	360	437
2003	4,933	1,243	833	4,390	414	502
2004	5,668	1,428	957	4,445	419	508
2005	5,183	1,306	875	4,474	422	511
2006	5,016	1,264	847	4,330	408	495
2007	4,536	1,143	766	3,916	369	448
2008	3,700	932	625	3,195	301	365
2009	3,579	902	605	3,205	302	366
2010	5,794	655	657	7,541	1,601	1,095
2011	5,964	674	676	7,762	1,648	1,127

* Data broken out by vintage was not available to the LTMT project team for 1997-2000.
Source: Summit Blue/Navigant analysis of Ducker Research market reports (2004.2007, 2009, 2010, and 2011) and data from the NW Council.

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Appendix E. Verdiem Interview Guides

E.1 Verdiem Competitor Interview Guide

Objectives: Determine market effects of NEEA's early support of Verdiem.

Is it true that Verdiem was the first in the market? If so, did competitors arise because of Verdiem? How big is that market response?

Sample:

Complete 5 interviews with high-level staff at Verdiem competitors in NW market

Company:

Product Name:

Initial Contact: Name, Title, Phone Number:

The Right Contact: Name, Title, Phone Number:

Interviewer:

Interview Date, Time:

Intro 1:
The Northwest Energy Efficiency Alliance, also known as NEEA, has asked us (Navigant) to help document the development of the market for networked PC power-management solutions: how the market started, its early evolution, and the most influential factors, companies, and products. NEEA intends to publish our findings in a 2012 report to help demonstrate the impact of their past work and inform their future efforts.

Navigant will keep confidential any information you provide. It will not be publicly associated in any way with you or your company. You may also request a copy of the final report.
Given [brand name product's] influence in this market, we'd like to include [company] in our research.

[Note to interviewer: If respondent asks for additional information about NEEA, please send them to the NEEA website: www.neea.org.]

Screen 1:
I'd like to speak with someone who can tell me about what drove [product's] development – from the beginning. Who would that be? [Probe: Is there more than one person there who would know about this? A product/brand manager? Someone from sales/marketing? A founding executive or board member?]

[Collect all contact info – first and last names, emails and phone #s if possible.]
Thank you for your help. I will follow up with [person suggested].

Intro 2: [For the correct respondent]
The Northwest Energy Efficiency Alliance, also known as NEEA, has asked us (Navigant) to help document the development of the market for networked PC power management solutions: how it started, the market's early evolution, and the influential factors, companies, and products. NEEA intends to publish our findings in a 2012 report to help demonstrate the impact of their past work and inform their future efforts.

Given [brand name product's] influence in this market, we'd like to include [company] in our research.

Is now a good time? Or can we schedule a time to talk later this week or early next week?

Background:
(Conduct preliminary internet research to address and then confirm answers with respondent during interview):

1. What year did you decide to develop a product for PC power management?

2. Did your company exist prior to this product's development, or was the product the reason for this company's founding?

3. What was your own role in the development and launch of [product]?

Drivers to Launch

4. What motivated [company] to develop [product]?

   [Prompt if needed: Demand from existing customers? Success of a similar product? Competitive advantage over market offerings at that time? Filling out your product offering?]

5. What firms did you see as first to market networked PC power-management solutions?

6. What other firms or products were you aware of in the market at the time you started development?

a. Was your decision to enter the market influenced by these other firms or products?
[If 6a=YES then ask 6b. Otherwise skip to 7.]

b. How did they influence your decision to enter the market?

7. In what year did you launch [product name] into the market?

8. Which companies/products did you see as your primary competitors when your power-management product launched?

Geographic Markets

9. Has [company] ever focused its sales efforts in a particular geographic market?

10. In which geographic markets was [product] first introduced? What led [company] to focus there?

11. **[Ask if PNW-focus was not already mentioned]** Have you sold [product] in the Pacific Northwest (i.e., Oregon, Washington State, Montana, Idaho)?

12. What led [company] to introduce or distribute [product] in the Northwest?

    [Prompt if needed: Demand from existing customers? Success of a similar product? Competitive advantage over market offerings at that time? Filling out your product offering?]

    [If 12 includes "success of competitors" or "market demand" then ask 12a; Else skip to 13**.]**

    a. What firms did you see as first to enter the Northwest market with networked PC power-management solutions?

    b. Was your decision to enter the Northwest market influenced by these other firms or products?

       [If 12b=YES then ask 12c; Else skip to 13.]

    c. How did they influence your decision to enter the market?

13. Which companies/products did you see as your primary competitors in the NW market at the time [product] launched there?

    a. [If Verdiem mentioned] How did Verdiem's experience influence your decision to enter the market?

14. Are you aware that the Northwest Energy Efficiency Alliance provided funding to Verdiem and collaborated with Verdiem to conduct pilot projects in the early 2000s?

    [If 14=YES then ask 14a; otherwise skip to optional questions]

    a. Did that effort have any effect on your approach to the Northwest? If so, please describe.

Optional Questions about Current Market

Phase 2 Objectives: Estimate market trends for PC Power Management

Market characterization (Is the market growing? Any issues or trends affecting the market opportunity for power-management software?

Review savings rate
[If someone is (1) talkative, (2) willing to discuss further, and (3) in an appropriate position to discuss current efforts, consider addressing these questions. These are out of scope of Phase 1, but this may help to inform Phase 2 efforts.

- What is your perception of the rate of growth of the PC power management market?
- Would you say that the market is growing, stagnate, or shrinking? [Probe for why].
- How would you describe your customers, in terms of geographic concentration, company size and industry? [Prompt: Institutional? Government? Larger or smaller organizations? Commercial (if so, which segments)? Residential? Industrial?]
- Do you have any data on energy savings from any of your customers that you would be willing to share?
- Do you have any customers in the Northwest who you think of as solid success stories or useful case studies for marketing purposes, who had both a good experience implementing the software and also have tracked their energy savings?
- **[IF YES TO either previous two questions]** Can we ask a NEEA representative follow up with you about them?

E.2 Verdiem Market Analyst Interview Guide

Objectives:

Investigate market effects of Verdiem early in the development of the market

Determine market influences contributing to Verdiem's recent decline in sales (beginning in 2009).

Sample:

- Complete up to 3 interviews with those knowledgeable about the networked PC power-management solution market, including Verdiem.
  - Verdiem (note that this interview will focus on the Current Market Conditions section of the interview guide)
  - 1-2 other market actors such as writers or analysts.

Company

Initial Contact: Name, Title, Phone Number

The Right Contact: Name, Title, Phone Number:

Interviewer:

Interview Date, Time:

Intro 1:
The Northwest Energy Efficiency Alliance, also known as NEEA, has asked us (Navigant) to help document trends in the market for networked PC power management solutions such as Verdiem's Surveyor, 1E's NightWatchman, Faronics' Power Save. NEEA intends to publish our findings in a 2012 report to help demonstrate the impact of their past work and inform their future efforts.

Given your knowledge of the market, we'd like to gain your input for our research.
[Note to interviewer: If respondent asks for additional information about NEEA, please send them to the NEEA website: www.neea.org.]

Screen 1:
I'd like to speak with someone who is familiar with the market for networked PC power-management solutions. Are you an appropriate person to speak to? [If no] Can you indicate who might be an appropriate contact?

[Collect all contact info – first and last names, emails and phone #s if possible.]

Thank you for your help. I will follow up with [person suggested].

Intro 2: [For the correct respondent]

The Northwest Energy Efficiency Alliance, also known as NEEA, has asked us (Navigant) to help document trends in the market for networked PC power-management solutions such as Verdiem's Surveyor, 1E's NightWatchman, Faronics' Power Save. NEEA intends to publish our findings in a 2012 report to help demonstrate the impact of their past work and inform their future efforts. Given your knowledge of the market, we'd like to gain your input for our research.
Is now a good time? Or can we schedule a time to talk later this week or early next week?

Background:

1) What is your role in the market for networked PC power-management solutions?

2) How long have you been [involved in/reporting on/etc] that market?

Evolution of the Market

3) What firms and products do you consider to have been the early leaders in the market for networked PC power management solutions?

4) What other firms or products were you aware of that played an important role in shaping the market for networked PC power management solutions?

    a) How did those firms/products shape the market? What were the most important?

    b) Did any of the firms/products play a particularly important role in innovation in the marketplace, either from a technological or business model perspective?

5) From your perspective, did any of those companies serve as a first mover that generated momentum for other entrants?

6) [If they have not mentioned Verdiem] Are you familiar with a company called Verdiem, or their product called Surveyor?

    a) If so, what is your perspective on Verdiem's role in the development of the market for networked PC power management solutions?

Current Status of the Market

7) What firms and products do you see as current leaders in the market for networked PC power management?

8) What is your perception of trends in that market over the past three years? Would you say that the market has grown, stagnated, or shrunk? [Probe for why]. Are those trends similar or different to those experienced in the Pacific Northwest during that time?

9) Do you know of any companies whose sales have increased or decreased disproportionately to the rest of the market during that three-year period?

   a) If so, which ones?

   b) What drove those dramatically [higher/lower] sales? [Probe: Loss of market share to competitors? Specific product features perceived as more/less advantageous?]

   c) [If Verdiem is not mentioned in Q9a] Do you know if Verdiem sales from 2009 to 2010 in the Pacific NW have grown, stagnated or shrunk?

      i) What drove Verdiem sales from 2009 to 2010 in the Pacific NW to have (grown, stagnated, shrunk)?