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Long Term Monitoring and Tracking Report on 2009 Activities

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Long Term Monitoring and Tracking Report on 2009 Activities

FINAL REPORT

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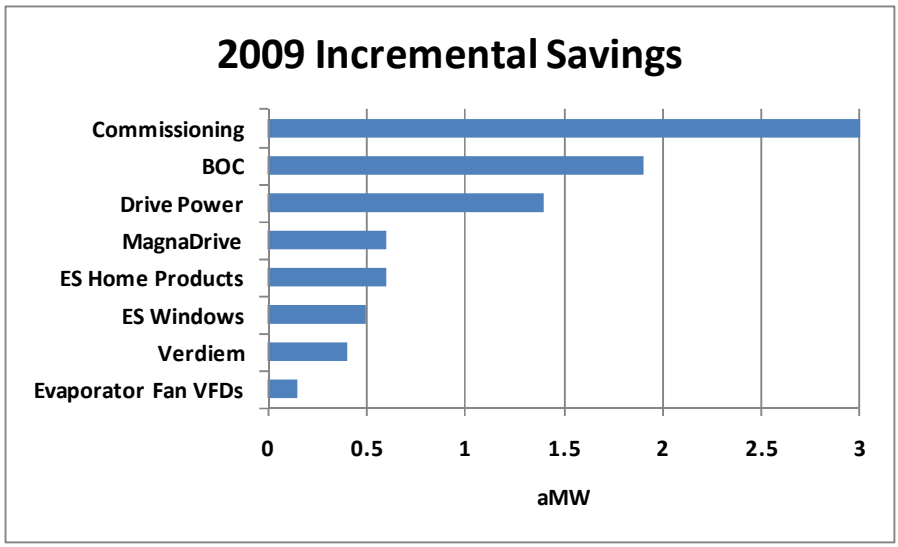
Executive Summary

Market transformation initiatives are long-term in nature. The development and launching of new products and services can be visualized as an "S"-shaped diffusion curve with relatively little market impact in the initial years and the major market effects occurring several years after an initiative is launched. 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, since 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.

ES.1 Results by Initiative

Of the eight initiatives assessed in the 2009 long term monitoring and tracking (LTMT), Building Commissioning represents the greatest incremental savings at 3 aMW, with Building Operator Certification and Drive Power at 1.9 aMW and 1.4 aMW, respectively. Across the eight initiatives, 2009 incremental savings (due to new activity occurring in 2009) are estimated to be 8.5 aMW (Figure ES-1).[1]

Figure ES-1. 2009 Incremental Energy Savings from the 2009 M&T Assessment (aMW)[2]



Source: Navigant Consulting Analysis

[1] In all cases, savings represent total estimated savings from market activity (as defined for each initiative) less estimated savings from baseline activity. Savings figures include savings from market activity for which utility incentives were provided.

[2] 2009 incremental savings are due to new activity occurring in 2009 and represent estimated savings from market activity less estimated savings from baseline activity. NEEA's reported values may not match those presented here, since NEEA adjusts for the effect of utility incentives and other factors not taken into account in this M&T analysis. Savings for Evaporator Fan Variable Frequency Drives (VFDs) are the average annual difference between the cumulative savings estimates from 2007 and 2009.

ES.1.1 Building Operator Certification

Building Operator Certification was awarded to 137 operators in 2009, with nearly two-thirds of the activity being conducted through the Northwest Energy Efficiency Council (NEEC). After accounting for retirements (due to the fact that some operators certified more than five years ago have not renewed their certifications), the number of certified building operators in the Northwest is now 1,077, a 6% increase over 2008. Incremental savings for the 137 new certifications in 2009 are estimated at 1.9 aMW.

ES.1.2 Commissioning and Commissioning in Public Buildings

Building commissioning has continued in both the public and private sectors, with the majority of activity occurring in the institutional sector and in schools, universities, and health care facilities. An estimated 33 million square feet of commercial space has been commissioned annually in 2008 and 2009, with the total nearly evenly split between commissioning of new buildings and retrocommissioning of existing buildings. Annual incremental savings are estimated at approximately 3.0 aMW, with more than two-thirds of the savings attributable to retrocommissioning.

ES.1.3 Drive Power

The Drive Power initiative has created significant market transformation both for sales of National Electrical Manufacturers Association (NEMA) Premium™ motors and for more efficient motor rewind practices. The sale of NEMA Premium™ motors has increased nearly four-fold since 2001, and *regional growth in sales of premium efficiency motors has been at approximately 25% per year, versus 13% nationally*. With more than 34,000 premium efficiency motors sold in the Northwest in 2009 (nearly half of which were in excess of estimated baseline sales), incremental savings from NEMA Premium™ sales are estimated at 0.9 aMW.

With regard to energy efficient rewinds, the M&T analysis concludes that members of the Green Motors Practices Group (*GMPG) tend to perform energy efficient rewinds that are fully compliant* with guidelines from the Electrical Apparatus Service Association (EASA). Conversely, few non-members make a distinction between efficient and standard rewinds and many claims of "efficient" rewinds do not represent EASA-compliant practices. It is estimated that nearly 4,000 EASA-compliant rewinds were performed in the Northwest in 2009, representing approximately 0.5 aMW of incremental savings.

ES.1.4 ENERGY STAR Home Products

The market for ENERGY STAR qualified refrigerators, dishwashers, and clothes washers changed significantly during the 2008-09 time period. A myriad of changes to the federal energy efficiency standards and to the ENERGY STAR criteria for these appliances reduced the per-unit energy savings and the number of models that qualified for ENERGY STAR, respectively. In addition, the recession focused consumer spending on need-based purchasing that was focused on first costs. ENERGY STAR refrigerators did not add any incremental savings in 2008

or 2009, because the baseline activity exceeded overall market activity in the Northwest. Implied energy savings from clothes washers was modest at 0.1 aMW per year in 2008 and 2009, and the market for ENERGY STAR dishwashers added 0.5 aMW per year in those years.

ES.1.5 ENERYGY STAR Residential Windows

The total area of ENERGY STAR windows shipped in the Northwest was just under 25 million square feet in 2009, with the market share of ENERGY STAR windows at more than 95% of all window shipments. Baseline activity represented nearly 70% of the market in 2009, yielding incremental savings of approximately 0.5 aMW.

ES.1.6 Evaporator Fan VFDs

The 2009 M&T analysis found that the market share of evaporator fan VFDs in refrigerated warehouses in the Northwest increased by 6% relative to the 2007 findings, and represented an additional 2,100 horsepower of capacity. The assumed baseline continues to grow and now accounts for close to 50% of market activity. The per-unit energy savings for evaporator fan VFDs in refrigerated warehouses are estimated to be about 4%-6% lower than previously assumed, depending on the warehouse type. This results in an incremental savings of approximately 0.3 aMW between 2007 and 2009.

ES.1.7 MagnaDrive

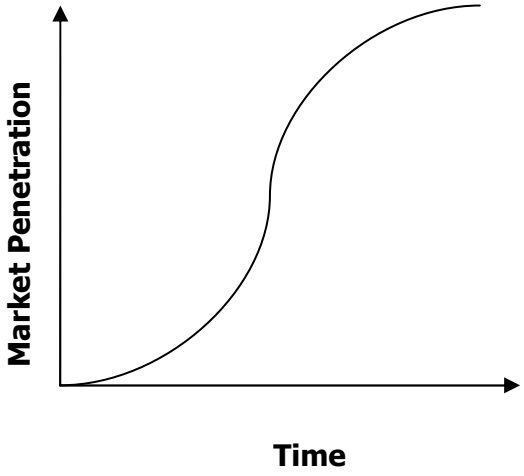
NEEA projects supporting MagnaDrive had initially significantly accelerated the transformation of the adjustable speed drive market. However, the Northwest has seen a significant reduction in MagnaDrive sales, probably due to the economic downturn, and couplings have become a major portion of sales and savings from the MagnaDrive technology. The total of both adjustable-speed drive (ASDs) and coupling horsepower in the Northwest in 2009 was 7,325 horsepower, significantly less than the 11,972 horsepower predicted by MagnaDrive. Coupling savings are conservatively estimated at around half the per-unit savings of ASDs, and couplings account for roughly two-thirds of the 0.6 aMW of incremental savings in 2009.

ES.1.8 Verdiem Network Energy Management Software

Annual sales network energy management systems in the region continue to vary from one year to the next with sales of roughly [redacted] units in 2009. Over the past two years, providers of network energy management increased their visibility and marketing efforts in the region, resulting in an increase in the baseline activity, which is now recommended to be established at 50% of market activity. Holding per-unit savings unchanged from previous estimates of 190 kWh per unit per year, incremental savings in 2009 are estimated to be 0.4 aMW.

Section 1. Introduction

Market transformation initiatives are long-term in nature. The development and launching of new products and services can be visualized as an "S"-shaped diffusion curve with relatively little market impact in the initial years and the major market effects occurring several years after an initiative is launched. 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, since 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 ("M&T" or "LTMT") is to measure and track critical market progress indicators and Alliance Cost-Effectiveness (ACE) model assumptions that are used to estimate long-term electricity savings. Long term M&T employs 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 may be required to improve the precision of the market effects estimates. Long-term M&T is *not* intended to be an exhaustive evaluation of initiative impacts but rather a relatively brief and conservative assessment of the market effects of these initiatives.

The 2009 M&T effort applied a market-wide, top-down approach where feasible and appropriate. This suggests that market penetration rates are often estimated for the product or activity that is being promoted, rather than individual sales or actions being counted. For example, the early stages of many NEEA market transformation initiatives include tracking the adoption of a vendor's energy efficiency product or documentation of 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 M&T 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, a "bottom-up" accounting of market activity was performed since NEEA believes that it is able to directly quantify all relevant market activity.

1.1 Monitoring and Tracking Methodology

The long-term M&T process was conducted as follows:

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 be tracked.** 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, specific data inputs and initiative indicators were identified for tracking.

3. **Development of a data collection/analysis work plan for each initiative.** These plans were based on a review of the M&T approach recommended by MPERs or past M&T assessments and on recent market research and insights from NEEA staff familiar with the various markets being addressed by NEEA initiatives. The work plans served as guides to the individual M&T assessments and included the following elements:

    - Background on the initiative
    - Assumptions, market indicators, and inputs to energy savings calculations
    - Methodology for data collection and analysis

4. **Execution of the work plans and reporting of findings and recommendations.** Individual M&T 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 M&T efforts.

After the long-term M&T report is finalized, NEEA staff presents the findings and recommended changes to the NEEA Cost-Effectiveness Committee and incorporates them into the ACE models once they are approved. As initiative monitoring and tracking procedures are initiated for each NEEA initiative after its active funding cycle, some will require greater data collection efforts than others. M&T efforts will continue to focus on developing reliable estimates of real market transformation at the state and regional level and the energy savings attributable to these initiatives. When there is high uncertainty surrounding energy savings for a particular initiative, and the savings are significant, additional data collection may be prudent. For those with limited impacts, or with good tracking data, existing data sources may be sufficient. Each initiative assessment in the following chapters contains recommendations for ongoing data collection activities.

1.2 M&T Review for 2009

The 2009 M&T effort reviewed eight NEEA initiatives, all of which were updates to previous M&T assessment. These eight initiatives include the following:

1. Building Operator Certification
2. Commissioning and Commissioning in Public Buildings
3. Drive Power Initiative
4. ENERGY STAR Home Products
5. ENERYG STAR Residential Windows
6. Evaporator Fan VFDs
7. MagnaDrive
8. Verdiem Network Energy Management Software

For each initiative, the M&T project team focused on tracking activity in the market, examining NEEA's baseline assumptions (to varying degrees, depending on the initiative and past M&T efforts), and assessing energy savings. Sections 2 through 9 of this report present background, methodologies, findings, and recommendations for each NEEA initiative in the order listed above.

1.3 Long Term M&T for 2009 and Beyond

Future long-term monitoring and tracking efforts may include updates to some of the initiatives assessed in this 2009 M&T report, as well as updates to previous M&T assessments and additional NEEA initiatives that no longer receive funding. A *tentative schedule* for each of the initiative tracking efforts for 2010 is shown in Table 1-1, along with the M&T assessments from the past five years. The list of initiatives to have reviews conducted for 2010 will be discussed with the NEEA project manager and reviewed by the Cost-effectiveness Committee of the NEEA Board before the 2010 plan is finalized.

Table 1-1. Timeline for Conducting / Updating Long-Term Monitoring & Tracking

INITIATIVE	2005	2006	2007	2008	2009	2010
ENERGY STAR Residential Windows	C		U		U	U
Building Operator Certification (BOC)	C		U	U	U	U
SAV-AIR	C	U		2008 M&T cancelled		
Just Enough Air	C	M&T Discontinued				
Evaporator Fan VFDs	C	U	U		U	
Siemens (Shell Solar)	C	U	U	Assess need annually		
BacGen	C	U		U		U
Verdiem	C		U		U	
Commissioning in Public Buildings	C		U		U	
Small Commercial HVAC (AirCare Plus)	C	M&T Discontinued				
ENERGY STAR Home Products			C		U	
MagnaDrive		C		U	U	
Dendritic Polysilicon Production (ASiMi)			C	Assess need annually		
Electric Motor Management (Drive Power)			C	U	U	U
Optichill (Microelectronics)			C	Recommended to discontinue		
SIS/AM400		C	U	Recommended to discontinue		

NOTES: C = Conduct initial analysis; U = Update to initial analysis

Shaded rows are initiative addressed in this 2009 M&T report.

Section 2. Building Operator Certification

Building Operator Certification (BOC), which was funded by the Alliance from 1997 through 2003, was offered as a professional development program that teaches facility managers, building operators, maintenance personnel, and others who monitor commercial building controls how to reduce energy and resource consumption in the facilities they operate. The effort was intended to achieve lasting improvement in the energy-efficient operation and maintenance of commercial buildings by developing a market for educated and certified building operators. Since the time that the BOC curriculum and delivery mechanism were firmly established several years ago, BOC has continued to be offered with limited Alliance assistance through the Northwest Energy Efficiency Council (NEEC) and the International Building Operators Association (IBOA, formerly the Northwest Building Operators Association, NWBOA). 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.

This fourth Long-Term Monitoring and Tracking report for the BOC assesses the current state of the market for certified building operators, including the following:

- Obtaining 2009 BOC tracking database updates directly from NEEC and IBOA for integration into an updated BOC tracking spreadsheet;
- Calculating updated "active" BOC certifications; and
- Researching BOC literature for possible updates for energy savings assumptions.

2.1 Assumptions and Indicators for Review

As established in recent M&T analyses, the energy savings impact of the BOC venture is based on the number of operators receiving certification and a series of assumptions regarding the size of the facilities and the percentage of energy consumption that is reduced. Specifically, energy savings for a given calendar year are calculated as follows:

Annual Energy Savings (kWh/year) =

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

x (2) Square footage per operator

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

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

where:

Number of operators certified within the past five years is based on NEEC and IBOA records.

Measure life is assumed to be five years, implying that savings are only counted for five years, beginning in the year of certification. 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. Throughout the report, building operators who have had a renewal or new certification within five years are referred to as "active building operators."

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

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

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 2009 M&T effort did not reveal any additional assumptions or changes in the savings methodology, but did result in an update of the electricity and gas consumption per square foot of participating facilities, which in turn raised the assumed kWh savings for each certified operator. Additional market transformation indicators include the total number of students who have attended BOC training (regardless of receiving certification) and the total number of Level 1 and Level 2 certifications (regardless of whether the operators' most recent certifications were granted in the past five years, *i.e.*, regardless of whether the ACE model currently counts energy savings associated with the certification).

2.2 *Methodology*

The 2009 M&T methodology is similar to the 2008 M&T methodology, although the literature review and interviews included several different sources, and the highly detailed analysis of square footage data from NEEC was conducted only in 2008. The 2009 M&T work began with consultations with key NEEA staff involved with training programs in the Northwest. Following this consultation, a secondary literature search was completed, which turned up a new evaluation of a BOC program at Kansas City Power and Light. Interviews were conducted with key staff at NEEC and the Northwest Energy Education Institute (NEEI). Interviewees provided primary insights into BOC in the Northwest. Certification data was collected directly from NEEC. IBOA certification data was collected in cooperation with NEEA staff who are currently working with IBOA. Secondary literature was reviewed for potential updates to assumptions from past M&T activities.

In brief, the following data collection activities were conducted:

1. **Contacted NEEC and IBOA staff for the following:**

    a. **Obtained current database of certification activity.** NEEC provided an Excel file containing the certification date, student name and contact information, and some building information for all certifications through December 2009. IBOA

provided a current database of IBOA-certified building operators in the Northwest to NEEA.

b. **Interviewed staff to assess views on BOC activity, drivers, impacts, and market perceptions.** See Table 2-1.

Table 2-1.Primary Data Collection

Interviewee/Survey Group	Number of Interviews/Surveys	Topic/Issues
NEEA staff	1 via telephone	Role of BetterBricks in recent NEEA support of BOC
NEEC and NEEI staff	Two via telephone	Qualitative current and future market for BOC; role of ARRA funding; role of recession; sources of demand for BOC training in the Northwest

2. **Reviewed literature on building energy consumption.** The current ACE model uses an energy consumption value of 16 kWh per square foot per year, based on a 2004 publication of the Commercial Building Stock Assessment (CBSA). The 2009 CBSA, released at the beginning of 2010, was used to update building energy use intensities that are an input to savings estimates. The 2007 Commercial Building Energy Consumption Survey (CBECS), conducted by the Department of Energy's Energy Information Agency (EIA) will not be released in part until later in 2010. This will provide a point of comparison to the latest CBSA.

3. **Reviewed evaluations of other BOC programs.** Programs reviewed included previous evaluations from around the country and a new evaluation of the Kansas City Power and Light BOC program.

2.3 Findings

2.3.1 Market Activity

Through the end of 2009, NEEC had certified 1,217 building operators in the Northwest and IBOA 389. In total, 1,077 (67%) of the 1,606 operators that have been certified in the Northwest to date were still active at the end of 2009 (Table 2-2). "Active" operators are those whose five year measure lives have not expired, as determined by whether they have received new or renewed certification within the past five years (e.g., between 2005 and 2009, inclusive).

Table 2-2. 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	290	21	0	57	145	0	347
2001	96	0	386	9	0	66	105	0	452
2002	155	1	540	42	1	107	197	2	647
2003	107	22	625	60	3	164	167	25	789
2004	58	54	629	35	9	190	93	63	819
2005	120	64	685	30	11	209	150	75	894
2006	77	61	701	53	13	249	130	74	950
2007	87	92	696	23	22	250	110	114	946
2008	142	70	768	28	32	246	170	102	1014
2009	85	51	802	52	23	275	137	74	1077
Total	**1217**	**415**	**802**	**389**	**114**	**275**	**1606**	**529**	**1077**

* 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.

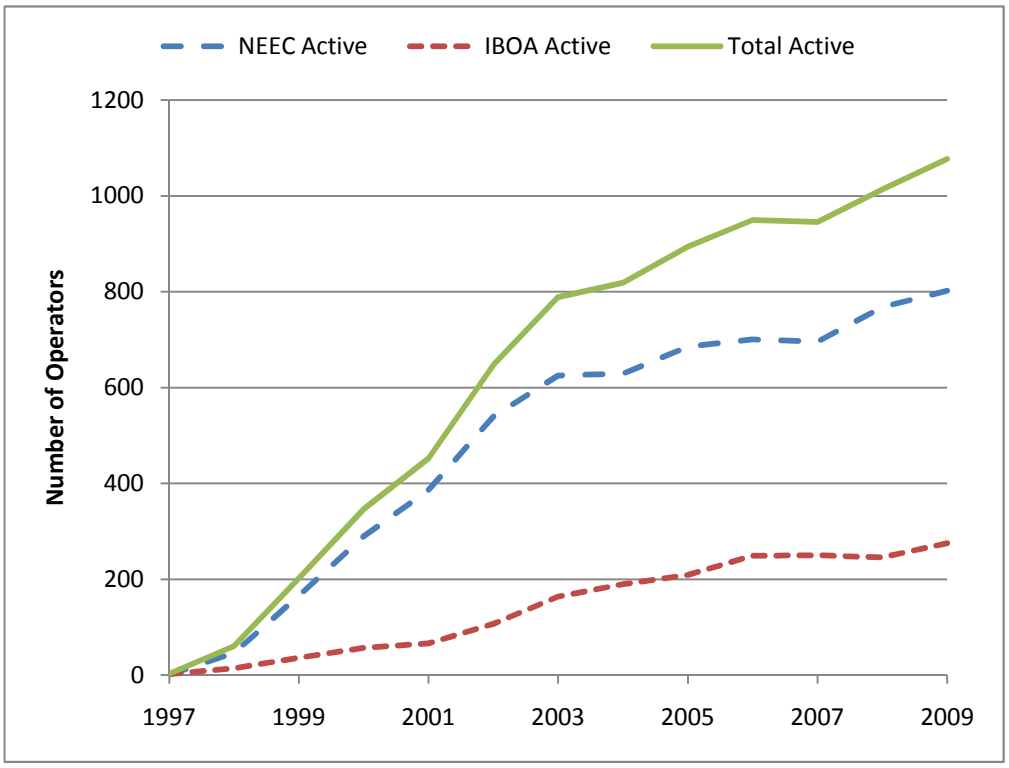
** Total Active is the number of certified building operators who have receive a new certification or renewal within five years of the year (table row) in which the data is presented. Total active(present year) = Total active (previous year) + Annual new – Annual net retired.

Source: Navigant Consulting analysis of 2009 NEEC certification database and 2009 IBOA certification database.

2009 showed slightly lower new activity than in recent years, perhaps reflecting the weak economy's impact on training budgets. However, the rate of retirements also dropped, which may reflect the increasing value of BOC in the marketplace. IBOA data for 2006-2008 was revised upwards based on the latest certification database received, which shows a higher rate of recertification than had been assumed in previous years, causing the number of retirements to be lower than previous estimates.

Figure 2-1 shows that the number of certified building operators in the Northwest continues to rise.

Figure 2-1. Trend in Number of Active Certified Building Operators, 1997-2009



Source: Navigant Consulting analysis of 2009 NEEC certification database and 2009 IBOA certification database

The nationwide profile of BOC training has risen dramatically over the last 10 years. In 2006, the National School Plant Management Association entered into a partnership with NEEC to provide training and credentialing for members through the BOC program.[3] The NEEC BOC program is now offered in eight states in the Northeast, California, North Carolina, Wisconsin, and through the Midwest Energy Efficiency Alliance in Illinois, Iowa, Minnesota, Missouri, and Ohio. The elevated nationwide profile of BOC training may lead to increased awareness and support of BOC training among national corporate decision makers, which could lead to an increase in BOC training activity.[4] National BOC growth continues at a rapid rate.

Building operator certification in the Northwest (and nationwide) appears to be poised for a significant increase in coming years, as increasing awareness of building energy efficiency and rising energy costs has raised the profile of energy-efficient building operations among facility managers. Near-term economic trouble has been holding back training budgets.[5] Both administrators of BOC programs in the Northwest predict that market and government forces favoring energy efficiency will offset near-term reductions in training budgets due to economic

[3] NEEC, *NSPMA and NEEC Announce Educational Partnership to Offer Building Operator Certification Program for Energy Efficiency*, October 2006, http://www.theboc.info/ne/pdf/PRelease_NSPMA_10_30_06.pdf

[4] Anecdotally, larger national corporations have had lower BOC participation to date than local government and smaller regional corporations.

[5] Interviews with various BOC program staff.

recession. The American Recovery and Reinvestment Act of 2009(ARRA), signed in February 2009, included a significant fund for energy efficiency job training, but to date that has not been a major source of additional funds for BOC training.[6]

2.3.2 Baseline Activity

The baseline activity for building operator certifications was likely zero before NEEC and IBOA training started in the 1990s, as these were the first programs of their kind when they were developed. Studies of nationwide BOC training have specifically stated that BOC training was started in the Northwest by IBOA and NEEC and championed and supported by NEEA in the early stages. BOC training has now expanded to the Northeast, Midwest, and Southwest, utilizing curricula developed by NEEC and IBOA. There are no comprehensive building operator training curricula being offered other than those developed by NEEC and IBOA. *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.*[7]

However, it is likely that informal educational outreach and training activities would have captured some of the same savings currently being captured by formal training of building operators. The ideas and strategies for saving energy presented in the BOC curricula are not unique, only the delivery method. Some of these same ideas and strategies for savings energy may have become known to a certain fraction of building operators *with or without* formal BOC training, via informal educational delivery methods, such as best practices guides, articles in trade publications, and in-house sharing of knowledge from self-motivated champions of energy efficiency.[8] There is no data available in the current research to suggest that a non-zero baseline is warranted at this time. It is recommended that a future M&T assessment include a comprehensive survey of non-participating building operators to determine whether continued use of a zero baseline is appropriate.

2.3.3 Per-Unit Energy Savings

Energy savings achieved by each active, certified operator are assumed to be the product of the final three factors of the energy savings equation described in Section 2.1, namely:

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

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[6] Interview of Northwest Energy Education Institute staff.

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

[8] A survey of facilities managers conducted in 2007 and 2008 indicated increasing emphasis being placed on energy efficiency. IFMA, *Energy Efficiency Index Research*, April, 2008.

Square footage per operator (in-depth analysis)

An in-depth analysis of the square footage per operator was conducted as part of the 2008 LTM&T effort. This resulted in the adoption of a revised value of 286,000 square feet per certified building operator. This assumption was not revisited in 2009.

Electricity Consumption per square foot

The 2005 M&T input value of 16 kWh/ft^2, used in 2005-2008 M&T reports for the annual electricity consumption at participating facilities, was based on recently published data at that time. As part of the 2009 M&T process, this assumption was updated using building type certification data from NEEC and the 2009 Commercial Building Stock Assessment (CBSA), released early in 2010. The analysis resulted in an updated M&T input value of 16.7 kWh/ ft^2.

The 2009 CBSA includes updated energy use intensities (EUIs) for a range of commercial building types. The NEEC certification database includes a facility type for each certified building operator. The following method was used to derive an updated energy use intensity value:

1. A distribution of building types was extracted from the NEEC database, giving the number of operators in each type of building. The fraction of total operators in each building type was calculated.

2. The building types in the NEEC database were mapped to analogous building types in the 2009 CBSA and an EUI was calculated for each mapped building type. All building types could be mapped cleanly except manufacturing.

3. A weighted average of the building type EUIs was calculated using the relative weights from step (1) and the EUIs from (2), with manufacturing assumed to be the same as the average of all others.[9]

The results of this analysis indicate a 4% increase in the average EUI from 16.0 kWh/ft^2 to 16.7 kWh/ft^2.

Savings from certification

The assumed energy savings realized as a result of BOC certification is 2.5% of a facility's energy consumption. This value is based on past M&T reports and was not changed from the 2008 analysis. Multiplying this value by the assumed energy intensity (above) of 16.7 kWh/ft^2 yields an estimate of 0.42 kWh of savings per square foot, which is consistent with a study

[9] EUIs at manufacturing facilities vary dramatically and are generally not stated in the literature.

prepared for Northeast Energy Efficiency Partnerships (NEEP) by RLW Analytics,[10] which calculated minimum annual savings 0.4 kWh/sq.ft. for non-schools. These estimates were based on engineering estimates for savings associated with certain O&M actions and on surveys of Certified Building Operators to determine the frequency with which these O&M actions were performed. The estimates do not cover the full range of possible O&M activities associated with the training, so they may underestimate the savings associated with BOC. The current percent energy savings may be conservative, but there is no conclusive evidence to change this assumption.

As stated above, the **energy savings per certified building operator** is the product of the following factors:

286,000 square feet per operator
x 16.7 kWh electricity consumption per square foot per year
x 2.5% savings

which equals 119,000 kWh of annual savings per operator.[11] This is roughly a 4% increase in savings per operator compared to the 2008 M&T report, due to the finding that the energy use intensity of buildings being managed is higher than previously assumed. For comparison, the annual kWh per operator was decreased nearly 20% in the 2008 M&T report due to the analysis of square footage managed by each operator.

Measure Life

The measure life assumption of five years is likely conservative. The intent behind the five year expiration of BOC training is that building operators who do not continue training and certification activities gradually forget what was taught and stop generating energy savings, or they may transfer to new positions or to new facilities that may not be within the Northwest. Some O&M measures need to be conducted every year to be successful in saving energy, but 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-efficiency equipment upgrades, they could generate larger energy savings over a longer period of time than is currently being assumed. However, given the uncertainty (this M&T review identified no available data in the literature on this point), it is reasonable to continue with the current 5-year assumption for measure lifetime. If the rate of renewals among certified building operators continues to increase, the lifetime assumption will become less important.

[10] RLW Analytics, *Impact and Process Evaluation: Building Operator Training and Certification (BOC) Program Final Report*, Prepared for Northeast Energy Efficiency Partnerships, June 2005
[11] This savings rate is applied to all active operators in 2009.

2.4 Conclusions and Recommendations

Building Operator Certification activity in the Northwest increased in 2009 and appears to be poised for significant future increases as a result of increasing awareness and government grant programs. Specific findings from the 2009 M&T assessment include the following:

- **The number of certified building operators continues to rise.** While the number of new certifications has dropped relative to 2008, the rate of retirements has also dropped, resulting in the total number of certified building operators continuing to increase in spite of reduced training budgets in a soft economy.

- **The market for BOC is being influenced by the conflicting forces of economic recession and increased awareness of and policy support for energy efficiency.** BOC training administrators mentioned that it was likely training budgets are dropping during the recession. However, they mentioned that awareness of energy efficiency opportunities among private and public sector decision makers continues to increase, as does the value of BOC in the marketplace.

- **Support from BetterBricks is partially compensating for a drop in training budgets.** BetterBricks has been actively promoting BOC since 2008, utilizing scholarships, marketing, and webinars to boost activity in the region.

- **When the economy rebounds, demand for BOC training will also rebound.** The soft economy is causing a brief suspension of growth in new BOC certifications. The main barrier to BOC training right now is a lack of available private funds for training. Public agencies like NEEA and ETO are helping to surmount this barrier by providing funding. ARRA funding has not led to any increase in training opportunities. The Federal Buildings Training Act of 2010 would require federal buildings to have trained building operators. This could create a dramatic increase in demand for BOC training.[12]

Table 2-3 shows that the addition of 137 newly certified building operators brings the total number of active certified building operators to 1077. Applying the increased per operator savings value of 119,000 kWh yields an implied energy savings 1.9 aMW for incremental 2009 activity. The major reasons for this increase are

- Ongoing new certification

- Reduced retirement rates

- Increase in annual savings per operator because of revised energy use intensity

[12] WBDG, *Legislation for Training Federal Facilities Personnel Has Wide Industry Support*, April 2010.

» Revision of IBOA data from previous years using 2009 updated database of certification activity

Table 2-3. M&T Recommendations for Key Indicators

Key Indicators	**2009 Incremental** (Due to *new* activity occurring in 2009)	**2009 Cumulative** (Calendar year 2009 values due to all activity since program inception)	Source
Market Activity			
Number of Active Certified Building Operators	137	1077	NEEC and IBOA. See Section 2.3.1
Baseline Activity			
Number of Active Certified Building Operators	0	0	Review of Literature. See Section 2.3.2
Per-Unit Energy Savings*			
kWh/operator per year	119,000	119,000	See Section 2.3.3
Implied Energy Savings (aMW)**			
Implied Energy Savings (aMW)	1.9	14.7	Market Activity minus Baseline Activity, times Per-Unit Savings, div 8760 hours

* Per unit savings was increased for 2009 as a result of a revision of commercial building energy use intensities. See Section 2.3.2.

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

Source: Navigant Consulting Analysis

The following recommendations are intended to guide future M&T work:

» **NEEA should obtain annual BOC tracking database updates directly from NEEC and IBOA for integration into NEEA's BOC spreadsheet model.** Both IBOA and NEEC now have functional tracking databases that track building operator certification and renewal activities, and NEEA has a good tool for calculating the number of active certified building operators.

- **Update energy savings assumptions every other year as potentially conclusive new data become available,** such as through BOC evaluations for other programs. At some point, if the annual savings calculated in other regions varies significantly from current assumptions in the Northwest, a bottom-up engineering revision of annual savings may be warranted, based on participant surveys of certified building operators.

- **A baseline study should be undertaken in conjunction with an updated estimate of energy efficiency activity undertaken by certified building operators.** The baseline study should establish the baseline rate of energy efficiency activity among non-participating building operators and compare to the energy efficiency activity of active certified building operators. This baseline study would also estimate the effect of ARRA funding upon the practices of building operators.

2.5 Bibliography

Interview with Erik Westerholm, Northwest Energy Education Institute, March, 2010.

Interview with Cynthia Putnam, Northwest Energy Efficiency Council, May, 2010.

Interview with Ken Baker, Kenergy, January, 2009.

IFMA, *Energy Efficiency Index Research*, April, 2008, http://www.ifma.org/tools/research/surveys/2008_energyeffindex.pdf

KEMA-XENERGY, *Assessment of the Commercial Building Stock in the Pacific Northwest*, Prepared for Northwest Energy Efficiency Alliance, 2004

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

National Institute of Building Sciences, *Legislation for Training Federal Facilities Personnel Has Wide Industry Support*, April 2010, http://www.nibs.org/index.php/wbdg/news/Entry/fedtrainingleg.

NEEC, *NSPMA and NEEC Announce Educational Partnership to Offer Building Operator Certification Program for Energy Efficiency*, October 2006, http://www.theboc.info/ne/pdf/PRelease_NSPMA_10_30_06.pdf

Opinion Dynamics Consulting, *Evaluation of Kansas City Power and Light's BOC Program*, Prepared for Kansas City Power and Light, 2009.

Quantum Consulting, *Commercial Building Operations and Maintenance Market Assessment*, Prepared for Northwest Energy Efficiency Alliance, 2006.

RLW Analytics, *Impact and Process Evaluation: Building Operator Training and Certification (BOC) Program Final Report*, Prepared for Northeast Energy Efficiency Partnerships, June 2005.*American Recovery and Reinvestment Act of 2009*, February, 2009.

Section 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.

These market transformation efforts were intended to establish an infrastructure to support increased commissioning activity well beyond the term of the projects—including knowledgeable and experienced commissioning providers, state and local laws and policies requiring or promoting commissioning, and resources for building owners to learn about the benefits of commissioning and to identify providers. However, there are few obvious sources of information to determine how successful the efforts were in achieving their goals.

The first Commissioning M&T review, conducted in 2005, consisted of a bottom-up accounting of commissioning activity that would be identified through state records, other secondary data such as research reports, and interviews with selected commissioning providers. *The second M&T 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. *This third M&T effort* has updated state policies to promote/require commissioning and surveyed commissioning providers to understand the market trends and drivers of demand for commissioning services in the Northwest.

3.1 Assumptions and Indicators for Review

According to the ACE model, annual electricity savings from building commissioning in the Northwest is the product of the commissioned public and commercial building space (in ft2) in the Northwest[13] and the savings from commissioning (in kWh per square foot).

The savings can be expressed as follows:

Electricity Savings (kWh/year) =

(1) Commercial and public building space commissioned within the past five years (in ft^2)

[13] Energy savings are achieved during each year of a measure's life. Since the measure life of a commissioning project is assumed to be five years, the ACE model includes all building floor space commissioned within the past five years to estimate cumulative annual energy savings.

x (2) Annual electricity savings per square foot attributable to commissioning activities (kWh/ft² per year)

where:

Commercial building space commissioned within the past five years has been estimated from previous M&T estimates, available secondary sources, interviews with officials from the four participating states, and a recent survey of commissioning providers.

Electricity savings per square foot attributable to commissioning was assumed to be 0.55 kWh/ft² per year for new buildings (*i.e.*, commissioning) and 1.7 kWh/ft² per year for existing buildings (*i.e.*, retrocommissioning), based on median data from a meta-analysis of commercial building commissioning conducted by Lawrence Berkeley National Laboratory (see Section 3.3.3).[14]

3.2 Methodology

Monitoring and tracking for NEEA's commissioning initiatives began with a series of interviews with state coordinators and other government officials familiar with commissioning activity at public buildings. In addition, the M&T effort included a survey of BCA members that included specific questions aimed at better understanding market trends in commissioning activity in both public and private buildings.[15] Secondary research was also conducted to lend additional credibility to the discussion of relevant state and local legislation and policies and to the estimates of commissioned building space and per-square-foot energy savings.

The data collection process included the following elements:

1. **Contacted each of the state liaisons who coordinated NEEA's commissioning efforts** under contract to either NEEA itself or to the Oregon Office of Energy (NEEA's prime contractor prior to 2004). The purpose of this effort was to obtain an update on how commissioning has been incorporated into policies/procedures, and to obtain estimates of the amount of commissioning being performed in public buildings and in all commercial buildings if available.

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[14] Mills, Evan, et al., *Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions*, LBNL, July 21, 2009. Referred to throughout this report as "2009 LBNL study." Also referenced in this report is the "2004 LBNL study" referred to in previous M&T reports: Mills, Evan, et al., *The Cost-Effectiveness of Commercial-Building Construction: A Meta-Analysis of Energy and Non-Energy Impacts in Existing Buildings and New Construction in the United States*, LBNL, December 15, 2004.

[15] The survey was designed to provide insights into broad market trends in terms of quantity and quality of commissioning work done in the Northwest in the past two years. Due to the relatively small sample of 20 respondents (compared to the 76 Northwest commissioning providers for the 2007 M&T report), the survey results were used to corroborate previous estimates of commissioning activity and trends, not to provide new quantitative estimates of market activity.

2. **Conducted a survey of commissioning providers (BCA members)** to assess industry trends and corroborate estimates of the total amount of commissioning occurring in the Northwest (see Appendix A.2).
3. **Reviewed secondary sources** with the aim of corroborating the results of the interviews (in terms of policy changes and commissioning market activity) as well as validating the assumptions of energy savings per square foot used in the previous M&T efforts.

Table 3-1 summarizes the primary data collection efforts of the M&T team.

Table 3-1. Primary Data Collection

Interviewee Group	Number of Interviews/Surveys	Topic/Issues
State liaisons to NEEA's Commissioning in Public Buildings Initiative	4 telephone interviews and email correspondence	State policies/requirements for commissioning, availability of qualified providers
Utility program managers	2 telephone interviews	Program participation, availability of qualified providers
Commissioning providers (BCA Members)	20 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 activity in the Northwest, based on the results of interviews with state liaisons, survey data analysis, and secondary research.

Commissioning of New Buildings

In order 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. In the 2007 M&T analysis, the 5-year total of new construction activity in the four Northwest states was estimated to be 297.4 million ft^2, based on the estimates from NEEA's commercial new construction study (hereafter referred to as "the CNC study").[16] The CNC study estimated that 21% of all new construction from 2002-2004 underwent building commissioning. The M&T team conservatively assumed that the rate

[16] Ecotope, Inc. *Characteristics of Pacific Northwest Non-Residential New Construction: 2002-2004 Building Stock.* Draft Summary Tables. January 2008. The estimates for 2002-2004 were extrapolated out through 2007, assuming a 10% annual increase in new construction, to reach the total estimate of 297,404,000 ft^2 for 2003-2007.

of commissioning remained steady at 21% over the five-year period, resulting in a total of 61.2 million ft² of commissioned new construction space from 2003 through 2007.

In 2008 and 2009, the pace of new construction activity in the Northwest appears to have slowed. Anecdotes from state liaison interviews, commissioning provider surveys, and industry publications suggest a decline in new construction due to poor economic conditions, particularly among the largest, most capital-intensive projects. Furthermore, the Northwest Power and Conservation Council only forecasted 59.8 million ft² of commercial new construction in the Northwest in 2009, compared to more than 71.3 million ft² estimated for 2007 in the last M&T report.[17]

Table 3-2 displays the M&T team's estimates of commercial new construction in the Northwest for the 2005 through 2009 time period (the five-year period of interest for this 2009 M&T analysis), which demonstrates a significant decline in activity from 2007 to 2009. McGraw-Hill Construction data confirm this trend, with the value of nonresidential new construction project starts in Washington and Oregon decreasing by 27% and 34%, respectively, from 2007 to 2009.[18] The 5-year total new construction estimate is 320,435,000 ft2.

Despite the reduction in total new construction activity, interviews with state liaisons and the survey of commissioning providers indicate that the market for commissioning is increasing in the region. Nearly two-thirds (65%) of survey respondents indicated that the total square footage of commissioned building space (including both new construction and retrocommissioning of existing buildings) has increased in the past two years, and not a single respondent indicated that the market had decreased. The percentage increase in square footage from 2007 to 2009 was estimated by respondents to be 19.5% on average (including zeroes for respondents indicating that the level of commissioning activity remained the same).

Based on these findings, the M&T team estimated that the total square footage of commissioned new building space increased 10% annually from 2007 to 2009; adding in the estimates of commissioned space for 2005-2007 as reported in the 2007 M&T report results in a 5-year total of 74.1 million ft2 of commissioned new buildings in the Northwest (Table 3-2).

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[17] Northwest Power and Conservation Council's medium growth scenario assumptions as cited in NEEA Report #E09-204, *Non-Residential Energy Savings from Northwest Energy Code Changes 2005-2008*, December 4, 2008.

[18] McGraw-Hill Construction estimated total start values for Oregon nonresidential new construction projects to be worth $2.2 billion in 2007, down to $1.5 billion in 2008, and a slight increase to $1.6 billion in 2009 (a 27% decrease from 2007 levels); similarly, Washington nonresidential projects were estimated to be $6.1 billion in 2007, down to $5.8 billion in 2008, and another decline to $4.0 billion in 2009 (a decrease of 34% from 2007 levels). Similar data could not be found for Idaho and Montana.
http://northwest.construction.com/features/archive/2010/0101_F2_Forecast2010.asp

Table 3-2. Estimate of Commissioned New Building Square Footage, 2005-2009

Year	Commercial New Construction (1000s ft²)	Commissioned Floor Space (1000s ft²)	Percent Commissioned
2005	58,944	12,131	20.6%
2006	64,838	13,344	20.6%
2007	71,322	14,678	20.6%
2008	65,551	16,146	24.6%
2009	59,780	17,760	29.7%
Total	**320,435**	**74,059**	23.1%

Sources: Values for 2005 through 2007 values are estimates from the previous 2007 M&T analysis. The 2009 value for *new construction* reflects the NPCC medium growth scenario (5th Power Plan), and the 2008 value is the average of 2007 and 2009. *Commissioned floor space* is assumed to increase 10% annually from 2007 to 2009, based on 2009 M&T survey data.

Several factors indicate that the amount of commissioned new building floorspace is likely increasing, despite the slowdown in total new construction:

1. In recent years, most major new construction projects have been in the public sector, not the private sector, with the exception of health care which has continued to develop new construction projects.[19] One commissioning provider survey respondent confirmed the trend toward more commissioning in public sector projects with the following observation provided via an online survey: "Very little private sector business but an increase in public sector commissioning given deadlines on spending stimulus money."

2. The NEEA-sponsored study of 2002-2004 nonresidential new construction in the Northwest found that the building types which were most commonly commissioned are institutions (typically government-owned buildings), schools, colleges, and hospitals.[20] The survey of commissioning providers confirmed that those sectors are most actively pursuing commissioning services. Thus, if the majority of new construction in the past two years has been in the public sector (government buildings, schools, and colleges) and in the health care sector, and those are the sectors which have most aggressively

[19] http://northwest.construction.com/northwest_construction_projects/2009/0701_Topprojects.asp. http://www.northwestconstructionmag.com/features/archive/2009/0709_F1_SeattleSurvives.asp.

[20] Each of those four categories (institution, schools, colleges, and hospitals) reported that more than 50% of floor area was commissioned. This study covered buildings constructed between 2002 and 2004, but the M&T team is assuming that commissioning levels did not decrease since then. Ecotope, Inc. *Baseline Characteristics of the 2002-2004 Nonresidential Sector: Idaho, Montana, Oregon and Washington. Progress Report.* Northwest Energy Efficiency Alliance Report #08-196. July 24, 2008.

adopted commissioning as a standard practice in new construction, the share of new buildings that have been commissioned has likely increased.

3. As promoted by NEEA during the Commissioning in Public Buildings initiative, several states have enacted policies in the past five years encouraging or requiring commissioning in newly constructed public buildings. Policies in place as of March 2010, as identified by the M&T research, are summarized in Table 3-3.

Table 3-3. 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 must achieve LEED Silver certification, and most are seeking the extra point for enhanced commissioning. Policy enacted in 2005.	State building code requires commissioning for all new commercial buildings; recent code revisions in 2009 have strengthened the requirement.
Oregon	No overarching state requirement for commissioning, but commissioning is required for schools receiving public purpose charge funds.	Incentives and tax credits available for commissioning, but no requirements. Recent failed attempt to require commissioning in latest energy code.
Idaho	New state buildings (including universities) are not fully required to commission buildings, but if they aren't, they must provide documentation as to why the buildings were not commissioned (as of 2008).	No policies identified.
Montana	New buildings are required to meet specific high performance standards including third party commissioning typically required for projects greater than $5 million (policy adopted in 2009).[21] Generally considered a standard practice, but limited new construction occurring.	No policies identified.
Source: Interviews with state liaisons.		

Retrocommissioning of Existing Buildings

As with new building commissioning, the M&T team's estimates of retrocommissioning market activity for 2008-2009 build on the 2007 M&T analysis. The 2007 M&T analysis used the results of a survey of commissioning providers in the Northwest to quantify the square footage of retrocommissioned floorspace in 2006 and extrapolated that data to cover the 2003-2007 time period. The survey respondents indicated that they retrocommissioned 16.3 million ft^2 in 2006;

[21] http://architecture.mt.gov/content/designconstruction/docs/High_Building_Performance.

the M&T team assumed that there had been 20% annual increases from 2003 to 2006 (based on anecdotal evidence) and that the level of retrocommissioning had held steady at 16.3 million ft^2 from 2006 to 2007. The total 5-year estimate for 2003-2007 was 67.0 ft^2 of retrocommissioned space. This estimate may have been conservative, as it was based on a bottom-up approach (i.e., only projects reported by the survey respondents were counted, and the estimates were not extrapolated out to the full population of retrocommissioning providers).

To assess the level of retrocommissioning activity in 2008 and 2009, the M&T team conducted interviews with state liaisons, interviews with utility retrocommissioning program managers, a survey of commissioning providers, and a review of available secondary sources. All of these sources indicate that retrocommissioning activity is happening sporadically at best and that the service is poorly understood in the marketplace. There are several utility and energy agency programs with incentives available in the region, but these programs are having limited uptake. Several sources indicated that poor understanding of the value of the retrocommissioning service is limiting activity, despite the availability of funding. One of the utility program managers indicated that it is a difficult sell to building owners because they don't fully understand the process and it is hard to predict if any deficiencies will be discovered and thus whether any resulting energy savings will help offset the cost of the study. One state liaison interviewee stated:

> *"Retrocommissioning – better awareness of the value is needed. We're trying to teach that all the time, but it's the bottom line, the awareness of the how it affects the bottom line [that is needed]. Case studies and making the business case and putting it in front of the decision makers. Incentives don't hurt, but I don't think we can do everything with incentives."*

One of the utility program managers interviewed pointed out that the skillset required for retrocommissioning is significantly different from new building commissioning.[22] Of the respondents in the 2010 survey of BCA members conducted by the M&T team, the majority (75%) of firms do provide retrocommissioning services, but these services make up a relatively small percentage of their total project work (on average, 18% of projects are retrocommissioning and the rest are new building commissioning). Just 20% of respondents do primarily retrocommissioning work (more than 50% of their projects). However, several respondents indicated that retrocommissioning activity was up over the past two years. Unlike new building commissioning, states do not require that existing buildings be retrocommissioned. However, several policies have been enacted for major renovations of public buildings (Table 3-4).

[22] Given the different skillsets and backgrounds required for commissioning and retrocommissioning, it is possible that retrocommissioning providers are not as likely to participate in the BCA and thus are underrepresented in the survey sample.

Table 3-4. Summary of State Policies Related to Existing Building Retrocommissioning

	Policies for State-Owned Buildings
Washington	No requirements, but some retrocommissioning is happening. Major renovations of state-owned buildings must achieve LEED Silver certification.
Oregon	Schools undergoing major renovations with public purpose charge funds are required to retrocommission their buildings.
Idaho	No policies identified.
Montana	Recently released an RFQ[23] to pre-qualify commissioning providers to conduct retrocommissioning in state buildings as part of the governor's 20x10 initiative to reduce state government energy consumption by 20% by the end of 2010. Expected to retrocommission 10-15 state buildings in 2010.
Source: State liaison interviews.	

As noted above, nearly two-thirds of survey respondents indicated that the total square footage of commissioned building space (including both new construction and retrocommissioning of existing buildings) has increased in the past two years. However, given the lack of available data on retrocommissioning market activity and the results of the commissioning provider survey that indicate that retrocommissioning constitutes a relatively small portion of their projects, the M&T analysis uses an assumption that all growth is accounted for through new building commissioning and that the annual floorspace of retrocommissioned buildings has remained constant at 2006 levels (i.e., 16.3 million ft² per year).[24] Table 3-5 summarizes the M&T team's estimates of retrocommissioned floorspace for the 2005-2009 time period. The total 5-year estimate is 78.9 million ft².

[23] RFQ available for download at http://svc.mt.gov/gsd/onestop/upload/RFQ_210074_RetroCommissioning.doc.
[24] The 2006 estimate for retrocommissioning activity was considered in the 2007 M&T report to be a conservative value for annual market activity. Analysis conducted for the 2007 report based on a prior NEEA study found that retrocommissioning activity may be more than twice this value, but a lower estimate was adopted (based on a detailed survey analysis expressly conducted for the 2007 M&T effort) to account for uncertainty in the NEEA study's underlying data.

Table 3-5. Estimate of Retrocommissioned Floorspace, 2005-2009

Year	Retrocommissioned Square Footage (1000s ft²)
2005	13,598
2006	16,318
2007	16,318
2008	16,318
2009	16,318
Total	**78,870**
Sources: Estimates for 2005-2007 are from previous 2007 M&T analysis. The 2008-2009 values are assumed to be the same as the 2006 estimate, which was based on the Cx provider survey conducted for the 2007 M&T report.	

Projected Future Market Activity

The majority of commissioning providers surveyed indicated that they anticipate the demand for new building commissioning and retrocommissioning to increase or remain steady in the next two years; 60% said the market would increase, 35% said it would remain the same, and one respondent said that it would decrease over the next two years. Most of the reasons cited for this forecasted increase involved rising energy costs or increasing market interest in LEED certification. The latest version of the LEED new construction standard places increased emphasis on commissioning, so that may result in more thorough implementation of commissioning in LEED buildings.[25]

Over one-third (35%) of commissioning survey respondents specifically stated that they anticipated an increased emphasis on retrocommissioning of existing buildings in the next two years, due to rising energy costs and an economic need to make older buildings work longer rather than conduct expensive new construction projects. One survey respondent described this as "rehab of buildings in lieu of new construction." The federal government is placing increased emphasis on retrofitting existing buildings for energy efficiency, and the proposed Building Star program is expected to include significant incentives for energy audits and building retrocommissioning studies ($0.05 per square foot of retrocommissioned space or 50% of the cost of the retrocommissioning study) as well as building operator training and efficiency equipment upgrades.[26]

[25] Allen Matkins / CTG / Green Building Insider. *4th Annual Green Building Survey*. 2010. Available for download at: http://www.allenmatkins.com/emails/GreenSurvey/Fourth%20Annual%20Green%20Building%20Survey%20v3.pdf

[26] http://www.greenbuildinglawblog.com/2010/03/articles/incentives/does-building-star-shine/.

How successful the Building Star program will be in promoting retrocommissioning remains to be seen, but there will likely be funding available for those building owners with an interest in pursuing retrocommissioning. Interviews with state liaisons and utility retrocommissioning program managers alike indicated that there was less consumer understanding of retrocommissioning's benefits and value in comparison to new building commissioning, so the success of Building Star's efforts to promote retrocommissioning will likely depend on their ability to effectively communicate the service's value proposition.

3.3.2 Baseline Activity

Through 2006, NEEA assumed that baseline activity was 10% of estimated commissioning market activity, meaning that approximately 10% of the market activity is assumed to have occurred without the influence of NEEA's commissioning initiatives.[27] The 2007 M&T effort updated this assumption to 30% based in part on the growing popularity of LEED certification. To validate this assumption for the 2009 M&T analysis, the M&T team interviewed state liaisons regarding NEEA's influence, surveyed commissioning providers about the market influences that they have observed, and reviewed papers and reports to discern other potential influences on the market for commissioning services in the Northwest.

It is clear from the interviews with state liaisons that NEEA had a significant influence in the adoption of commissioning in public buildings as a requirement or standard practice; however, it 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. Several potential market influences were examined, such as state, county, and municipal government requirements for commissioning in public buildings (thought to be heavily influenced by NEEA's efforts), as discussed in Section 3.3.1. Other market influences examined include the following:

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 retrocommissioning in private sector.
3. Recent availability of ARRA stimulus funding for state energy office efforts.

Influence of LEED Certification

To obtain LEED certification at any level, some building commissioning must occur; an additional bonus point for more extensive commissioning is often sought for higher levels of LEED certification (e.g., LEED Silver, Gold, or Platinum). The survey of commissioning

[27] 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 M&T report.

providers conducted by the M&T team revealed that some commissioning providers believe that the LEED commissioning requirement is viewed by consumers as an unnecessary hurdle which they want to clear with minimal costs. One survey respondent stated,

> *"An increasing number of projects are commissioned solely to meet LEED rating requirements. In my opinion the quality of commissioning provided to meet LEED requirements is far below best practices, as defined by ASHRAE Guideline 0-2005. While LEED requirements have increased the awareness of commissioning and number of projects being commissioned, the overall impact has been to decrease the average quality of the Cx services provided."*

Numerous survey respondents indicated that the combination of the LEED commissioning requirement with a lack of consumer understanding of commissioning's benefits was resulting in projects going to the lowest bidder with little regard for the quality of commissioning work done.

The states of Washington and Oregon as well as several of 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, no state, county, or city governments in Montana or Idaho have adopted LEED requirements.[28] See Appendix A.1 for a summary of the LEED requirements in Washington and Oregon.

Utility Commissioning and Retrocommissioning Programs

Several utilities in the Northwest have implemented programs to incentivize commissioning and retrocommissioning in the past several years, including Puget Sound Energy and Avista Utilities. The program staff from each of these programs provided insights into the programs' participation levels and possible influences from NEEA on the creation of the programs. Both program managers indicated that they prequalified a small pool of retrocommissioning providers, and that there was not a problem in having enough qualified providers to meet demand.

The Avista Utilities retrocommissioning program had not had any participants as of March 2010, and the Puget Sound Energy retrocommissioning program was just beginning to record initial activity.. The Puget Sound program does not use the word "retrocommissioning," but rather "energy optimization," which is targeted monitoring and observation to identify low-cost energy savings, with the entire focus on achieving energy savings.

One of the program managers indicated that NEEA and the BCA had provided vital support to the region's commissioning industry in terms of developing a qualified base of commissioning

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

providers, but indicated a continuing need for educating commissioning providers, particularly on the calculation of energy savings.

Availability of ARRA Federal Stimulus Funds

Interviews with state liaisons indicate that little—if any—federal stimulus funding from the American Recovery and Reinvestment Act (ARRA) had been used by state governments to fund commissioning or retrocommissioning projects at this point. However, some ARRA funding has been earmarked for retrocommissioning projects in Montana in 2010, and several other states indicated that ARRA funding has been slow to be distributed but may be used for future commissioning and retrocommissioning projects.

Summary of Baseline Activity

State and local requirements for LEED certification in new public buildings as well as private sector interest in LEED and green building continues to be the primary non-NEEA influence in the commissioning market in the Northwest. Utility programs and ARRA funding do not appear to be having a significant influence on commissioning and retrocommissioning activity at this time, but will likely influence the market in the future and should be reassessed in future M&T efforts.

NEEA and the BCA whose creation NEEA supported are widely credited with building a qualified workforce in the region to conduct commissioning projects. One state liaison stated that "NEEA helped us develop the program that makes it easy for the state to reach the quality commissioning providers that we need." NEEA's efforts to educate state government officials on the benefits of commissioning and retrocommissioning may have influenced the adoption of LEED standards (as well as the commissioning requirements detailed in previous sections); these efforts may also have encouraged state officials to pursue the extra point for enhanced commissioning in LEED projects.

The M&T team concludes that the previous estimate of 30% baseline activity is reasonable; the baseline activity may be slightly higher for new building commissioning (given the interest in LEED certification) but is likely lower for retrocommissioning (given the lesser popularity of the LEED Existing Building standard).

3.3.3 Per-Unit Energy Savings

Previous M&T efforts used the values presented in the 2004 LBNL study of 0.55 kWh/ft²-year for new building commissioning and 1.70 kWh/ft²-year for existing building retrocommissioning. 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 collected 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 M&T team

concluded that the previous estimates of 0.55 kWh/ft²-year (commissioning) and 1.70 kWh/ft²-year (retrocommissioning) were reasonable to continue using.[29]

Several additional secondary sources were reviewed to corroborate the findings of the LBNL study, including the 2007 California Retrocommissioning Market Characterization Study and a Portland Energy Conservation, Inc. (PECI) study on energy savings from individual retrocommissioning measures:

- **The California retrocommissioning study** used estimates ranging from 1.7% to 8.1% electricity savings, varying by sector, with colleges and offices having the highest electricity savings and the health care sector having the lowest.[30] The LBNL study, which was based on a much larger sample, presented median electricity savings of 9% for retrocommissioning. Given that many of the buildings that are retrocommissioned in the Northwest are government office buildings and universities (which the California study identified as achieving higher savings) as well as possible difference in building characteristics between California and the rest of the country, it seems reasonable to use the LBNL value which is based on the larger sample.
- **The PECI study on energy savings from existing building commissioning** (i.e., retrocommissioning) did not present whole building median savings, but instead analyzed the savings of individual retrocommissioning measures and identified a "key measure mix" of commonly implemented measures which would likely account for 75% of the potential savings in most buildings.[31] Altogether, the savings of the key measure mix equal 1.05 kWh/ft²-year. However, the point of this analysis was to develop a streamlined "building operational tune-up" which would achieve most of the potential savings from retrocommissioning at a reduced cost, so the electricity savings from a more comprehensive retrocommissioning process would likely be greater than those estimated in this analysis. The authors of the PECI study also acknowledged that there are measures that are implemented less frequently that would achieve significantly greater savings that are not included in this key measure mix.

No additional sources of information on savings estimates for new building commissioning could be identified; estimating energy savings for new building commissioning is particularly

[29] The 2004 LBNL study presented median electricity savings of 9% for existing building retrocommissioning and 8% for new building commissioning. The 2009 LBNL study presented median electricity savings of 9% for existing building retrocommissioning (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.

[30] California Commissioning Collaborative. *2007 California Retrocommissioning Market Characterization.* Developed by PECI and Summit Building Engineering. April 2008. These savings estimates are based on published evaluation reports, data reported from California retrocommissioning programs, and the project team's assumptions.

[31] PECI. *A Study on Energy Savings and Measure Cost Effectiveness of Existing Building Commissioning.* Submitted to LBNL, December 15, 2009.

difficult because of the uncertainty of not knowing how the building would have operated if it had not been commissioned.

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. The following are the major conclusions of the M&T 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 state liaison interviews and commissioning provider surveys. None of the state liaisons or utility program managers reported difficulties finding enough qualified commissioning providers to meet the current level of demand. There are still disparities within the region, however; the BCA website lists 37 members in Washington, nine members in Oregon, two members in Idaho, and one member in Montana.

2. **Most commissioning is occurring in the institutional sector, schools, universities, and health care sector.** NEEA's effort to promote commissioning within the public sector (including institutions, schools, and universities) appears to be successful, as state and local policies have been enacted to promote commissioning of new construction and major renovations in public buildings across the region.

3. **Market interest in LEED certification is continuing to drive demand for commissioning services.** However, many commissioning providers believe that building owners seeking LEED certification do not value the commissioning process and view it as merely a burdensome requirement to be met for the lowest possible cost. Some commissioning providers may be underbidding the more qualified providers and providing lower quality commissioning services.

4. **There is a continued need for consumer education about the benefits of commissioning, especially retrocommissioning.** State liaisons, 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 retrocommissioning is poorly understood.

Table 3-6 summarizes recommendations for the values of key indicators for projects completed in 2008, 2009, and 2005-2009 (cumulative). New building commissioning market activity is estimated at 74.1 million ft^2 in the past five years, and retrocommissioning activity is estimated at 78.9 million ft^2. The baseline is assumed to be 30%, as in the 2007 M&T analysis, and the per-unit energy savings also remain the same as in the previous analysis. The implied energy savings are approximately 3 aMW (incremental) each year in 2008 and 2009, and the cumulative savings in 2009 for the five-year period from 2005-2009 is nearly 14 aMW.

Table 3-6. M&T Recommendations for Key Indicators

Key Indicators Reviewed	2008 Incremental (Due to new activity occurring in 2008)	2009 Incremental (Due to new activity occurring in 2009)	2009 Cumulative (Calendar year 2009 values due to all activity since program inception)
Current Market Activity			
Commissioned buildings (millions ft²)	16.1	17.8	74.1
Retrocommissioned buildings (millions ft²)	16.3	16.3	78.9
Total Market Activity	32.5	34.1	152.9
Current Baseline Activity*			
Commissioned buildings (millions ft²)	4.8	5.3	22.2
Retrocommissioned buildings (millions ft²)	4.9	4.9	23.7
Total Baseline Activity	9.7	10.2	45.9
Per-Unit Energy Savings			
kWh/ft² (Commissioning)	No Change (0.55)		0.55
kWh/ft² (Retrocommissioning)	No Change (1.70)		1.70
Implied Energy Savings*			
Commissioned buildings (aMW)	0.7	0.8	3.3
Retrocommissioned buildings (aMW)	2.2	2.2	10.7
Total Implied Energy Savings (aMW)	2.9	3.0	14.0

* Baseline activity for 2008-9 is assumed to be 30% of market activity (the same as in the 2007 M&T analysis). Prior to 2007, the baseline assumption was 10%.

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

Source: Navigant Consulting Analysis

The next M&T effort is recommended to take place in two years. Recommendations for future M&T research include the following:

1. **Conduct a more comprehensive survey of commissioning providers and building owners to quantify commissioning market activity.** Similar to the survey used in the

2007 M&T analysis, NEEA may wish to seek a partner such as PECI to co-sponsor a survey of commissioning providers and building owners geared toward updating quantitative estimates of building commissioning activity in the Northwest. Surveys should also qualitatively assess the influence of various market forces on the decision to pursue commissioning projects, including federal funding for commissioning and retrocommissioning (via ARRA funding and the anticipated Building Star program), utility programs for retrocommissioning and green building, state and local policies, and economic factors, to monitor possible changes in baseline activity.

2. **Surveys of commissioning providers should more clearly differentiate between commissioning and retrocommissioning activity.** The service provider market appears to be bifurcated, with many providers specializing in one service or another. Trends in commissioning may not mirror trends in retrocommissioning, and as such, baseline activity as a share of market activity should be estimated separately for commissioning versus retrocommissioning.

3.5 Bibliography

Allen Matkins / CTG / Green Building Insider. *4th Annual Green Building Survey.* 2010.

California Commissioning Collaborative. *2007 California Retrocommissioning Market Characterization.* Developed by PECI and Summit Building Engineering. April 2008.

Ecotope, Inc. *Baseline Characteristics of the 2002-2004 Nonresidential Sector: Idaho, Montana, Oregon and Washington. Progress Report.* NEEA Report #08-196. July 24, 2008.

Ecotope, Inc. *Characteristics of Pacific Northwest Non-Residential New Construction: 2002-2004 Building Stock.* Draft Summary Tables. January 2008.

Mills, Evan, et al., *Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions,* LBNL, July 21, 2009.

Mills, Evan, et al., *The Cost-Effectiveness of Commercial-Building Construction: A Meta-Analysis of Energy and Non-Energy Impacts in Existing Buildings and New Construction in the United States*, LBNL, December 15, 2004.

NEEA Report #E09-204, *Non-Residential Energy Savings from Northwest Energy Code Changes 2005-2008*, December 4, 2008.

PECI. *A Study on Energy Savings and Measure Cost Effectiveness of Existing Building Commissioning.* Submitted to LBNL, December 15, 2009.

Section 4. Drive Power Initiative

The Drive Power Initiative (DPI) was an electric motor market transformation initiative funded by NEEA and administered by the Electric League of the Pacific Northwest between 1999 and 2004. The main objectives of the DPI were the following:

- 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.
- Help motor service centers improve their repair practices and expand their motor management services.

The primary objective of the first two LTMT efforts, conducted in 2007 and 2008, was to trace back the roots of influence for motor efficiency improvements to identify and isolate the effect that DPI has had on transforming the new motors and repair market. In particular, the first effort focused on sales of NEMA Premium™ motors and the share of these sales that were influenced by NEEA. The 2008 M&T effort updated these figures and also attempted to quantify the impact of new services and changes in practices at motor repair centers.

The 2009 effort built on the 2008 report by 1) updating the NEMA Premium™ motor sales projection using the most recently available data, and 2) better quantifying the changes in motor service center rewind practices using more extensive surveys. In particular, this year's surveys clearly establish with respondents the definition of "efficient rewind" according to the Electrical Apparatus Service Association (EASA) Tech Note 16.[32]

4.1 Assumptions and Indicators for Review

To study the affect of the DPI on the motors market in the Northwest, the evaluation team identified a list of indicators that would help track the progress of the DPI. This section defines these indicators and describes how they support the market transformation effort. The specific indicators identified were:

1. **Sale of NEMA Premium™ motors in the Northwest.** NEEA was involved in the formation of a premium efficiency motors brand (NEMA Premium™), which end users were encouraged to buy over standard efficiency motors. Through outreach and education, NEEA encouraged customers to purchase NEMA Premium™ motors.[33]

[32] The complete Tech Note 16 is presented in Appendix B.1
[33] Details of NEEA's efforts to help form the NEMA Premium™ brand are provided in the 2007 LTMT report.

2. **Energy efficient repair and rewind activity.** Motor service centers in the Northwest are adopting energy efficient repair methods consistent with EASA best practices. Through these service centers, NEEA also tried to educate customers to request efficient rewinds.

3. **Effect of outreach activities,** via distribution of the Energy Motor Management (EM2) database and its effect on end user repair and replacement decisions. The EM2 software helps its users keep track of motors in their facilities and make informed decisions regarding repair and replacements. This indicator was discussed in the 2007 M&T report and is not addressed for 2009.

An important assumption underlying the analysis of savings from sales of new motors is a measure life of at least ten years; roughly the average life of a motor is before it is retired or rewound.[34] Since NEMA Premium™ motors were introduced in 2001, it is assumed that there has been no degradation of energy savings due to retirements. Retirement of motors will be considered in future M&T efforts as the age of the first NEMA Premium™ motors approaches the assumed measure life.

4.2 Methodology

This M&T effort assessed trends in different sectors of the motors market in the Northwest, and the factors/programs that were responsible for these trends were identified. Three primary methods were used to obtain data:

1. **Obtained NEMA motor shipment data from the Consortium for Energy Efficiency (CEE).** This data is generated by the National Electrical Manufacturers Association (NEMA) and was made available by CEE. Motor *sales data* is not widely collected and is difficult to obtain, but *shipment data* are available and were used as a proxy for estimating sales. Shipment data for both standard and NEMA Premium™ motors were obtained from CEE.

2. **Re-contacted and interviewed** the Green Motors Practices Group (GMPG), which is active in efforts to promote efficiency in the motors industry in the Northwest, and CEE staff to better understand the state of the motors market in the Northwest.

3. **Interviewed and surveyed motor service centers in the Northwest.** The evaluation team contacted 18 out of the 99 motor service centers identified by the GMPG, with the specific aim of a) determining how many motors are rewound annually and what percentage of these are energy efficient rewinds, b) gaining insight into energy savings due to efficient rewinds, and c) estimating the effect of the DPI on the prevalence of energy efficient rewinds.

[34] According to NREL,(http://www.nrel.gov/docs/fy05osti/37002.pdf) motors last between 30,000 and 40,000 hours. This translates to approximately 10 years based on motor usage of 3,500 hours per year.

Table 4-1 summarizes the primary data collection efforts of the M&T team.

Table 4-1. Primary Data Collection

Interviewee Group	Number of Interviews/Surveys	Topic/Issues
Green Motors Practices Group	One extended interview with GMPG management via telephone and email	» Motor rewind activity in recent years. » Baseline estimate of efficient rewind practices. » State of the current motors repair market. » Validation of current methodology to estimate energy efficient rewinds performed in the Northwest.
Northwest motor service centers	18 via telephone survey out of a regional population of 99 service centers.	» Motor rewind activity in recent years » EASA tech-note compliant activity in recent years » Market for energy efficient rewinds » The effect of Drive Power initiative on the market » Energy savings from tech-note 16 compliant rewinds
Consortium for Energy Efficiency	One extended interview with CEE staff via telephone	» Motor rewind activity in recent years. » Baseline estimate of efficient rewind practices. » State of the current motors repair market. » Validation of current methodology to estimate energy efficient rewinds performed in the Northwest.

Motor Service Center Surveys

For the surveys with motor service center interviews, a brief interview guide was developed to ensure consistency of questioning (see Appendix B), and a list of service centers in the Northwest was obtained from GMPG, which has attempted to identify as many operating centers as possible through publicly available information. This list was organized by state and by status of participation in the GMPG, and for each service center the size was given in terms of number of employees. A target sample set of 18 service centers was created according to the following criteria:

» The 18 service centers chosen for this exercise were from all the four states in the Northwest. The distribution of the service centers among the states was roughly proportional to the relative number of motor sales in the four states (from NEMA data). This resulted in a target distribution as follows: Washington (8), Oregon (6), Idaho (3), Montana (1).

» Half of the 18 service centers were targeted from a pool of "Large" centers, and half from a pool of "Small" centers. The size designation was based on data on the number of employees at each company. For each state, those centers larger than the statewide average were considered "Large" and those smaller were considered "Small."

» Ten of the 18 service centers were designated to be GMPG participants; the other eight non-participants.[35]

In conducting the interviews, the complete list of service centers was grouped by state and size. Calls were made at random across states until each state's quota (target distribution) was filled. Within each state, interviews were attempted first with one large center and then one small center, and back and forth until the quotas were met. "Large" centers were contacted from largest to smallest in order to ensure that those likely to represent the most rewinds were included in the sample. "Small" centers were contacted beginning with the median "Small" facility in the state and proceeding one larger or smaller as more sample was needed. Once the quotas for size and/or GMPG participation were reached, facilities of the relevant size/participation category were subsequently skipped in the selection process. The resulting sample distribution by state, size, and participation status is shown in Table 4-2

Table 4-2. Sample Distribution for Motor Service Center Survey

State	GMP Participant		GMP Non Participant		Total
	Large	Small	Large	Small	
Idaho	1	1		1	3
Montana	1				1
Washington	2	2	2	2	8
Oregon	2	2	1	1	6
Total	6	5	3	4	18

4.3 Findings

Findings for this 2009 M&T report are divided into the two major areas of research: 1) Sales of NEMA Premium™ motors, and 2) energy efficient rewinds. Within each of these sections, the three M&T subtopic areas are covered: market activity, baseline activity, and per-unit savings.

Since detailed discussion of the estimation of *NEMA Premium™ sales* have been presented in previous M&T reports, only a summary of market activity is presented below, and additional detail is provided in Appendix B. For *energy efficient rewinds*, a full explanation is provided below in the body of this section.

[35] Both GMPG participants and non participants have the ability to perform EASA Tech Note 16 compliant energy efficient rewinds, but only participants are actively monitored by the GMPG.

4.3.1 Sales of NEMA Premium Motors

Market Activity

Motor *sales data* are not widely collected and are difficult to obtain, but *shipment data* is reasonably available and can be used as a proxy for estimating sales. As in previous M&T reports, motor shipment data in the nation, which were generated by NEMA, were collected from CEE and used to estimate sales data. National shipment data for NEMA Premium™ motors dates back to 2001, with 2007 the most recent year covered. Regional data were not tracked until 2004, and the reporting sources were not consistent until 2005, so the M&T analysis estimated *Northwest* sales of NEMA Premium™ motors as follows:

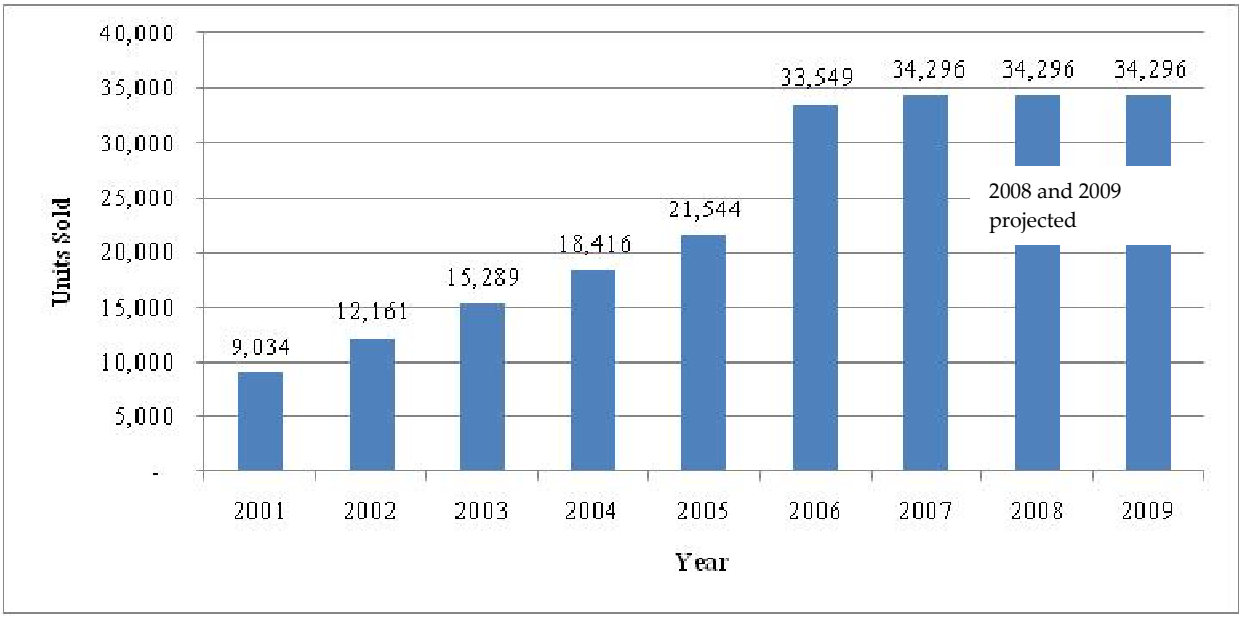
1. Northwest premium motor sales for 2001 were based on *national* shipments in 2001 and on the share of motors sold in the region versus all of the United States (using the three years of available data, 2005 through 2007).
2. Sales for 2002 through 2004 were projected by linear interpolation between the 2001 estimate and the 2005 estimate (see below).
3. Sales for 2005 through 2007 were based on available data, adjusted to account for data deficiencies described in Appendix B.[36]
4. Sales for the two most recent years (2008 and 2009 for the 2009 M&T report) are assumed to be flat, rather than increasing over the last year of available data according to a projected growth curve (as was done in the 2007 M&T analysis[37]).

The result is an estimate of more than 21,000 NEMA Premium™ motors shipped in the Northwest in 2005, rising to more than 34,000 per year between 2007 and 2009 (Figure 4-1). Total sales since 2001 are estimated to be more than 210,000 units.

[36] Only non-OEM motor shipments were reported from 2004 onwards; and one major manufacturer no longer reported shipments after 2004. See Appendix A to this chapter for a discussion of how reported data were adjusted to estimate the volume of shipments.

[37] For the 2007 LTMT report, the latest data available was through 2005 and suggested a steady growth in sales of more than 20% annually since 2001.. The 2006 and 2007 data appear to have flattened out (2% growth in 2007) and thus the analysis projects steady sales rather than continued growth.

Figure 4-1. Estimated NEMA Premium™ Motor Sales in the Northwest, 2001-2009 *



* Values are projected based on reported regional shipment data from 2005 through 2007 and national data from 2001 through 2007. Premium motor sales are assumed to remain flat between 2007 and 2009.

Source: NEMA; and Navigant Consulting projections

Baseline Activity

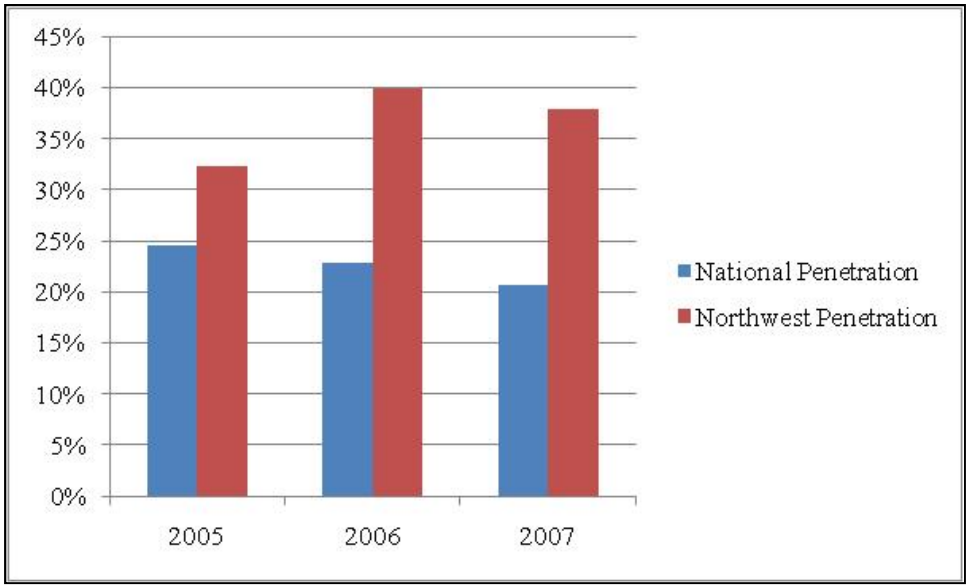
Baseline activity refers to sales of NEMA Premium™ motors that would have occurred even in the absence of NEEA's Drive Power effort. As discussed in the 2007 M&T report, an existing standard for efficient motors existed prior to NEMA. However, this standard was often reported as unclear and confusing and was never a popular choice with consumers. This gave rise to the need for a new, easily recognizable specification. The NEMA Premium™ brand was established after a summit held with NEEA, CEE, the U.S. Environmental Protection Agency, and various motor manufacturers in 1999 and 2000. NEMA Premium™ is an easily recognizable third-party brand that can provide credibility to an efficient motor product.

NEEA was an active participant in all the decisions that led to the formation of the NEMA Premium™ brand; it also provided the working committee with some case studies. Some responsibility for the savings from the sale of NEMA Premium™ Motors can reasonably be attributed to NEEA, as it was integrally involved in the process that resulted in the NEMA Premium™ brand being formed. Through other programs that NEEA was integrally involved in, such as one on one consumer outreach activities, the NEMA Premium™ brand awareness grew in the Northwest, leading to higher market penetration.

As previously discussed, the M&T 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. *In a change from previous M&T analyses*, baselines for 2002 through 2004 were based on linear interpolation between the 2001 and 2005

values; and for 2005 through 2007 the baseline market share was calculated using NEMA Premium™ motors' share of all motors shipped in the nation as reported by NEMA. The national market share for NEMA Premium™ motors was 24% of *all motors sold* in 2005, dropping to 21% in 2007 (Figure 4-2). For comparison, the higher NEMA Premium™ market shares for the Northwest are shown as well.

Figure 4-2. National NEMA Premium™ Motor Sales as Share of All Motor Sales, 2005-2007



Source: NEMA

Baseline sales of premium efficiency motors for these years were then calculated by multiplying each year's national market share (in percent) by the estimated total motor sales in the Northwest (see Market Activity, above).[38] For 2008 and 2009 the baseline value was kept constant at the value calculated for 2007. (This assumption is consistent with the flat projection of sales of NEMA Premium™ motors, above.) This resulted in a 2009 baseline sales estimate of more than 18,600 motors and a cumulative baseline through 2009 of nearly 140,000 units (Table 4-3).

[38] Regional motor sales were calculated in the same manner as national sales: reported data from NEMA was adjusted to account for missing data using an adjustment factor. See Appendix A for reported data and the calculated adjustment factors by year.

Table 4-3.
Estimated Baseline Sales of NEMA Premium™ Motors in the Northwest, 2001-2009*

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Northwest Regional Sales**	NA				66,754	84,188	90,458	NA		NA
National NEMA Premium™ Market Share					24%	23%	21%			NA
Baseline Motor Sales	9,034	10,863	12,692	14,521	16,350	19,165	18,636	18,636	18,636	138,533

* All sales in 2001 were assumed to be part of the baseline. Complete regional shipment data (including non-premium motors) was not available until 2005; therefore, baseline sales values for 2002-2004 were based linear interpolation between 2001 and 2005. 2008 and 2009 baseline activity was assumed to remain constant at 2007 level.

** Regional sales are total motor sales and not just premium motor sales. Figures are adjusted from NEMA reported values to account for missing data. See Appendix B for explanation of the adjustment factor of roughly 1.7.
Source: NEMA and Navigant Consulting analysis

Per-Unit Savings

Per-unit savings values were estimated using the approach from the 2008 M&T report, with exception that a more conservative view was taken on the average motor size and, therefore, on the average savings for each premium motor sold. The result is a decline in per-unit savings from the 629 kWh/year for each motor to 517 kWh/year.

To estimate the savings from replacing standard efficiency motors with NEMA Premium™ motors, data was compiled for hours of operation and average efficiency for EPAct and premium efficiency motors.[39] Annual energy consumption for a motor can be calculated as the product of the following factors:

1) Motor horsepower multiplied by the kW conversion factor of 0.746 kW/hp[40],
2) Annual run-time hours,[41]
3) Motor loading factor,[42] and

[39] Although motor efficiencies are available for each motor size that is commercially available, hours of operation are reported for six size ranges only. To calculate energy savings for motors in a given size range, an average efficiency for available motors in that size range was calculated using their respective nominal efficiencies. Data was obtained from U.S. DOE, *United States Industrial Electric Motor Systems Market Opportunities Assessment*, December 2002 and from CEE, *CEE Premium Efficiency Motors Initiative – Efficiency Specifications*, undated.

[40] 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.

[41] Run-time hours are different for motors of different sizes. Values were obtained from the Green Motors Practices Group's July 2007 submittal to the Northwest Power and Conservation Council's Regional Technical Forum.

4) The number 1 divided by motor efficiency.[43]

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. Per-unit savings due to use of premium efficiency motors in the Northwest is presented in Table 4-4. Savings for various motor size categories are weighted according to regional sales volumes from the two most recent years of available data (2006 and 2007). For purposes of calculating energy consumption, a single, representative horsepower value was assigned to each size category. This value was assumed to be the average horsepower rating among all NEMA Premium™ motor sizes sold in the Northwest within each size category.[44] The result is a single per-unit savings estimate of 517 kWh/year for each premium motor sold. This value was applied to NEMA Premium™ motor sales in the Northwest each year, including retroactively, to estimate regional savings.

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

[43] For each motor size, efficiency figures are averaged across the values for three RPM levels as well as both open and drip-proof motors. Base efficiency assumptions were for efficiencies of federal standard (EPAct) efficiency motors. NEMA Premium™ efficiencies were obtained from CEE. See Footnote 39.

[44] 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: CEE.

Table 4-4. Average Annual Per-Unit Energy Savings from NEMA Premium™ Motors in the Northwest

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	9,998	986
6 to 20	13.1	3,391	89.8%	91.2%	408	6,109	2,491
21 to 50	36.3	4,067	91.9%	93.0%	1,012	2,057	2,082
51 to 100	78.3	5,329	93.4%	94.4%	2,259	781	1,764
101 to 200	143.8	5,200	94.4%	95.2%	3,281	450	1,475
201 to 500	350.5	6,132	94.4%	95.2%	9,435	137	1,293
Total		**N/A**	**N/A**	**N/A**	**517**	19,531	10,090

* Motor Efficiency data were available for different motor sizes (hp). An average efficiency for a particular size range was calculated to estimate per unit energy savings. It was assumed that all sizes had equal weight.

** Per unit energy savings are calculated according to the following formula (using lettered column labels above):
kWh savings = A*(0.746)*B*(0.68)*(1/C – 1/D).

*** Annual NEMA Premium™ sales by motor size are from NEMA shipment reports for 2006 & 2007.

Source: Table 1-15 in U.S. DOE, *United States Industrial Electric Motor Systems Market Opportunities Assessment*, Table 1-15, December 2002; Navigant Consulting analysis.

The per unit savings value calculated here is significantly lower than that calculated in the last LTMT report. This is as the distribution of motor sales is not skewed as highly towards bigger motors in 2007, as compared to motor sale distribution by size in 2006.

4.3.2 Energy Efficient Rewinds

Market Activity

As a part of the 2007 LTMT report, it was estimated that in 2001 less than 10% 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 GMPG, through the support of the DPI, which encouraged the use of energy efficient rewinds. During the 2007 M&T evaluation, it was noted that by the end of 2007, 20 service centers—representing 20% of the motor repair market—were a part of the GMPG. Ten of these service centers were interviewed for the 2008 LTMT report, but estimates for market share and baseline were not included in the Drive Power savings projections due to lack of data.

To better understand service center practices, a more detailed survey was conducted of 18 service centers in the Northwest as part of the 2009 LTMT effort (see Methodology in Section 4.2). Among the topics addressed, the survey provided information on the number of energy efficient rewinds performed in the region. As explained below, an important distinction is made between energy efficient rewinds as defined by service center respondents and energy efficient rewinds as specified by EASA Tech Note 16.

Reported Energy Efficient Rewind Activity

Through the work of the GMPG, the Regional Technical Forum (RTF) has approved efficient rewinds as an approved energy efficiency measure eligible for utility incentives. As a result, many efficient rewinds are documented by participating service centers and reported both to local utilities and to the GMPG. In 2009 (the first full year of reporting) 342 efficient rewinds were reported, totaling approximately 66,000 horsepower.

The GMPG recognizes that some of its members did not provide data on rewind activity, and those reporting may have omitted some efficient rewinds—especially where incentives were not involved. Thus, the reported rewinds account for an unknown share of efficient rewinds performed in the Northwest. The service center survey conducted for the 2009 M&T report provides additional data that can be used to estimate total energy efficient rewind activity in the region.[45]

A critical aspect of quantifying efficient rewinds for purposes of estimating energy savings is how rigorously the service centers comply with EASA guidelines. The unit savings estimates presented in the 2008 M&T report and updated below for 2009 are based on energy efficient rewinds *in full compliance* with EASA Tech Note 16. Therefore, an "efficient" rewind claimed by a service center but complying with only a portion of the EASA guidelines is not deemed to be an "efficient rewind" for purposes of this M&T analysis.

GMPG members are educated in proper efficient rewind practices and are expected to comply with EASA guidelines. The survey of service centers confirmed members' rigorous rewind practices and provided an indication of how non-members view and conduct efficient rewinds.

Survey Results Regarding Efficient Rewinds

The EASA guidelines call for compliance with "EASA Recommended Practice for the Repair of Rotating Electrical Apparatus" and adherence to a list of "DOs" and "DON'Ts" specified in

[45] According to the GMPG, its members tend to report primarily larger motors for which a utility incentive is provided. Thus, the average motor size for reported efficient rewinds is nearly 200 hp, compared to the average size of a new motor sold which is under 20 hp. It is anticipated that many efficient rewinds are not reported especially for small motors.

Tech Note 16.[46] Service center respondents to the M&T survey provided estimates of their total rewinds performed in the Northwest in 2009 as well as the share of rewinds that "you consider" to be energy efficient rewinds. The EASA guidelines were then reviewed in detail by the M&T interviewer (who asked for each item on the Tech Note 16 list whether respondents "routinely," "sometimes," or "never" do (or avoid) the requirement), and respondents were asked for the share of rewinds that are "fully compliant" with Tech Note 16.

Results from the survey indicate that *all GMPG respondents perform fully compliant energy efficient rewinds*, as defined by Tech Note 16, on a majority of rewinds that they perform. By contrast, only two of the eight non-members surveyed perform EASA-compliant rewinds, based on self-reporting. Notably, two additional non-members claimed to perform at least some efficient rewinds when based on their own definition of "efficient," but they retracted their claims when asked to use EASA guidelines as the basis for qualifying as energy efficient.

Among the survey respondents, the ten GMPG members claimed to perform more than 850 EASA-compliant efficient rewinds in the Northwest in 2009, compared to less than 50 for the eight non-members. Survey results for the number of rewinds performed in the Northwest in 2009, both energy efficient and in total, are provided in Table 4-5. The breakout of efficient rewinds as self-defined by the respondent vs. EASA-compliant indicates that GMPG members generally associate "efficient rewind" with EASA compliance, while non-members are more likely to consider a rewind "efficient" even if it falls short of EASA guidelines.

Table 4-5. 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: Service center survey					

Respondents accounted for nearly 25% of the population of GMPG members and nearly 15% of the population of non-member service centers. Extrapolating the survey results to the

[46] See EASA Tech Note No. 16 (Revised September 1999), http://www.greenmotors.org/downloads/Guidelines%20for%20Maintaining%20Motor%20Efficiency%20During%20Rebuilding.pdf.

populations of these two groups yields an estimate of nearly 4,000 efficient rewinds performed in the Northwest in 2009 (Table 4-6).[47]

Table 4-6. 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: Service center survey and GMPG			

Baseline Activity

As noted in previous M&T reports, initially most of the influence of the DPI was on the purchase of NEMA Premium™ motors by customers. However, since repairing or rewinding a motor often costs significantly less than buying a new motor (according to service centers interviewed), many customers prefer repairing or rewinding as opposed to buying a new motor. Thus, in its later stages, the DPI promoted energy efficiency rewinds to motor service centers. One interviewee from the 2007 M&T expressed that changing the thought process and decision making process of customers and service centers through education and outreach activities was one of DPI's most notable achievements.

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% of respondents believe that the number of efficient rewinds being performed today would be different without the DPI, and only three believe that the number would be the same. The increased availability of information and awareness of efficient rewinds were cited as reasons for the influence of the initiative on the market. Only four of 18 respondents believe that the prominence of efficient rewinds would be increasing anyway due to market forces (and without the influence of the DPI).

NEEA's and GMPG's efforts in educating service centers and customers were stated as the main factor in changing the perception of the market towards efficient repair activity in the

[47] The share of the population accounted for by survey respondents was based on service center data provided by the GMPG and estimated two ways, according to the relative share of: 1) service centers in the survey versus in the GMPG database and 2) service center *employees* (this is a proxy for the size of the service center) represented by respondents versus those represented in the GMPG database. The first approach yielded the highest share of the population accounted for in the survey (23% for GMPG members and 14% for non-members), and thus was used as the more conservative approach for extrapolating survey results to the population.

Northwest, although several GMPG members suggested that NEEA's main accomplishment was in transforming the new motors market and not the repair market. Furthermore, most non participants had either not heard of the program or failed to positively indicate a program influence. It is important to note, however, that market transformation is not always explicitly recognized by market actors who do not engage directly with a "program." Several indicated that they tend to serve niche markets and have loyal customer bases which they have been serving for a long time.

The evidence suggests that without the DPI, efficient rewinds and comprehensive customer service at motor service centers would not have grown as prevalent as they are today. 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. Especially given the strict criteria placed on "energy efficient rewinds," it is unlikely that many EASA-compliant rewinds (the only rewinds counted for market activity) would be occurring without the DPI. As such, a 5% baseline is recommended, which translates to 336 rewinds in 2009.

Per Unit Energy Savings

The energy savings for energy efficient rewinds can be calculated in a similar manner to savings from use of premium efficiency motors. The only difference is in the "before" and "after" efficiencies. Rather than using efficiencies of standard vs. NEMA Premium™ motors, the calculation is based on efficiencies after a *standard rewind* vs. an *efficient rewind*. 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 4-7.

Table 4-7 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		
20	385	150	2,116		
Source: Green Motors Practices Group					

The average size of motor receiving efficient rewinds is not know with certainty, but can be estimated from available data and interviews conducted for the M&T analysis. As noted above, 342 efficient rewinds were reported directly to GMPG by its members in 2009, representing approximately 66,000 HP, or 193 HP per motor. Interviews with the GMPG indicated that most motor rewinds are for motors larger than 75 HP, whereas motors below 75 HP are more commonly replaced by new motors. Thus, a reasonable estimate for the size of a typical motor receiving an energy efficient rewind is between 75 HP and 200 HP. This M&T analysis uses the low-end estimate of 75 HP, which corresponds to annual savings of 1,097 kWh per motor (see Table 4-7).[48]

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 exponentially through 2006 and continued to increase in 2007 (the last year for which data is available), while national sales appeared to rise linearly through 2006 and declined in 2007.

[48] The GMPG further indicated that rewinds likely average between 200 and 250 HP. This is consistent with the fact that the average annual savings reported by the GMPG for the 342 rewinds reported by its members in 2009 are more than 3,500 kWh per motor, which falls between the 200 and 250 HP entries in Table 4-7.

- Through 2007, the sale of NEMA Premium™ motors has increased nearly four-fold since 2001, and *regional growth in sales of premium efficiency motors has been at approximately 25% per year, versus 13% nationally*.
- NEMA Premium™ motors have comprised 37% of motor sales in the Northwest since 2005, while national market share has remained at only 23%.
- *GMPG members tend to perform energy efficient rewinds that are fully compliant* with EASA guidelines. Few non-members make a distinction between efficient and standard rewinds, and many of the reported "efficient" rewinds are not EASA-compliant.
- Most efficient rewinds are performed on larger motors that provide for more significant savings than the average estimated in the 2007 M&T report.

Table 4-8 and Table 4-9 summarize recommendations for the values of key indicators for both premium motor sales and energy efficient rewinds. It is estimated that more than 34,000 NEMA Premium™ motors were sold in the Northwest in 2009, bringing cumulative sales since 2001 to more than 212,000 units. Baseline sales are estimated at approximately 18,600 in 2009, or just over half (54%) of the total market activity. With an annual per-unit savings of 517 kWh, the incremental energy savings implied by these figures is 0.9 aMW in 2009, for a cumulative total of 4.4 aMW.

Table 4-8. Recommendations for Key Indicators – NEMA Premium Motor Sales

Key Indicators Reviewed	**2009 Incremental** (Due to new activity occurring in 2009)	**2009 Cumulative** Calendar year 2009 values due to all activity since program inception	Source
Current Market Activity			
NEMA Premium™ motors sold in the Northwest	34,296	212,880	Section 4.3.1 *Market Activity*
Current Baseline Activity			
NEMA Premium™ motors sold in the Northwest	18,636	138,533	Section 4.3.1 *Baseline Activity*
Per-Unit Energy Savings			
NEMA Premium™ motors sold in the Northwest	517*	517*	Section 4.3.1 *Per-unit Savings*
Implied Energy Savings (aMW)			
NEMA Premium™ motors sold in the Northwest	0.9	4.4	Market Activity minus Baseline Activity, times Per-Unit Savings, divided by 8760 hours, divided by 1000
Total (including energy efficient rewinds—see Table 4-9)	1.4	4.9	

* Per-unit savings values were re-estimated for the 2009 M&T report using updated sales data and a more conservative approach to average motor size. The result is a lower savings estimate that has been retroactively applied to motor sales for all years.

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

Source: Navigant Consulting Analysis.

For energy efficient rewinds, it was estimated that nearly 4,000 EASA-compliant energy efficient rewinds were performed in 2009, with a baseline of 5% of market activity. Per unit savings are significantly higher than estimated in the 2007 M&T, recognizing the fact that rewinds are typically performed on motors larger in size than the average new motor sold in the market. The per-unit savings of 1,097 kWh per years implies that energy savings attributable to NEEA

were 0.5 aMW in 2009.[49] Total incremental savings in 2009 from both NEMA Premium™ sales and efficient rewinds is estimated at 1.4 aMW.

Table 4-9 Recommendations for Key Indicators – Energy Efficient Rewinds

Key Indicators Reviewed	**2009 Incremental** (Due to new activity occurring in 2009)	**2009 Cumulative** Calendar year 2009 values due to all activity since program inception	Source
Current Market Activity			
EASA-compliant rewinds performed in the Northwest	3,992	3,992	Section 4.3.2 *Market Activity*
Current Baseline Activity			
EASA-compliant rewinds performed in the Northwest	5% of market activity (336 motors)	5% of market activity (336 motors)	Section 4.3.2 *Per-unit Savings*
Per-Unit Energy Savings			
EASA-compliant rewinds performed in the Northwest	1,097	1,097	Section 4.3.2 *Per-unit Savings*
Implied Energy Savings (aMW)			
EASA-compliant rewinds performed in the Northwest	0.5	0.5	Market Activity minus Baseline Activity, times Per-Unit Savings, divided by 8760 hours, divided by 1000
Total (including NEMA Premium™ motor sales—see Table 4-8)	1.4	4.9	

* Per-unit savings values were re-estimated for the 2009 M&T report using updated sales data and a more conservative approach to average motor size. The result is a lower savings estimate that has been retroactively applied to motor sales for all years.

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

Source: Navigant Consulting Analysis.

[49] As noted in Section 4.3.2, the GMPG provided the evaluation 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.

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

- **Conduct a streamlined update to the NEMA Premium™ motor sales assessment in the Northwest**, at least for one more year before new federal standards go into effect that make NEMA Premium™ the new standard. NEMA releases motor shipment data each year that can be used for these updates. Since data is from two years prior to the release date, the new data allows for a true up of the market activity projections made in the M&T analysis. This annual update should be focused on the new shipment data and include limited secondary research and interviews. After the 2010 M&T, a decision will need to be made regarding NEEA's influence on the federal standards and whether new premium motor sales should contribute to regional savings estimates.

- **Develop a more robust characterization of market activity, including efficient rewinds, every two years.** This update should include market actor interviews (and possibly a follow-up survey of motor service centers) to better understand and quantify baselines and energy efficient rewind practices. In particular, the size of motors receiving efficient rewinds should be more precisely estimated. Service center surveys should focus on quantifying EASA-compliant rewinds for GMPG members and on assessing changing awareness and rewind practices for non-members.

4.5 Bibliography

Consortium of Energy Efficiency, *"CEE premium efficiency initiative, efficiency specifications."*

Consortium of Energy Efficiency, *"Summer 2007 Newsletter – CEE."*

The Green Motors Practices Group, *"Quality Motor Rewinding, an Energy Efficiency Measure."* Regional technical forum submittal 1.0.

Electrical Apparatus Service Association (EASA) *"The effect of repair/rewinding on motor efficiency."*

NEEA, *2007 Long-Term Monitoring and Tracking Report*, 2008.

National Electrical Manufacturers Association (NEMA), *National NEMA Premium™ sales report 2001 – 2004*.

NEMA, "State level national shipment data for 2005 – NEMA."

NEMA, "State level national shipment data for 2006 – NEMA."

NEMA, "State level national shipment data for 2007 – NEMA."

NEMA press release *"NEMA premium motor sales show increase – 4 Nov 2004."*

U.S Department of Energy *"When to purchase NEMA premium motors / Energy tips – motor systems."*

Section 5. ENERGY STAR Home Products

The ENERGY STAR Home Products (ESHP) program was active from March 2001 through the first quarter of 2004. Created with the goal of increasing demand for and the sale of high efficiency clothes washers, dishwashers, and refrigerators, the program focused on relationships with key market actors as its core strategy for achieving success. Through targeted public outreach campaigns as well as partnerships with manufacturers, utilities, and retailers, the program staff deployed a set of tools that would enhance consumer awareness about ENERGY STAR Home Products and their non-energy benefits, including cost savings. According to the ENERGY STAR Home Products Market Progress Evaluation Report (MPER) No. 2, "it has effectively involved utilities, retailers, manufacturers, and consumers in recognizing and embracing high efficiency appliances."[50]

The ESHP program around clothes washers was conducted in between two other NEEA efforts in the market for energy efficient clothes washers. ESHP built on NEEA's prior involvement in the market, which began with the WashWise Program (1997 through 2000). Prior to NEEA's involvement in WashWise, there was no ENERGY STAR standard for clothes washers. NEEA helped open the market for ENERGY STAR clothes washers in the Northwest. Following ESHP, NEEA promoted ultra-high efficiency clothes washers and pushed for more robust ENERGY STAR specifications for clothes washers.

This M&T effort focuses on NEEA's involvement in the market for ENERGY STAR clothes washers, dishwashers, and refrigerators. For dishwashers and refrigerators, this involvement is limited to NEEA's ESHP program. For clothes washers, this includes NEEA's WashWise and ESHP programs as they relate to clothes washers; it does not include the Consumer Products program's focus on ultra-high efficiency clothes washers.

The assessment provides an update on market progress since the last M&T effort, which was conducted in 2007-08. In addition to updating sales figures, this M&T effort also revisits the per-unit energy savings for each ESHP appliance. The review of these per-unit energy savings estimates is especially relevant given the increased scrutiny around the credibility of the ENERGY STAR program. This analysis includes a review of the findings of recent audits of the ENERGY STAR program and their applicability to NEEA's energy savings estimates.

5.1 Assumptions and Indicators for Review

Energy savings created by the sale of appliances covered by the ENERGY STAR Home Products program are calculated using the tools developed by NEEA based on input from the Regional Technical Forum. A formal ACE model exists for clothes washers, while NEEA spreadsheets are

[50] Dethman & Associates. *ENERGY STAR Home Products Program: Market Progress Evaluation Report, No. 2.* August 24, 2005. Prepared for NEEA, Report #E04-131.

used to quantify the energy savings from dishwashers and refrigerators. Inputs used to determine energy savings include the following:

- Quantity of each appliance sold in the Northwest in each calendar year.
- Energy savings per unit.

Energy savings are calculated by multiplying these factors together for each category of appliance separately; the savings by category are then summed to estimate the aggregate program effects. A more formal equation for each appliance's annual energy savings calculation follows:

Gross Annual Energy Savings for appliance type X (kWh/year) =

Number of units of ENERGY STAR appliance type X * Per-unit energy savings for appliance type X (kWh/year)

Where:

- **Number of units of ENERGY STAR appliance X** is the total number of the specific ENERGY STAR appliance type in use in the Northwest in a given year, and
- **Per-unit energy savings for appliance type X** is the annual energy savings for each appliance type.

Other factors that may be relevant to evaluating the net market impacts include the following:

- National and regional market share data (which may provide insight into the level of baseline market activity)
- Effect of utility incentives in sale of ENERGY STAR home products

This M&T effort analyzes the appropriate baseline level but does not investigate the role of utility incentives in the region.

5.2 Methodology

In order to determine the ENERGY STAR Home Products program's market effects, data about the three product types' current market activity, baseline activity, and per-unit energy savings were gathered and analyzed. The first part of this M&T report focuses on the market-level activity and how NEEA's ENERGY STAR Home Products program contributed to that activity. The second part of the report describes the verification of per-unit savings estimates currently being used by NEEA. Research for the 2009-10 M&T effort involved the following activities:

- **Contacted NEEA's Planning Manager.** The Planning Manager assisted Navigant Consulting in obtaining Association of Home Appliance Manufacturers (AHAM) sales data for the nation and for the Northwest. In addition, Ms. Jerko provided updated ACE and spreadsheet models for the M&T team's review.

- **Reviewed existing ACE and spreadsheet models used by NEEA.** NEEA has spreadsheets that it uses to track savings for refrigerators and dishwashers and an ACE model for clothes-washers. The M&T team will request these models from NEEA and review the inputs, assumptions and the underlying methodology of these models.

- **Analyzed AHAM sales data reports from 2007 to 2008.** These reports were analyzed to approximate current and market activity and baseline market activity from a top-down perspective. Market activity for 2009 was projected based on earlier years' activity.

- **Reviewed the ENERGY STAR website.** The ENERGY STAR website was reviewed specifically for the purpose of comparing the assumptions made to calculate per-unit energy savings for all three home products. The M&T team downloaded the ENERGY STAR calculators and reviewed their inputs. Section 5.3.3 on per-unit energy savings highlights differences among the ENERGY STAR assumptions and the Regional Technical Forum's (RTF) assumptions, which underlie NEEA's estimates.

- **Reviewed recent audits of the ENERGY STAR program.** Government agencies have conducted four audits of the ENERGY STAR program in the last three years. These audits were designed to highlight inconsistencies in the program and areas in which the program could be improved to preserve the credibility of the ENERGY STAR label. The M&T team reviewed each of these reports to determine the applicability of the findings to the estimation of energy savings associated with NEEA's ESHP program.

- **Reviewed per-unit energy savings spreadsheets provided by the Northwest Power and Conservation Council.** These spreadsheets were used by the Council to calculate per-unit energy savings as part of the Sixth Power Plan, using the latest federal and ENERGY STAR standards. These spreadsheets were reviewed in detail with special attention given to the savings algorithm and the input assumptions.

A summary of the primary data collection undertaken for this effort is included in Table 5-1.

Table 5-1. Primary Data Collection Activities

Interviewee Group	Number of Interviews/Surveys	Topic/Issues
NEEA Staff	1 telephone interview	Current AHAM data, salient issues to investigate

5.3 Findings

This section presents findings after conducting interviews, reviewing secondary sources, and analyzing the data. Findings are presented in the following manner:

- **Section** 1.3.1 **Market Activity** – This section focuses on recent market activity for each of the three home appliances involved in the ESHP. Market activity for 2009 is estimated using previous years' data since 2009 data were not available at the time of this study.

» **Section 5.3.2 Baseline Activity** – Using NEEA's existing baseline methodology, the evaluation team estimated the baseline for each of the three types of appliances. This analysis builds on the 2007-08 M&T effort and identifies potential improvements in the method.

» **Section 5.3.3 Per-Unit Energy Savings** – NEEA uses per-unit energy savings figures as estimated by the RTF. The RTF spreadsheets and ENERGY STAR calculators were analyzed to validate the calculation procedure, assumptions made, and inputs to the model.

5.3.1 Market Activity

Market activity for all three types of appliance included in ESHP has been affected by changes to the ENERGY STAR criteria in the past two years. The ENERGY STAR criteria for refrigerators changed in 2008, and the criteria for clothes washers and dishwashers changed in 2009. The changes for refrigerators and dishwashers were significant in this round of adjustments, while the 2009 clothes washer criteria change was less dramatic (5% improvement in efficiency) but built on a significant change to the criteria in 2007 (21% improvement in efficiency).[51] Consequently, the market share of ENERGY STAR units for all three appliance types has decreased during the 2007-2008 time period; this report anticipates that the trend continues in 2009.

This section presents the following metrics to quantify market trends for the three appliance types:

» **Market Units -** This is the total number of appliances (ENERGY STAR and non-ENERGY STAR) that have been sold in the Northwest from the beginning of NEEA's involvement in the market for each appliance (1997 to 2009 for clothes washers, 2001 to 2009 for dishwashers and refrigerators).

» **ENERGY STAR Market Share** – This is the percentage of units sold in the Northwest that are rated ENERGY STAR.

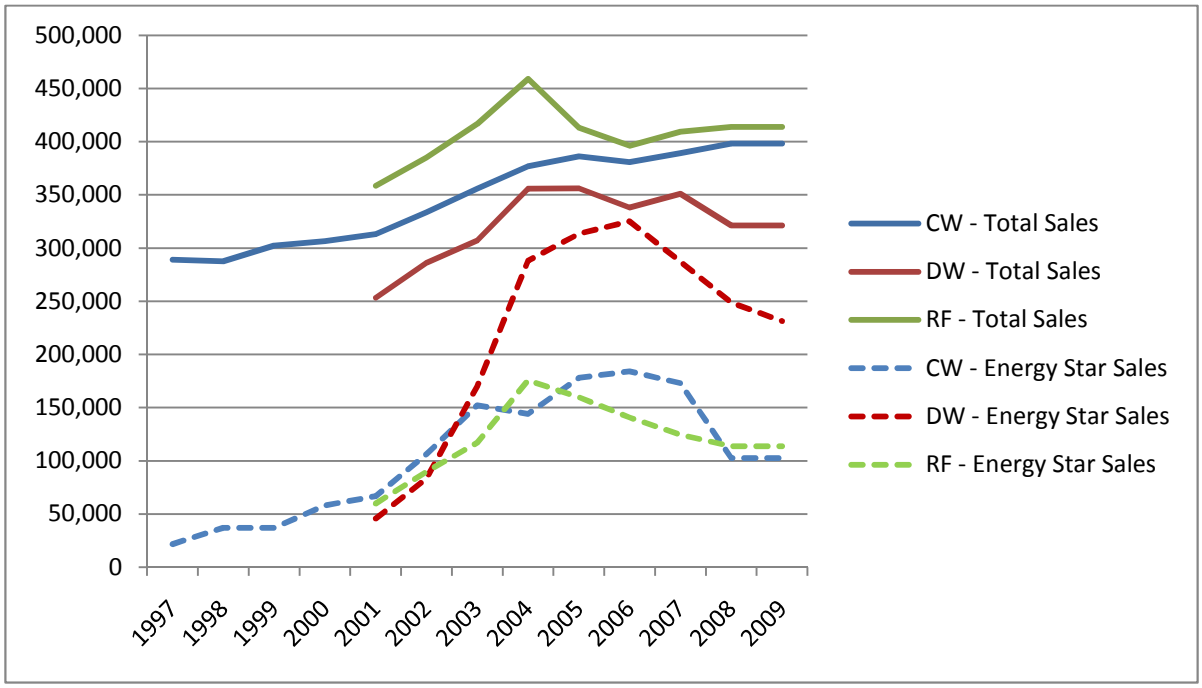
» **Market Activity** – This is the product of Market Units and ENERGY STAR Market Share. Market Activity indicates the total number of ENERGY STAR products sold in the region.

The first step in estimating current market activity is to forecast the total (ENERGY STAR and non-ENERGY STAR) units sold in the Northwest for each of the appliance types (clothes washers, dishwashers, and refrigerators). Market activity since the time of NEEA's first involvement in the market for each technology is summarized in Figure 5-1. As with other

[51] D&R International. May 2008. *Clothes Washer Product Snapshot*. Prepared for U.S. Department of Energy. Available: http://www.energystar.gov/ia/partners/reps/pt_reps_res_retail/files/CW_ProductSnapshot_May08.pdf

consumer goods, sales in 2008 and 2009 leveled off as the recession limited consumer spending. Early data in 2010 indicate that this trend may reverse as the economy continues to recover.[52]

Figure 5-1. Appliance Sales in the Northwest Since NEEA's ESHP Initiative



Source: AHAM sales data and ENERGY STAR market penetration data.

Clothes Washers

The M&T team recommends two main changes to the way that NEEA tracks market activity of ENERGY STAR clothes washers in its ACE model:

1. Segment Tier 3 to explicitly account for the 2009 change in the ENERGY STAR criteria for clothes washers;[53]
2. Simplify the way that market activity is reported in the ACE model to enhance transparency; and

The remainder of this section explains the M&T team's approach to and rationale for these recommendations. The end of the section summarizes recommended values for the market activity using this revised methodology. Appendix C reports the market activity in the format currently used in the ACE model; the appendix also provides a modification to reporting market activity in the current model.

[52] Bater, J. March 30, 2010. "Consumer Spending Rises a Bit, but Incomes Stagnant [sic]." *Wall Street Journal.*
[53] The evaluation team also recommends changing per-unit energy savings associated with ENERGY STAR clothes washers, as discussed in Section 5.3.3.

SEGMENT TIER 3

The approach to accounting for market activity in the clothes washer market reflects the classifications of energy performance provided for clothes washers. These tiers are based on the modified energy factor (MEF), which is a metric for assessing energy performance. MEF accounts for the capacity of the washer and the total energy consumption per cycle (which includes the machine's electrical energy consumption, the hot water energy consumption, and the energy required to remove the remaining moisture in the wash load).[54] Historically, NEEA has accounted for four tiers of ENERGY STAR clothes washers, as shown in Table 5-2.

Table 5-2. Clothes Washers: Historical Tiers of Energy Performance and Inclusion in ENERGY STAR Criteria

	MEF Range	Dates Included in ENERGY STAR
Tier 1	1.26-1.41	1996-2003
Tier 2	1.42-1.71	1997-2006
Tier 3	1.72-1.99	2003-Present
Tier 4	2.0+	2007-Present
Sources: ACE Model for Clothes Washers, provided by NEEA and ENERGY STAR (Clothes Washers Key Product Criteria)		

In 2009, however, DOE established a new set of ENERGY STAR criteria for clothes washers that does not coincide with the current tiered system. As of July 1, 2009, clothes washers would qualify for ENERGY STAR with a minimum MEF of 1.8.[55] This new ENERGY STAR criteria is in the middle of the current Tier 3.

The M&T team recommends segmenting Tier 3 into two sub-tiers that match the new ENERGY STAR criteria, as shown in Table 5-3. Tier 3a includes models with MEF 1.72-1.29 and Tier 3b includes models with MEF 1.8-1.99. The naming can be adjusted to reflect NEEA's preferences, but the principle that market activity is segmented into these two sub-tiers is important because it will provide a more accurate representation of market activity and the associated energy savings.[56]

[54] ENERGY STAR. 2009. "Clothes Washer Key Product Criteria. Available: http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers

[55] ENERGY STAR. 2009. "Clothes Washer Key Product Criteria. Available: http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers

[56] Section 5.3.3 addresses the adjustments to per-unit energy savings that must be made in order to implement this change. The discussion in the current section is limited to market activity.

Table 5-3. Clothes Washers: Recommended Tiers of Energy Performance and Inclusion in ENERGY STAR Criteria

	MEF Range	Dates Included in ENERGY STAR
Tier 1	1.26-1.41	1996-2003
Tier 2	1.42-1.71	1997-2006
Tier 3a	1.72-1.79	2003-July 1, 2009
Tier 3b	1.8-1.99	2003-Present
Tier 4	2.0+	2007-Present
Sources: ACE Model for Clothes Washers, provided by NEEA and ENERGY STAR (Clothes Washers Key Product Criteria)		

These tiers will need to be adjusted in future years as well. Starting January 1, 2011, only Tier 4 will be included in the ENERGY STAR criteria. At that point, there will be no more new market activity reported in Tiers 1, 2, 3a, or 3b. Separately, DOE is engaged in a rulemaking regarding the federal standard for clothes washer efficiency; it is required to complete the rulemaking by December 31, 2011, with any recommended changes taking effect no later than January 1, 2015.

SIMPLIFY THE REPORTING OF MARKET ACTIVITY

The M&T team suggests that NEEA reconsider the way that market activity and the associated energy savings[57] are tracked to enhance transparency. The M&T team suggests that the market activity reported in a given tier reflect the number of units sold *in that tier;* currently, NEEA uses an incremental approach to report market activity, as discussed on the next page. The approach that the evaluation team recommends will allow for a better understanding of where market activity is actually taking place, facilitating analysis of the market and enabling program managers to assess consumer behavior in a more straightforward fashion. Further, it will provide for more transparency in determining the model's accuracy.

In summary, the M&T team suggests that market activity be reported in the following manner:

m_1 = Number of ENERGY STAR units sold with MEF 1.26-1.41

m_2 = Number of ENERGY STAR units sold with MEF 1.42-1.71

m_{3a} = Number of ENERGY STAR units sold with MEF 1.71-1.79

m_{3b} = Number of ENERGY STAR units sold with MEF 1.8-1.99

[57] Section 5.3.3 includes a discussion of the changes to the calculation of per-unit energy savings that are needed to accompany these changes to market activity tracking.

m_4 = Number of ENERGY STAR units sold with MEF $\geq$2.0

Under this suggested structure revision,

Total ENERGY STAR Market Activity = $m_1+m_2+m_{3a}+m_{3b}+m_4$.

This accounting approach does not affect energy savings. It is simply a revision to the accounting process.

This includes a revision to the current methodology, which uses an incremental approach to track market activity and the associated energy savings. Under the current methodology, the tracking of market activity makes it appear that NEEA is counting sales of clothes washers that are no longer qualified for ENERGY STAR towards its savings estimates. It is time-consuming to interpret and makes it difficult to determine actual market activity in any given tier.[58] This approach is paired with an incremental approach to tracking energy savings, which the M&T also suggests revising (as discussed in Section 5.3.3).

The current approach to tracking market activity is as follows:

m_{1*} = Number of ENERGY STAR units sold with MEF $\geq$1.26

m_{2*} = Number of ENERGY STAR units sold with MEF $\geq$1.42

m_{3a*} = Number of ENERGY STAR units sold with MEF $\geq$1.71

m_{3b*} = Number of ENERGY STAR units sold with MEF $\geq$1.8

m_{4*} = Number of ENERGY STAR units sold with MEF $\geq$2.0

Under this current structure,

Total ENERGY STAR Market Activity = m_{1*}.

This approach inhibits a quick check for reasonableness of the data and requires additional calculations to determine current market activity. It can arrive at the proper results but is subject to more frequent error because of its complexities. The revised approach would calculate energy savings in a more intuitive manner.

[58] The M&T team understands that NEEA initially constructed the ACE model in this way to parallel other tracking efforts in the region. However, given the difficulty in interpreting the savings, the M&T team recommends that the ACE model be adjusted to be more easily understandable.

RECOMMENDED VALUES FOR MARKET ACTIVITY

Total market activity for clothes washers grew in 2008 in spite of the recession. The share of that activity attributable to ENERGY STAR models, however, decreased significantly. The decrease started in 2007 in the Northwest; an ENERGY STAR report anticipated this trend at the national level as well because of a significant revision to the ENERGY STAR criteria.[59] The January 1, 2007, criteria required a 21% increase in performance compared to the previous set of criteria in order to qualify for ENERGY STAR.[60] As a result, fewer models qualified for ENERGY STAR in 2007 and in 2008 than in previous years.

Market activity since NEEA's first involvement with energy efficiency clothes washers in 1997 is presented in Table C-1 and Table 5-4. Table C-1 presents market activity using NEEA's current accounting methodology, while Table 5-4 presents market activity using the M&T team's proposed accounting methodology.

[59] D&R International. May 2008. *Clothes Washer Product Snapshot*. Prepared for U.S. Department of Energy. Available: http://www.energystar.gov/ia/partners/reps/pt_reps_res_retail/files/CW_ProductSnapshot_May08.pdf

[60] *Ibid.*

Table 5-4. Clothes Washer Unit Sales in the Northwest: Proposed Methodology

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
ENERGY STAR Market Share	8%	13%	12 %	19%	21%	32%	43%	38%	46%	48%	44%	26%	26%
ENERGY STAR Units Sold	21,820	37,100	37,114	58,142	66,919	106,064	152,365	144,005	177,938	184,157	173,087	102,584	102,584
Percent of Total Market Activity													
Tier 1 Market Penetration	2%	3%	1%	2%	1%	2%	1%	0%	0%	0%	0%	0%	0%
Tier 2 Market Penetration	5%	10%	11%	17%	20%	30%	31%	23%	22%	23%	0%	0%	0%
Tier 3 Market Penetration	-	-	-	-	-	-	10%	15%	24%	25%	25%	13%	0/15%
Tier 4 Market Penetration	-	-	-	-	-	-	-	-	-	-	19%	13%	11%

Source: Navigant Consulting analysis of ENERGY STAR data from http://www.energystar.gov/index.cfm?c=manuf_res.pt_appliances and 2008 AHAM data provided by NEEA

Notes:

1. Market share for 2009 was assumed to be the same as for 2008.
2. Unit sales were estimated by multiplying the assumed market share by the total unit sales (based on AHAM data).
3. This table includes updates to the data included in the 2007-08 M&T report for 2006 and 2007 sales; these changes are based on the most current data reported for those years by AHAM and ENERGY STAR.

Dishwashers

The market for ENERGY STAR dishwashers changed significantly during this M&T period. A change in the ENERGY STAR standard in 2009 caused a significant decrease in the market penetration of ENERGY STAR dishwashers during this M&T period. Additionally, overall sales of dishwashers (including both ENERGY STAR and conventional units) decreased in 2008, consistent with an overall decrease in consumer spending in the beginning of the recession.[61] Consumer expenditures on durable goods declined in all but three months of 2009.[62]

The ENERGY STAR program for dishwashers was subject to significant scrutiny during 2007 and 2008, following the release of a government audit of the program. Prior to the current M&T period, the ENERGY STAR standard was not rigorous enough to meet the intended goal of promoting the top 25% of products in the marketplace as measured by energy performance.[63] During 2004-2006, the ENERGY STAR specification for dishwashers allowed more than 70% of the dishwashers sold to qualify for ENERGY STAR.[64] As a result, the ENERGY STAR dishwashers had captured nearly all of the Northwest market (96%) and the national market (92%) by 2006.[65] Following the adoption of the new standard, the market share for ENERGY STAR dishwashers decreased in the Northwest (82% in 2007 and 77% in 2008) and nationally (77% in 2007 and 67% in 2008). It is possible that the recession also contributed to these decreases in ENERGY STAR market share, given the enhanced cost-consciousness with which consumers shopped.[66]

[61] Barbaro, M. and L. Uchitelle. January 14, 2008. "Americans Cut Back Sharply on Spending." *New York Times.*

[62] U.S. Department of Commerce, Bureau of Economic Analysis. March 29, 2010. "Table 2.8.1 Percent change from Preceding Period in Real Personal Consumption Expenditures by Major Type of Product, Monthly." Accessed April 12, 2010.

[63] U.S. Government Accountability Office. September 2007. *Energy Efficiency: Opportunities Exist for Federal Agencies to Better Inform Household Consumers.* Report to the Chairman, Committee on Energy and Natural Resources, U.S. Senate.

[64] *Ibid.*

[65] Association of Home Appliance Manufacturers, 2008 data.

[66] Elliott, S. November 4, 2008. "Thrift is New Normal as Coupons Make a Comeback in U.S." *The New York Times.*

Table 5-5. Dishwasher Unit Sales in the Northwest

	2001	2002	2003	2004	2005	2006	2007	2008	2009
ENERGY STAR Market Share	18%	29%	55%	81%	88%	96%	82%	77%	72%
ENERGY STAR Units Sold	45,703	83,237	169,885	288,164	313,553	325,245	287,246	248,845	231,282

Source: Navigant Consulting analysis of ENERGY STAR data from http://www.energystar.gov/index.cfm?c=manuf_res.pt_appliances and 2008 AHAM data provided by NEEA

Notes:

4. Market share for 2009 was assumed to decrease by another 5% below 2008 market share, continuing the trend initially realized between 2007 and 2008.
5. Unit sales were estimated by multiplying the assumed market share by the total unit sales (based on AHAM data).
6. This table includes updates to the data included in the 2007-08 M&T report for 2006 and 2007 sales; these changes are based on the most current data reported for those years by AHAM and ENERGY STAR.

It should be noted that market activity in 2011 and beyond will need to be adjusted for retirements. The ENERGY STAR savings calculator assumes a lifetime of 10 years for dishwashers,[67] implying that units purchased in 2001 will be retired after 2010. Calculations in this M&T effort do not account for any retirements.

Refrigerators

The market share of ENERGY STAR refrigerators in the Northwest has continually decreased since 2005. In part, this may be due to frequent changes in the ENERGY STAR standard. After refrigerators initially qualified for ENERGY STAR in 1996, the ENERGY STAR criteria were updated on January 1, 2003, on January 1, 2004, and on April 28, 2008. These frequent changes reduce the number of refrigerators available under the ENERGY STAR label in the short term as manufacturers roll out their new products.

[67] ENERGY STAR. Updated October 2009. "Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Dishwashers: Assumptions for Dishwashers." Available: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls

Table 5-6. Refrigerator Unit Sales in the Northwest

	2001	2002	2003	2004	2005	2006	2007	2008	2009
ENERGY STAR Market Share	17%	23%	28%	38%	39%	36%	30%	27%	27%
ENERGY STAR Units Sold	60,052	89,755	117,164	175,619	159,862	140,724	124,699	113,618	113,618

Source: Navigant Consulting analysis of ENERGY STAR data from http://www.energystar.gov/index.cfm?c=manuf_res.pt_appliances and 2008 AHAM data provided by NEEA

Notes:

7. Market share for 2009 was assumed to remain constant at the 2008 market share; this is consistent with what happened after the most recent major change in the ENERGY STAR standard on January 1, 2004: the following year's market penetration was very similar to the first year of the standard change.
8. Unit sales were estimated by multiplying the assumed market share by the total unit sales (based on AHAM data).
9. This table includes updates to the data included in the 2007-08 M&T report for 2005-2008 market penetration and 2007 sales; these changes are based on the most current data reported for those years by AHAM and ENERGY STAR.

5.3.2 Baseline Activity

Baseline activity seeks to estimate the amount of market activity that would have happened in the absence of NEEA's ESHP initiative. Overall awareness of the ENERGY STAR brand remains high across the country, as evidenced by a steady level of aided recognition of the ENERGY STAR label (76% in 2008 and 77% in 2009).[68] Further, 80% of respondents who recognized the label and purchased an ENERGY STAR product indicate that the ENERGY STAR label very much or somewhat influenced a purchase decision in 2000, compared with 76% in 2008.[69] This continued awareness and influence at the national level is manifesting itself in increases to the baseline across the ESHP appliances, as consumers gradually replace older appliances.

The methods used to estimate baseline activity for ESHP have evolved since the initiative's inception. Through 2005, baseline activity was measured by market penetration in the inactive region of the country; the inactive region was defined by those states that had not been reached by ENERGY STAR-specific promotions. The baseline estimate changed to national market

[68] Environmental Protection Agency. 2010. *National Awareness of ENERGY STAR for 2009: Analysis of CEE Household Survey.* Provided by NEEA.
[69] *Ibid.*

penetration in 2006 as ENERGY STAR promotions reached a broader audience.[70] It became more difficult to identify truly "inactive" regions,[71] creating the necessity to shift the baseline to a better representation of what would have happened in the absence of NEEA's ESHP initiative. This national market share continues to serve as the estimated baseline for the years covered by this M&T effort.

Clothes Washers

The M&T team proposes using the same framework for calculating the baseline penetration of the various tiers of energy efficiency as was used to calculate the market activity (as presented in Section 5.3.1). That is, the M&T team proposes to report baseline activity in each tier as the number of units sold *in that tier*, a change from the current incremental reporting. Presenting the actual level of market activity in each tier is more transparent and more straightforward for reviewers, including program administrators, funders, and evaluators.

Baseline activity since NEEA's first involvement with energy efficiency clothes washers in 1997 is presented in Table C-2. and Table 5-7. Table C-2. presents baseline activity using NEEA's current accounting methodology, while Table 5-7 presents baseline activity using the M&T team's proposed accounting methodology.

[70] Information obtained from Navigant Consulting's 2007 interview with Christine Jerko, NEEA.
[71] The difference in market share between the inactive regions and the national average was small in 2005 (less than 5% in all three cases).

Table 5-7. Clothes Washers: Baseline Activity in the Northwest: Proposed Methodology

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
ENERGY STAR Market Share	3%	4%	7%	8%	8%	13%	18%	27%	34%	38%	42%	24%	24%
Percent of Total Market Activity													
Tier 1 Market Penetration	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%
Tier 2 Market Penetration	2%	3%	6%	7%	7%	12%	13%	16%	16%	18%	0%	0%	0%
Tier 3 Market Penetration	-	-	-	-	-	-	4%	11%	18%	20%	22%	11%	0/13%
Tier 4 Market Penetration	-	-	-	-	-	-	-	-	-	-	19%	14%	11%

Source: Navigant Consulting analysis of ENERGY STAR data from http://www.energystar.gov/index.cfm?c=manuf_res.pt_appliances and 2008 AHAM data provided by NEEA

Notes: Market share for 2009 was assumed to be the same as for 2008.

Dishwashers

Baseline activity for dishwashers is treated in a special way because the Northwest lagged the "inactive" region at the outset of the ENERGY STAR Home Products initiative. When the ESHP initiative began, the market share of ENERGY STAR dishwashers in the Northwest (8%) was behind the inactive region's (11%) market share. As a result, the M&T team provides NEEA with "extra credit" for making up this difference (11%-8%=3%) in market penetration. The 3% extra credit is counted *in addition to* any difference between the traditional estimate of baseline market penetration (inactive region through 2005 and national average 2006 and beyond) and the market penetration in the Northwest. This is deemed appropriate because it is unlikely that the region would have surpassed the national average in the absence of the ESHP program.

The M&T suggests a slight modification to the baseline methodology for dishwashers to enable NEEA to account for this added benefit of its activities.[72] The M&T team suggests decreasing the baseline by the difference in the ENERGY STAR market penetration between the Northwest region and the inactive region when NEEA's ESHP effort began. The overall effect of this change on savings estimates from ENERGY STAR dishwashers is negligible but still worth noting.

NEEA's baseline estimates and the evaluation team's recommended revised estimates are provided in Table 5-8. These were updated to reflect the most current data available from ENERGY STAR, including some changes to previous years' levels of market penetration.

[72] This suggestion was initially included in the 2007-08 M&T report but had not been reflected in the NEEA tracking spreadsheet.

Table 5-8. Dishwashers: Comparison of NEEA's Baseline with Suggested Baseline

	2001	2002	2003	2004	2005	2006	2007	2008	2009*
NEEA's Current Baseline									
Market Share	20%	37%	56%	76%	80%	92%	77%	67%	57%
Units Sold	50,681	105,753	171,900	271,365	283,562	311,930	271,693	215,960	183,098
M&T Team's Recommended Baseline									
Market Share	17%	34%	53%	73%	77%	89%	74%	64%	54%
Units Sold	43,175	97,278	162,794	260,818	273,007	301,912	261,288	206,437	173,576

Source: Navigant Consulting analysis of ENERGY STAR data from http://www.energystar.gov/index.cfm?c=manuf_res.pt_appliances and 2008 AHAM data provided by NEEA

Notes:

10. Market share for 2009 was assumed to decrease by another 10% below 2008 market share, continuing the trend initially realized between 2007 and 2008.
11. Unit sales were estimated by multiplying the assumed market share by the total unit sales (based on AHAM data).

Refrigerators

The M&T team recommends using the same approach to baseline that NEEA has historically used. In 2008 and 2009, this means using the national average as the baseline.

A major shift occurred in 2008: the market penetration of ENERGY STAR refrigerators was higher at the national level than it was in the Northwest. This is the first year that the Northwest fell behind the baseline estimate since the ESHP program began. In 2007, the difference was small: market penetration of ENERGY STAR refrigerators in the Northwest exceeded the market penetration at the national level by only 0.5%. In 2008, that gap was closed, as market penetration at the national level reached 31%, while it fell to 27% in the Northwest. It is not practical to assume that the Northwest market would have been more accepting of ENERGY STAR refrigerators in the absence of NEEA's initiative because it is unlikely that other market forces would have established the infrastructure to promote ENERGY STAR refrigerators that the ESHP initiative did. Thus, Table 5-9 indicates that baseline activity is the same as market activity, a more realistic assumption.

Table 5-9. Refrigerators: Baseline Activity in the Northwest

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Baseline ENERGY STAR Market Share	16%	18%	23%	30%	29%	31%	30%	27%	27%
ENERGY STAR Units Sold	58,520	69,640	95,034	138,085	118,642	123,574	123,266	113,618	113,618

Source: Navigant Consulting analysis of ENERGY STAR data from http://www.energystar.gov/index.cfm?c=manuf_res.pt_appliances and 2008 AHAM data provided by NEEA

Notes:

12. Baseline market share is reported to be the same as market activity, although it was actually higher (31%). Baseline activity is intended to indicate the level of market activity that would have taken place in the absence of NEEA's initiative; it's unlikely that market share would have actually been higher without NEEA's support.
13. Market share for 2009 was assumed to remain constant at the 2008 market share; this is consistent with what happened after the most recent major change in the ENERGY STAR standard on January 1, 2004: the following year's market penetration was similar to the first year of the standard change.
14. Unit sales were estimated by multiplying the assumed market share by the total unit sales (based on AHAM data).
15. This table includes updates to the data included in the 2007-08 M&T report for 2007-08 sales; these changes are based on the most current data reported for those years by AHAM and ENERGY STAR.

5.3.3 Per-Unit Energy Savings

The ENERGY STAR program has come under intense scrutiny in the past three years, bringing into question the validity of the per-unit energy savings estimates used by NEEA and the RTF. Since September 2007, three different government agencies have issued four reports that investigate different aspects of the credibility of the ENERGY STAR program:

- U.S. Government Accountability Office (GAO). September 2007. *Energy Efficiency: Opportunities Exist for Federal Agencies to Better Inform Household Consumers.* GAO-07-1162.
- U.S. Environmental Protection Agency (EPA) Office of Inspector General. December 2008. *Evaluation Report: Improvements Needed to Validate Reported ENERGY STAR Benefits.* 09-P-0061.
- U.S. Department of Energy (DOE) Office of Inspector General Office of Audit Services. October 2009. *Audit Report: The Department's Management of the ENERGY STAR Program.* DOE/IG-0827.

» U.S. Government Accountability Office (GAO). March 2010. *ENERGY STAR Program: Covert Testing Shows the ENERGY STAR Program Certification Process is Vulnerable to Fraud and Abuse.* GAO-10-470.

The M&T team analyzed these reports and determined that it is premature to decrease the per-unit energy savings that NEEA claims for its ESHP program efforts. (A summary of the findings from these reports and their relevance to NEEA is included in Appendix C. These reports identify weaknesses in the ENERGY STAR programs operated by both EPA and DOE, but they did not go so far as to quantify the *impact* of those weaknesses on energy savings; the agencies have not made clear their intentions to quantify such impacts in the future. Specific examples of manufacturers of clothes washers, dishwashers, and refrigerators that somehow manipulated the system are included, but the report does not specify what proportion of total ENERGY STAR sales these models represent at that national or regional level.

It is clear that DOE will need to improve its screening of candidate products and monitoring of how its label is used in stores. It is not clear, however, how these shortcomings have affected the actual energy savings produced by these three appliances in the ENERGY STAR program. Until additional information is available about the real effects of these issues, the M&T team recommends no adjustments to the per-unit energy savings estimates.

Per-unit energy savings are estimated using methodologies developed by the RTF. The M&T team reviewed the methodology used for each appliance type and provides recommendations for adjusting those for all three appliances based on the updates to federal standards and ENERGY STAR criteria. This section provides updates on the per-unit energy savings and compares RTF savings to those found in the ENERGY STAR calculators.

Clothes Washers

The M&T team recommends that NEEA use a per-unit energy savings estimate that reflects the energy savings realized by ENERGY STAR units in comparison to the federal standard *at the time that the product was purchased.* This means that, for example, the energy savings associated with an ENERGY STAR unit purchased in 2004 should reflect the difference between the energy performance of that unit and the performance of a unit that met the federal minimum requirements in 2004. Similarly, energy savings associated with an ENERGY STAR unit purchased in 2007 should reflect the difference between the performance of that unit and the minimum federal standard in 2007.

This recommendation reflects the M&T team's position that the per-unit energy savings estimate needs to reflect changing market conditions. Both the federal standard and the ENERGY STAR criteria have changed since NEEA's first involvement in the market. It is likely that these changes would have happened even in the absence of NEEA's involvement in the market. Considering the energy savings *at the time of purchase* reflects the consumer's options when the purchase decision was made. Thus, the M&T team suggests that the bar by which

energy savings are measured be adjusted as the federal standard and ENERGY STAR criteria changed.

Table 5-10 summarizes the M&T team's recommended values for per-unit energy savings for clothes washers purchased in a given year.

Table 5-10. Clothes Washers: Per-Unit Energy Savings Estimates

Year of Purchase	T1 (1.26 - 1.41)	T2 (1.42 - 1.71)	T3(1.72 - 1.99)	T4 (> 2.0)
1996	338	454	557	599
1997	338	454	557	599
1998	338	454	557	599
1999	338	454	557	599
2000	338	454	557	599
2001	338	454	557	599
2002	338	454	557	599
2003	338	454	557	599
2004	-	116	219	261
2005	-	116	219	261
2006	-	116	219	261
2007	-	-	104	146
2008	-	-	104	146
2009	-	-	Tier 3: 0 Tier 3b: 36	78

Refrigerators

The savings from ENERGY STAR refrigerators must be adjusted starting in 2008 to account for the change in the ENERGY STAR standard. The revised standard required ENERGY STAR-qualified refrigerators to exceed the federal standard by 20%.[73] This enhanced the previous ENERGY STAR standard, which required a 15% increase in performance over the federal standard.[74] During this time, the federal standard remained constant.[75] The change took effect on April 28, 2008.

The per-unit energy savings for 2009 reflects an average of the energy savings under the old and new ENERGY STAR standards, weighted according to the percentage of the year that the standard was in effect (four months for the old standard, and eight months for the new). In the absence of better data, the calculation assumes a uniform distribution of sales each month.

$$2009\ Per\ Unit\ Energy\ Savings = \left(Energy\ savings_{old} * \frac{4}{12}\right) + \left(Energy\ Savings_{New} * \frac{8}{12}\right)$$

where

$Energy\ savings_{old}$ = Annual energy savings expected under old ENERGY STAR standard (as cited in 2007-08 M&T report)

$Energy\ savings_{new}$ = Annual energy savings expected under new ENERGY STAR standard (as explained below)

The M&T team used the same approach to calculate energy savings under the new ENERGY STAR standard as was used in the 2007-08 M&T report. The approach considers a weighted average of the types of models in the marketplace and the expected level of energy savings from each of those models. The weighting is based on the models available in the marketplace, not on actual sales; it is reasonable to assume that the distribution of models available in the marketplace closely resembles actual sales since manufacturers attempt to produce the products that consumers want to purchase. The types of refrigerator-freezer configurations available in the marketplace has shifted significantly in the past five years;[76] thus, the M&T team suggests using updated weighting factors for 2008 and 2009.

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[73] ENERGY STAR. 2008. "Refrigerators and Freezers Key Product Criteria." Available: http://www.energystar.gov/index.cfm?c=refrig.pr_crit_refrigerators

[74] Ibid.

[75] U.S. Department of Energy: Energy Efficiency and Renewable Energy. February 26, 2010. "Refrigerator, Refrigerator-Freezer, and Freezers Rulemaking." Available: http://www1.eere.energy.gov/buildings/appliance_standards/residential/refrigerators_freezers.html

[76] U.S. Department of Energy. December 2009. *New Opportunities Multiply Savings: Refrigerator Market Profile 2009*. Available: http://www.energystar.gov/ia/partners/manuf_res/downloads/Refrigerator_Market_Profile_2009.pdf

The per-unit energy savings estimates used for the new ENERGY STAR standard are based on the difference between the maximum annual energy consumption allowed under the federal standard and the ENERGY STAR standard.[77] This is consistent with the methodology used by the RTF to calculate energy savings for 2006 and 2007. The ENERGY STAR calculator uses slightly different per-unit energy savings estimates,[78] but the M&T team will remain consistent with the previously acknowledged reasonable methodology.

Table 5-11. Refrigerators: Annual Per-Unit Energy Savings

	2006-April 2008		May 2008-December 2009	
Refrigerator Configuration	**Annual Savings (kWh/yr)**	**Weights [79]**	**Annual Savings (kWh/yr)**	**Weights**
ENERGY STAR Refrigerator with Bottom Freezer - No Ice	101	5.6%	115	16%
ENERGY STAR Refrigerator with Bottom Freezer - Ice	156	0.0%	138	2%
ENERGY STAR Refrigerator with Top Freezer - Ice	86	33.3%	-	0%
ENERGY STAR Refrigerator with Top Freezer - No Ice	84	38.9%	95	38%
ENERGY STAR Refrigerator with Side-by-Side - No Ice	110	5.6%	132	4%
ENERGY STAR Refrigerator with Side-by-Side - Ice	120	16.7%	144	40%
Average Weighted savings	**92**	**100 %**	**120**	**100%**
Sources: Summit Blue's analysis of RTF savings spreadsheets; DOE Refrigerator Market Profile 2009.				

For 2008, the M&T team suggests using 111 kWh/year for per-unit energy savings, as calculated using the weighted average methodology described earlier in this section. That number is increased to the full 120 kWh/year starting in 2009.

[77] U.S. Department of Energy. December 2009. *New Opportunities Multiply Savings: Refrigerator Market Profile 2009.* Available: http://www.energystar.gov/ia/partners/manuf_res/downloads/Refrigerator_Market_Profile_2009.pdf

[78] ENERGY STAR. April 2009. "ENERGY STAR Savings Calculator: Assumptions for Residential Refrigerators." Available: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Consumer_Residential_Refrig_Sav_Calc.xls

[79] These weights are based on AHAM sales data for 2005.

Dishwashers

A change to the ENERGY STAR standard for dishwashers reduced the per-unit energy savings starting in 2009. The revised standard changed the basis for ENERGY STAR qualification from an Energy Factor to an annual estimate of energy use.[80] This change made the calculation of energy savings more straightforward, as it no longer requires a conversion from the Energy Factor to energy savings.

The per-unit energy savings for 2009 reflects an average of the energy savings under the old and new ENERGY STAR standards, weighted according to the percentage of the year that the standard was in effect (eight months for the old standard and four months for the new). In the absence of better data, the calculation assumes a uniform distribution of sales each month.

$$2009\ Per\ Unit\ Energy\ Savings = \left(Energy\ savings_{old} * \frac{8}{12}\right) + \left(Energy\ Savings_{New} * \frac{4}{12}\right)$$

where

$Energy\ savings_{old}$ = Annual energy savings expected under old ENERGY STAR standard

$Energy\ savings_{new}$ = Annual energy savings expected under new ENERGY STAR standard

The annual energy savings expected under the new ENERGY STAR standard are based on the methodology provided in the RTF's Supply Curves for the Sixth Power Plan.[81] The per-unit energy savings estimates had to adjusted for 2009 calculations, however. The RTF model calculates its per-unit energy savings based on the revised federal standard that went into effect on January 1, 2010, since this period is coincident with the planning period used for the Sixth Power Plan.

The M&T team used input from the RTF model and from the ENERGY STAR Savings Calculator for Dishwashers to arrive at the per-unit energy savings estimate. This approach involved calculating a weighted average of the energy savings anticipated under the new ENERGY STAR standard based on the composition of model efficiency available in the marketplace.

Table 5-12 summarizes the data used to calculate the per-unit energy savings for 2009. The M&T team suggests revising the per-unit energy savings estimate effective January 1, 2010, to reflect the new federal standard. Further revision will be required when a more rigorous ENERGY STAR standard takes effect on July 1, 2011.

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[80] ENERGY STAR. August 11, 2009. "Dishwasher Key Product Criteria." Available: http://www.energystar.gov/index.cfm?c=dishwash.pr_crit_dishwashers

[81] Regional Technical Forum. October 22, 2009. "Conservation Supply Curve Files: Clothes Washers and Dryers – Single Family." Available: http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm

Table 5-12. Dishwashers: Change in Per-Unit Energy Savings

	Annual Energy Savings (kWh/yr)	2009: # of Months in Effect
Old ENERGY STAR Standard (through August 2009)	97.6	8
New ENERGY STAR Standard (Beginning Sept 2009	47.4	4
Weighted Average for 2009	80.9	

Source: 2007 M&T Report (Old Energy Standard), ENERGY STAR Calculator and RTF spreadsheet (New Energy Standard).

Note: Annual energy savings under the new ENERGY STAR standard assumes a distribution of electric (64%) and gas (36%) water heating based on RTF's 2007 Dishwasher spreadsheet (EStar DishwasherFY07_v1_7_postJan07.xls).

5.4 Conclusions and Recommendations

The market for ENERGY STAR qualified refrigerators, dishwashers, and clothes washers changed during the 2008-09 time period. A myriad of changes to the federal energy efficiency standards and to the ENERGY STAR criteria for these appliances reduced the per-unit energy savings and the number of models that qualified for ENERGY STAR, respectively. In addition, the recession focused consumer spending on need-based purchasing that was focused on first costs. As a result, the annual implied energy savings from NEEA's ENERGY STAR Home Products initiative are lower in 2008 and 2009, relative to those realized in 2006 and 2007. Overall, the cumulative implied energy savings did increase for dishwashers and clothes washers during this time period, but they remained the same for refrigerators.

Other important findings from the report are as follows:

- In 2008, national market share for ENERGY STAR refrigerators exceeded the market share in the Northwest for the first time. This market still struggles to achieve 30% penetration for ENERGY STAR models.
- It is not yet appropriate to reduce per-unit energy savings in response to the concerns about the credibility of the ENERGY STAR program that have been detailed in a series of reports by the GAO and Inspectors General. These reports identify important

concerns about the program's operations but did not provide any detail about how the market (and related energy savings) have actually been impacted.

» For per-unit energy savings during 2008 and 2009, the M&T team recommends updating the per-unit energy savings for all three appliance types to recognize the changes in federal energy efficiency standards and ENERGY STAR criteria.

Table 5-13 summarizes the M&T team's findings. ENERGY STAR *refrigerators* did not add any incremental savings in 2008 or 2009, because the baseline activity exceeded overall market activity in the Northwest; the cumulative savings reported in this M&T report are lower than those reported in the 2007-08 due to updates to previous years' ENERGY STAR market penetration data at the national and regional level by ENERGY STAR. Implied energy savings from *clothes washers* was modest at 0.1 aMW per year in 2008 and 2009, and the market for ENERGY STAR *dishwashers* added 0.5 aMW per year in those years. Altogether, NEEA's initiatives in the market for ENERGY STAR Home Products have helped achieve 20.5 aMW of energy saving since the initiatives began.

Table 5-13. M&T Recommendations for Key Indicators

Key Indicators Reviewed	2008 Incremental (Due to *new* activity occurring in 2008)	2009 Incremental (Due to *new* activity occurring in 2009)	2009 Cumulative (Calendar year 2009 values due to all activity since program inception)
Market Activity			
ENERGY STAR Refrigerators sales in the NW	113,618	113,618	1,095,110
ENERGY STAR Clothes Washers sales in the NW	102,584	104,956	1,363,196
ENERGY STAR Dishwashers sales in the NW	248,845	231,282	1,993,159
Baseline Activity			
ENERGY STAR Refrigerators sales in the NW*	113,618	113,618	953,997
ENERGY STAR Clothes Washers sales in the NW	94,376	96,559	926,536
ENERGY STAR Dishwashers sales in the NW	206,437	173,576	1,766,244
Per-Unit Energy Savings			
ENERGY STAR Refrigerators	111	120	56
ENERGY STAR Clothes Washers	125	54	346
ENERGY STAR Dishwashers	98	81	93
Implied Energy Savings (aMW)**			
ENERGY STAR Refrigerators	0.00	0.00	0.9
ENERGY STAR Clothes Washers	0.1	0.1	17.2
ENERGY STAR Dishwashers	0.5	0.5	2.4
Total Energy Savings across All Appliance Types	0.6	0.6	20.5

* Baseline activity for refrigerators is equal to market activity in 2008 and 2009 because the nationwide market penetration for ENERGY STAR refrigerators (which is used as the proxy for baseline activity) was greater than market penetration in the Northwest.

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

Source: Navigant Consulting Analysis

The M&T team recommends that the next M&T effort be conducted in two years and that it focus on updates to the per-unit energy savings for these appliances. Federal energy efficiency standards and ENERGY STAR criteria for these appliances are expected to change in the next two years; per-unit energy savings should be updated accordingly. In addition, the M&T effort should verify the sales data and ENERGY STAR market penetration levels as well. The M&T effort may also investigate the extent to which future investigative reports quantify impacts to energy savings of ENERGY STAR's current and past management practices; it is possible that previous years' energy savings estimates will be affected.

5.5 Bibliography

Association of Home Appliance Manufacturers, 2008 data.

Barbaro, M. and L. Uchitelle. January 14, 2008. "Americans Cut Back Sharply on Spending." *New York Times.*

Bater, J. March 30, 2010. "Consumer Spending Rises a Bit, but Incomes Stagnant [sic]." *Wall Street Journal.*

D&R International. May 2008. *Clothes Washer Product Snapshot.* Prepared for U.S. Department of Energy. Available: http://www.energystar.gov/ia/partners/reps/pt_reps_res_retail/files/CW_ProductSnapshot_May08.pdf

Dethman & Associates. *ENERGY STAR Home Products Program: Market Progress Evaluation Report, No. 2.* August 24, 2005. Prepared for NEEA, Report #E04-131.

Elliott, S. November 4, 2008. "Thrift is New Normal as Coupons Make a Comeback in U.S." *The New York Times.*

ENERGY STAR. 2008. "Refrigerators and Freezers Key Product Criteria." Available: http://www.energystar.gov/index.cfm?c=refrig.pr_crit_refrigerators

ENERGY STAR. 2009. "Clothes Washer Key Product Criteria. Available: http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers

ENERGY STAR. April 2009. "ENERGY STAR Savings Calculator: Assumptions for Residential Refrigerators." Available: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Consumer_Residential_Refrig_Sav_Calc.xls

ENERGY STAR. August 11, 2009. "Dishwasher Key Product Criteria." Available: http://www.energystar.gov/index.cfm?c=dishwash.pr_crit_dishwashers

ENERGY STAR. Updated October 2009. "Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Dishwashers: Assumptions for Dishwashers." Available: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls

Environmental Protection Agency. 2010. *National Awareness of ENERGY STAR for 2009: Analysis of CEE Household Survey.* Provided by NEEA.

Interview with Christine Jerko, 2007.

NEEA. 2009. ACE Model for Clothes Washers. Provided by Christine Jerko.

NEEA. 2009. Spreadsheet models for Dishwashers and Refrigerators. Provided by Christine Jerko.

Regional Technical Forum. October 22, 2009. "Conservation Supply Curve Files: Clothes Washers and Dryers – Single Family." Available: http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm

U.S. Department of Commerce, Bureau of Economic Analysis. March 29, 2010. "Table 2.8.1 Percent change from Preceding Period in Real Personal Consumption Expenditures by Major Type of Product, Monthly." Accessed April 12, 2010.

U.S. Department of Energy (DOE) Office of Inspector General Office of Audit Services. October 2009. *Audit Report: The Department's Management of the ENERGY STAR Program.* DOE/IG-0827.

U.S. Department of Energy. December 2009. *New Opportunities Multiply Savings: Refrigerator Market Profile 2009.* Available: http://www.energystar.gov/ia/partners/manuf_res/downloads/Refrigerator_Market_Profile_2009.pdf

U.S. Department of Energy: Energy Efficiency and Renewable Energy. February 26, 2010. "Refrigerator, Refrigerator-Freezer, and Freezers Rulemaking." Available: http://www1.eere.energy.gov/buildings/appliance_standards/residential/refrigerators_freezers.html

U.S. Environmental Protection Agency (EPA) Office of Inspector General. December 2008. *Evaluation Report: Improvements Needed to Validate Reported ENERGY STAR Benefits.* 09-P-0061.

U.S. Government Accountability Office. September 2007. *Energy Efficiency: Opportunities Exist for Federal Agencies to Better Inform Household Consumers.* Report to the Chairman, Committee on Energy and Natural Resources, U.S. Senate. GAO-07-1162.

U.S. Government Accountability Office (GAO). March 2010. *ENERGY STAR Program: Covert Testing Shows the ENERGY STAR Program Certification Process is Vulnerable to Fraud and Abuse.* GAO-10-470.

Section 6. ENERGY STAR Residential Windows

The ENERGY STAR residential windows initiative, funded by NEEA from February 1998 to June 2001, targeted window manufacturers, regional utilities, builders, retailers, and wholesalers. The purpose of the initiative was to increase the market share for high efficiency fenestration products in the residential market and also to decrease at least two market barriers: lack of awareness and initial cost premiums. NEEA adjusted the regional standards for ENERGY STAR windows to fit the national standard of Class 35 (U value = 0.35) as defined by the ENERGY STAR program. The market transformation effort showed rapid results as the market penetration of ENERGY STAR windows jumped significantly from just 13% in 1997 to 70% in 2002.

The M&T efforts assessing the ENERGY STAR windows initiative have addressed market size, market penetration, and expected annual savings. The analysis has evolved to include estimates of savings due to reduced cooling loads, reduced furnace fan operation, and installation of windows with an installed U value less than 0.35.

This 2009 M&T effort updates the regional market penetration and baseline estimates using the latest version of the windows statistical report published by the Window and Door Manufacturers Association (WDMA). Reports published by the WDMA in odd years have nationally aggregated data whereas reports published in even years have detailed regional data. The latest report available was published in 2009, and thus is aggregated at a national level. Consequently, the 2009 M&T analysis estimated regional sales based on national shipment data and previously published regional data, as was done for past M&T reports. It is anticipated that the next M&T assessment will be conducted for 2010 and will utilize the full regional data that will soon be available.

6.1 Assumptions and Indicators for Review

The energy savings impact of the ENERGY STAR ™ windows program is broadly based on the market share and baseline of ENERGY STAR windows and the energy savings per-unit of installed window area. The energy savings are further dependent on home type, vintage, and heating and cooling system type of the home. Generically, energy savings for a given calendar year are calculated as follows:

Energy Savings =

(1) Windows shipped in the Northwest

x (2) Average area per window

x (3) Market share of ENERGY STAR windows

x (4) Market penetration of heating and cooling system types

- (5) Savings savings per unit of window area (stratified by heating and cooling types)

where:

Windows shipped in the Northwest is based on an analysis of data contained in market research studies published by Ducker Research Company and the WDMA.

Average area per window varies by window type. These values were supplied by NEEA and were validated as a part of the 2007 M&T effort.

Market share of ENERGY STAR windows is the percentage of shipped residential windows that are ENERGY STAR and is based on data from interviews with window manufacturers in the Northwest.

Market penetration of heating and cooling system types come from data supplied by the Northwest Power and Conservation Council (NW Council). The appropriate market penetration value to use in the savings calculation depends on home type, home vintage, and the type of savings being calculated (electric or gas, heating or cooling, etc.).

Savings per unit of window area is defined as the annual energy savings due to reduced HVAC energy consumption per unit of window area. The values were 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 M&T 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

6.2 Methodology

The 2009 M&T effort for the ENERGY STAR Windows initiative provides an update to the market activity and baseline for ENERGY STAR residential windows. Specifically, the evaluation team conducted the following data collection and analysis activities.

- **Purchased** the *AAMA/WDMA U.S. Industry Statistical Review and Forecast - 2008/2009*. This annual publication contains research on windows, doors and skylight markets and provided updated national window shipment data.[82]

[82] The report is available at http://www.aamanet.org/general.asp?sect=1&id=45. Product Code: MIR-08-09

- » **Updated** market penetration and baseline estimates using the approach applied in the 2007 M&T assessment.
- » **Applied** the per-unit savings (verified in the 2007 M&T report) to the updated market penetration and baseline estimates to calculate the implied energy savings as attributable to NEEA.

6.3 Findings

6.3.1 Market Activity

The evaluation team tracked the number and total area of windows shipped in the Northwest from 2001 to 2009, the market share of ENERGY STAR windows, and the total ENERGY STAR window area shipped to homes with electric space heating, gas space heating, and central air conditioning.

Windows Shipped in the Northwest

Since the 2004 M&T report, which covered the first M&T assessment of NEEA initiatives, the analysis of ENERGY STAR Windows has used windows shipments (for which data is readily available) as a proxy for sales. The *number of windows shipped in the Northwest* from 2001 to 2009 were derived from market research reports published by Ducker Research Company and the WDMA.[83] 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. The last complete report that NEEA purchased was published in 2004, and it contains final data only through 2003. Since the most recent report is a summary report, the evaluation applied the national growth rates in window, skylight, and patio door shipments for new construction and replacement/remodel applications to the *actual regional shipment data from 2003*[84] to get the total number of windows shipped in the Northwest for the years 2004-2009.

Table 6-1 shows the number of fenestration products shipped in the Northwest from 2001-2009. Gross window shipments have been steadily declining since 2005. Fenestration shipments from 2007 to 2009 are shown here, and a more detailed table with data starting from 2001 is shown in Appendix D.

[83] *AAMA/WDMA 2008 – 2009 U.S. National Review and Forecast*, by Ducker Research Company, published by the WDMA, April 2009

[84] Ducker's regional shipment data for the Northwest includes shipments to Washington and Oregon only. The evaluation team used population data from the US Census Bureau as a proxy to add in the number of windows shipped to Idaho and Montana.

Table 6-1. Fenestration Products Shipped in the Northwest from 2007-2009 (thousands)

Year	New Construction			Existing Homes		
	Windows	*Skylights*	*Patio Doors*	*Windows*	*Skylights*	*Patio Doors*
2007	999	29	79	1,534	39	109
2008	667	19	53	1,378	30	97
2009	387	11	31	1,200	25	85
Source: Navigant Consulting analysis of Ducker Research market reports						

The *average area per window* varies by window type; these were established as a part of the 2007 M&T effort:

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

Table 6-2 shows the total area of windows shipped in the Northwest from 2007 to 2009. A more detailed table with data starting from 2001 is shown in Appendix D.

Table 6-2. Total Area of Windows Shipped in the Northwest from 2007-2009 (thousand square feet)

	New Construction	Existing Homes	Total
2007	18,427	24,673	43,100
2008	14,662	19,633	34,295
2009	11,171	14,958	26,130
Source: Calculations of data in Table 6-1 and assumptions regarding average area per window			

Market Share of ENERGY STAR Windows

Based on research conducted for the 2007 M&T effort, the evaluation team found that ENERGY STAR market share continued to grow rapidly after NEEA had ceased funding, and that it had risen to 95% by 2007. This can be explained as follows:

- The *market share of ENERGY STAR windows* during the years 1998-2000 was researched as part of the evaluation contract for the program. The estimates were based on interviews with window manufacturers, retailers, wholesalers, distributors, and builders, and the results suggested that market share of ENERGY STAR in windows shipments had risen from just 13% in 1997 to 57% by the end of 2000, and 66% by the second quarter of 2001.

- In the research conducted for the 2004 M&T effort, Summit Blue found that ENERGY STAR market share continued to grow rapidly after NEEA had ceased funding, and that

it had risen to 89% by 2004. This estimate and the estimates for 2001-2003 were based on interviews with a small sample of window manufacturers in the Northwest, the group of which was estimated to represent more than 50% of the market.[85]

» As a part of the 2007 effort, the evaluation team updated and confirmed the high level of market penetration through informal discussions with a group of regional manufacturers; based on these interviews the evaluation team determined that the market penetration for ENERGY STAR windows had increased to approximately 95% by the end of 2007.

The evaluation team proposes that the market penetration of ENERGY STAR residential windows stay constant at 95[86] % as,

» 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 to assume that the market penetration stay at 95%.

» Given the state of the economy it will be hard to convince new customers to buy ENERGY STAR windows when cheaper alternatives are available.

Table 6-3 shows the market share of ENERGY STAR windows as a percentage of all windows shipped and as total window area from 2007 through 2009. A detailed table with data from 1997 through 2009 is shown in Appendix D.

Table 6-3. Market Share of ENERGY STAR Windows Shipped in the Northwest from 2007-2009

	ENERGY STAR Market Share (%)	New Construction (sqft x 1,000)	Existing Homes (sqft x 1,000)	Total (sqft x 1,000)
2007	95%	17,505	23,439	40,945
2008	95%	13,929	18,651	32,580
2009	95%	10,613	14,210	24,823
Source: Navigant Consulting analysis of interview data applied to gross window areas from Table 6-2.				

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 Northwest Power and Conservation Council. These numbers

[85] See the 2004 M&T report for more details. *NW Alliance Residential ENERGY STAR Windows Program – Draft M&T Findings;* Prepared by Summit Blue Consulting for the Northwest Energy Efficiency Alliance; March 11, 2005

[86] The ACE model for ENERGY STAR residential windows also recommends that market share be kept constant at 95%.

were validated as a part of the 2007 M&T report, and the details on how these numbers were calculated is also presented in that report. Table 6-4 shows the breakout of heating system fuel and home type by vintage. While more than two out of five existing homes (44%) use electricity to heat their homes, just one-third of new construction uses electric heat.

Table 6-4. Market Penetration of Heating Fuel and Home Type by Vintage

Heating Fuel	Home Type	New Construction	Existing Homes
Electric Heat	Single Family	9.1%	25.1%
	Multi-Family	15.1%	12.0%
	Manufactured	9.1%	6.6%
Gas Heat	Single Family	53.6%	41.0%
	Multi-Family	10.2%	1.5%
	Manufactured	1.5%	0.7%
All Other Heating	All Home Types	1.4%	13.2%
Total		**100.0%**	**100.0%**
Source: 2007ENERGY STAR residential windows LTMT report			

Table 6-5 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 nearly twice as likely to have central air conditioning as existing homes.

Table 6-5. Market Penetration of Central Air Conditioning by Home Type and Vintage

	New Construction	Existing Homes
Single Family	26.6%	17.2%
Multi-Family	6.7%	1.6%
Manufactured	4.5%	2.0%
Total	**37.8%**	**20.8%**
Source: Navigant Consulting analysis of regional data from the NW Council		

The evaluation team applied the percentages from Table 6-4 to the window area shipment data as presented in Table 6-3 to get the area of ENERGY STAR windows shipped to homes with electric and gas heat from 2001-2009. Table 6-6 shows the ENERGY STAR window area for homes with electric heat, while Table 6-7 shows the ENERGY STAR window area for homes with gas heat.[87] This same method was also employed for homes with central air conditioning

[87] This analysis assumes that window shipments are made 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. While the M&T team finds this to be a reasonable assumption for this analysis, it may be prudent to explore this further in future efforts.

as presented in Table 6-8.[88] These tables present data from 2007 through 2009. Detailed tables are in Appendix D.

Table 6-6. Area of Windows Shipped to Homes with Electric Space Heating from 2007-2009 (thousand square feet)

Year	New Construction			Existing Homes		
	Single Family	*Multi-Family*	*Manufactured*	*Single Family*	*Multi-Family*	*Manufactured*
2007	1,601	2,641	1,588	5,875	2,807	1,549
2008	1,274	2,101	1,264	4,675	2,234	1,233
2009	970	1,601	963	3,562	1,702	939
Source: Navigant Consulting analysis of Ducker Research market reports (2004, 2007 and 2009) and data from the NW Council						

[88] 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, i.e., some window shipments that affect heating consumption also affect air conditioning consumption.

Table 6-7. Area of Windows Shipped to Homes with Gas Space Heating from 2007-2009 (thousand square feet)

Year	New Construction			Existing Homes		
	Single Family	*Multi-Family*	*Manufactured*	*Single Family*	*Multi-Family*	*Manufactured*
2007	9,389	1,779	265	9,613	341	166
2008	7,471	1,416	211	7,649	272	132
2009	5,692	1,079	160	5,828	207	101

Source: Navigant Consulting analysis of Ducker Research market reports (2004,2007 and 2009) and data from the NW Council

Table 6-8. Area of Windows Shipped to Homes with Central Air Conditioning from 2007-2009 (thousand square feet)

Year	New Construction			Existing Homes		
	Single Family	*Multi-Family*	*Manufactured*	*Single Family*	*Multi-Family*	*Manufactured*
2007	4,662	1,175	787	4,025	379	460
2008	3,710	935	627	3,203	302	366
2009	2,826	712	477	2,440	230	279

Source: Navigant Consulting analysis of Ducker Research market reports (2004.2007 and 2009) and data from the NW Council

6.3.2 Baseline Activity

The baseline estimate for 2009 is calculated using NEEA's methodology that was validated as a part of the 2007 LTMT evaluation. NEEA's baseline estimates are based on an analysis of regions *with* active promotions of ENERGY STAR windows ("active regions") versus those regions of the country *without* active promotions ("inactive regions"). According to this analysis, the market share of ENERGY STAR windows in inactive regions would be a reasonable proxy for the baseline.

The formula used to determine market share in inactive regions is:

IRMS = [(USPop * NMS) - (ARPop * ARMS)] / IRPop

where:

IRMS = Inactive Region Market Share of ENERGY STAR windows

USPop = the population of people in the United States

NMS = National Market Share of ENERGY STAR windows

ARPop = the population of people in active regions

ARMS = Active Region Market Share of ENERGY STAR windows

IRPop = the population of people in inactive regions

For this 2009 M&T analysis, the active and inactive regional market share values were left unchanged from the values used in the 2007 M&T report and are presented in Table 6-9.[89] These values will be updated in the 2010 M&T report.

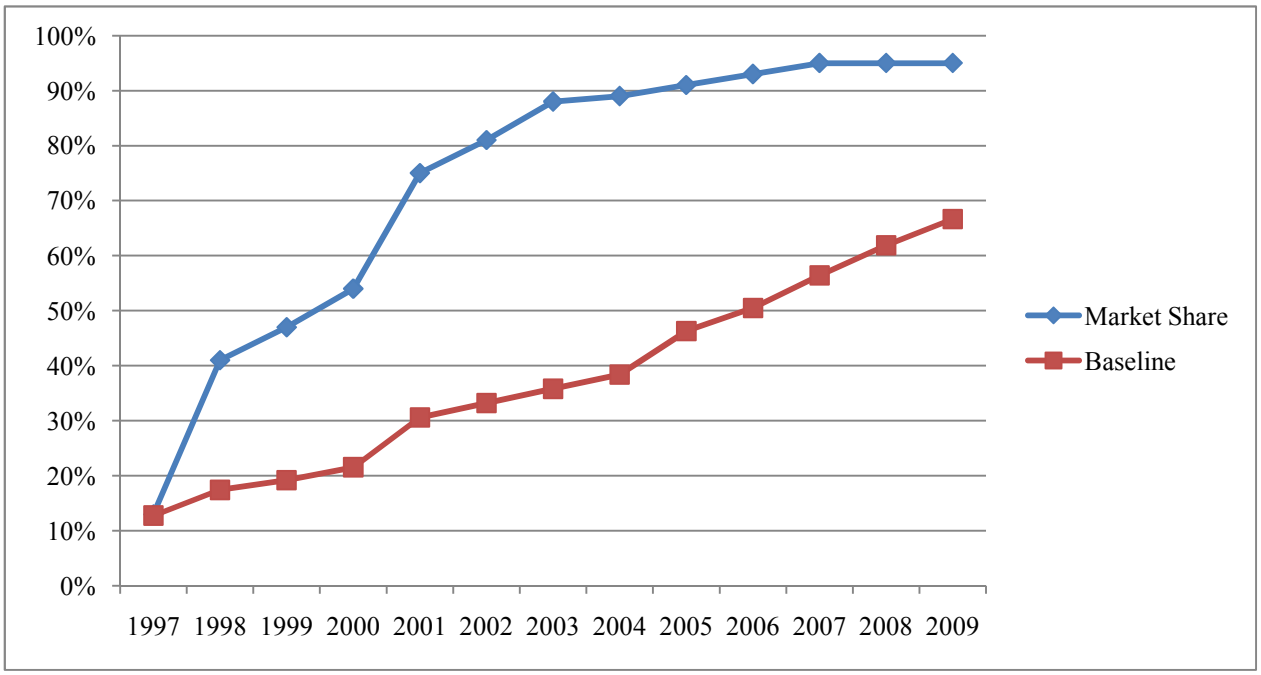
Table 6-9. Active and Inactive Region Market Share of ENERGY STAR Windows

Region	Population	Market Share
Active Region	*95,785,531*	*67%*
Nation	*295,233,783*	*53%*
Inactive Region	*199,448,252*	*46%*
Source: US EPA and US Census data		

After calculating the inactive region market share, NEEA used the national market share growth rates from the partner resource guide to determine the inactive region share back to 2001. In the years 1998, 1999, 2000, and 2006 - 2009, NEEA revised its initial growth estimates of 5% per year to instead use a diffusion of Innovation curve (S-curve) to estimate the rate at which the baseline would grow. Figure 6-1 shows the market share of ENERGY STAR windows in the Northwest as compared to the baseline from 1997-2009. In 2001, the first year for which market share data was reported in the partners resource guide, baseline activity is estimated to be 31% of the market. By 2005, this value had risen to 46%, and it is estimated at 67% in 2009 using the Innovation curve.

[89] The underlying data were taken from the Environmental Protection Agency's (EPA) ENERGY STAR 2007 partner resource guide for windows, doors, and skylights.
http://www.energystar.gov/ia/partners/manuf_res/windows/Windows_PRG.pdf

Figure 6-1. Comparison of the Market Share of ENERGY STAR Windows to the Baseline



Source: 2009 M&T analyses and the 2009 ENERGY STAR Windows ACE model

6.3.3 Per-Unit Energy Savings

The *savings per unit of window area* is defined as 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
- Gas savings due to reduced gas-heating usage
- Electricity savings due to reduced gas furnace-fan operation

Per unit savings remain unchanged from those calculated as a part of the 2007 LTMT effort. The average per-unit savings are weighted by the market share of heating and cooling system types as presented in Table 6-4 and Table 6-5. The weighted average values can be used 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 0.63 kWh/sqft-yr, while the weighted average gas savings is 2.78 kBtu/sqft-yr. Table 6-10 shows the weighted average savings values by savings end-use and vintage.

Table 6-10. Electric and Gas Weighted Average Per-Unit Savings

Savings End-Use	New Construction	Existing Homes	Weighted Average
Electric Heating (kWh/sqft-yr)	0.44	0.70	0.59
Central Air Conditioning (kWh/sqft-yr)	0.02	0.01	0.01
Reduced Furnace Fan Operation (kWh/sqft-yr)	0.02	0.03	0.02
Total Electricity Savings (kWh/sqft-yr)	***0.48***	***0.7***	***0.6***
Total Gas Savings (kBtu/sqft-yr)	***2.42***	***3.05***	***2.78***
Source: Navigant Consulting analysis of per-unit savings values and heating and cooling system market shares.			

6.4 Conclusions and Recommendations

NEEA's ENERGY STAR Windows market transformation program continues to achieve significant energy savings into 2009. Although gross window shipments in the Northwest have been receding since 2005, the percentage of those windows that have the efficiency level promoted by NEEA's initiative is nearing 100% and is likely to remain there. Specific findings from the 2009 M&T effort include:

- **The number of ENERGY STAR windows shipped in the Northwest dropped off from 2005 through 2009.** The total area of ENERGY STAR windows dropped from just over 45 million square feet in 2005 to just under 25 million square feet in 2009, likely due to the economic decline and the slowing of new building and renovation activity.
- **The market share of ENERGY STAR windows is assumed to remain at 95%.** The market share remains unchanged from the last LTMT effort, given the absence of a detailed study or evidence to the contrary.
- **Baseline activity represents 67% of the market in 2009.** In addition, the evaluation team found that NEEA's analysis of active versus inactive regions remains a reasonable and practical approach to estimating baseline activity, which will be updated in the 2010 M&T report.

Table 6-11 summarizes recommendations for the values of key indicators, which are characterized for ENERGY STAR windows sales in the Northwest. Sales of ENERGY STAR windows in the Northwest were roughly 33 million square feet in 2008 and 25 million in 2009. Baseline sales account for roughly two-thirds of the total market activity, yielding incremental savings of approximately 0.8 aMW in 2008 and 0.5 aMW in 2009.

Table 6-11. M&T Recommendations for Key Indicators

Key Indicators Reviewed	2008 Incremental (Due to *new* activity occurring in 2008)	2009 Incremental (Due to *new* activity occurring in 2009)	2009 Cumulative (Calendar year 2009 values due to all activity since program inception)	Source
Market Activity				
ENERGY STAR Windows sold in the Northwest (sqft x 1000)	32,580	24,823	430,477	See Section 6.3.1
Baseline Activity				
ENERGY STAR Windows sold in the Northwest (sqft x 1000)	21,226	17,413	213,796	See Section 6.3.2
Per-Unit Energy Savings				
kWh/sf/year	0.6	0.6	0.6	See section 6.3.3
Implied Energy Savings (aMW)				
New ENERGY STAR Windows sold in the Northwest (aMW)	0.8	0.5	14.8	Market Activity minus Baseline Activity, times Per-Unit Savings, divided by 8760 hours, divided by 1000

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

Source: Navigant Consulting Analysis

The following recommendations are intended to guide future M&T work:

» **Align future M&T efforts with the release of the complete Ducker report.** Ducker Research releases a complete report with the data disaggregated by region in March or April of every even-numbered year, while summary reports with data aggregated at the national level are released in odd-number years.[90] M&T for ENERGY STAR Windows should therefore be conducted once every two years in the even-numbered years to take

[90] The next report is expected to be available by summer 2010.

advantage of the most up-to-date and Northwest-specific data available. This report will be used to update both baseline and market share assessments going forward.

» **Update the baseline activity estimates based on the latest EPA or other data on ENERGY STAR market share for active states.** The baseline values are estimated according to the market penetration in "inactive states." This data has been provided by EPA in the past, but alternatives may be required for future M&T analysis.

» **Update the market share of ENERGY STAR windows to reflect new specifications.** The standard for ENERGY STAR windows has been updated as of January 4, 2010.[91] The minimum requirements for U value has been lowered (from 0.35 to 0.3 Btu/h. ft^2-F).

» **Obtain and use the most up-to-date equipment saturation levels and savings values from the Northwest Power and Conservation Council.** The NW council will be requested for updated per unit savings figures that represent the new ENERGY STAR standards.

6.5 Bibliography

Study of the U.S. Market for Windows, Doors, and Skylights; Ducker Research Company; April 2004

U.S. Industry Statistical Review and Forecast; Ducker Research Company; April 2007

U.S. Industry Statistical Review and Forecast; Ducker Research Company; April 2009

Market Research Report: Baseline Characteristics of the Residential Sector – Idaho, Montana, Oregon, and Washington; Ecotope; December 2001.

Single-Family Residential New Construction Characteristics and Practices Study; RLW Analytics; March 27, 2007.

NW Alliance Residential ENERGY STAR Windows Program – LTMT report; Prepared by Summit Blue Consulting for the Northwest Energy Efficiency Alliance; April 2008

Baseline Market Assessment: ENERGY STAR High Efficiency Residential Windows, Executive Summary; Prepared by Macro International, Inc. for the Northwest Energy Efficiency Alliance; December 1998

Windows, Doors, and Skylights: 2007 Partner Resource Guide; http://www.energystar.gov/ia/partners/manuf_res/windows/Windows_PRG.pdf

Windows, Doors, and Skylights: 2010 Partner Resource Guide;

[91] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=WI

http://www.energystar.gov/ia/partners/manuf_res/downloads/PartnerResourceGuide-LowRes.pdf

2006 Cost-Effectiveness Analysis Key Assumptions: ENERGY STAR Windows; Northwest Energy Efficiency Alliance; May 8, 2007

Long Term Monitoring and Tracking Report on 2005 Activities; Prepared by Summit Blue Consulting for the Northwest Energy Efficiency Alliance; April 14, 2006

Energy Audit of Building Systems – An Engineering Approach; Moncef Krarti, PhD; (CRC-2000); pg 225

Section 7. Evaporator Fan VFDs

In January 1998, NEEA contracted with Cascade Energy Engineering (Cascade) to implement the Evaporator Fan Variable Frequency Drive (VFD) Initiative, which was funded for 6 years until the program's end in January 2004. The initial objective was to make VFDs the industry standard for evaporator fans in all types of refrigerated warehouses in the Northwest, including controlled atmosphere rooms, refrigerated-only fruit storage, food distribution centers, dairy-milk coolers, food-processor blast cells, and other types of common cold storage. The strategy was to demonstrate to warehouse owners and facility operators the energy-efficiency benefits of VFDs, as well as the non-energy advantages such as reduced mass loss and other positive impacts on product quality. The effort focused on market acceptance and the possible emergence of additional products and service providers. This initiative was considered successful, and an additional objective was added in early 2002 to investigate making VFD ventilation fans standard practice in potato and onion storage facilities.

The M&T effort for 2009 focused on refining the per-unit energy savings assumed for VFDs installed on evaporator fans in refrigerated warehouses, with a secondary emphasis of determining recent changes in market activity. Information on operating hours and market penetration of evaporator fan VFDs was collected through a representative survey of refrigerated warehouse facilities in the Northwest, and findings were then extrapolated to all refrigerated warehouse facilities in the region. This approach complemented previous M&T research, which primarily established regional market activity.

7.1 Assumptions and Indicators for Review

The gross energy savings impact of the VFD Initiative is based on the total evaporator fan capacity (horsepower) in refrigerated warehouse facilities in the Northwest, the market penetration of VFDs on these evaporator fans, and an estimate of the annual energy savings per unit horsepower.

Specifically, the gross annual energy savings can be calculated as:

Electricity Savings (kWh/year) =

(1) Total evaporator fan capacity in refrigerated warehouse facilities in the Northwest (HP)

x (2) Market penetration of VFDs on evaporator fans (%)

x (3) Annual energy savings per unit horsepower (kWh/HP)

where:

Total evaporator fan capacity in refrigerated warehouse facilities in the Northwest (HP) is based on United States Department of Agriculture (USDA) data on the refrigerated warehouse industry using a conversion factor of HP per cubic foot of refrigerated volume.[92]

Market penetration of VFDs on evaporator fans (%) has been estimated by analyzing the results of interviews with refrigerated warehouse facility operators in the Northwest.

Annual energy savings per unit horsepower (kWh/HP) for the 2009 M&T report are 3,300 kWh per horsepower for regular storage and 2,300 kWh per horsepower for "controlled atmosphere" storage. The per-unit savings have previously been assumed to be 3,500 kWh per horsepower for refrigerated-only storage and 2,400 kWh per horsepower for controlled atmosphere storage, based on information from Cascade Engineering field trials cited in MPER-3.[93] Updating these numbers was a primary focus of this year's M&T work.

The "controlled atmosphere" storage referenced above is a special type of refrigerated warehouse in which the composition of the atmosphere in the storage room is controlled to reduce fruit spoilage. According to MPER-3, VFDs installed on evaporator fans in controlled atmosphere rooms will achieve different savings than the same measure in common "refrigerated-only" cold storage rooms because of different cooling requirements for long-term fruit storage. As a result, each of the previous three inputs to the savings calculation must be disaggregated by storage type (controlled atmosphere or refrigerated-only).

7.2 Methodology

This methodology section identifies the major tasks associated with primary data collection and describes the population of refrigerated warehouses, according to the manner in which they are categorized for the survey sampling and market activity reporting. Further detail on development of the sample, the survey instrument, and the interview guide are provided in Appendix E.1.

Primary Data Collection

The primary data collection methods in 2009 were surveys and interviews conducted with refrigerated warehouse operators in the Northwest. Questions relating to current evaporator fan VFD market and baseline activity were incorporated into the survey instrument to accomplish the secondary goal of updating these market indicators as well. This survey effort included the following major activities:

[92] USDA, *Capacity of Refrigerated Warehouses: 2009 Summary*, January 2010.
[93] Per unit savings data were previously obtained from MPER-3: Pacific Energy Associates, Inc. and MetaResources Group, *Evaporator Fan VFD Market Transformation Initiative: Market Progress Evaluation Report #3*, prepared for Northwest Energy Efficiency Alliance, 2002.

1. Determining the original methods Cascade used to estimate the average per-unit energy savings;

2. Refining the database of refrigerated warehouse facilities in the Northwest compiled for the 2007 M&T;

3. Constructing a representative sample, including both controlled atmosphere and refrigerated-only refrigerated warehouse facilities;

4. Administering surveys of 31 facilities, including 15 update surveys with 2007 M&T survey participants (see Table 7-1);

5. Asking seven of these 15 respondents from the 2007 M&T survey additional questions about particular 2007 responses that were likely to provide a snapshot of the current market (e.g., plans to change or expand their facility, the presence of barriers to installing VFDs, etc.), as part of a "follow-up interview."

6. Compiling 2009 survey results with the 2007 survey results and extrapolating the combined results to the population of refrigerated warehouse facilities.

Table 7-1. Primary Data Collection

Interviewee/Survey Group	Number of Interviews/Surveys	Topic/Issues
Cascade Energy Engineering staff	1 completed interview via email exchanges	Original methodologies used for MPER calculations
United States Department of Agriculture staff	1 completed interview via telephone	Use and applicability of USDA report on refrigerated warehouse capacity
Operators of refrigerated warehouse facilities (surveyed)	46 completed surveys • 28 via telephone in 2009 • 3 online in 2009 • 15 via telephone in 2007	Use and installations of VFDs; hours of operation
Operators of refrigerated warehouse facilities (interviewed)	7 completed interviews via telephone in 2009 (included as a subset of the 28 telephone surveys above)	Follow-up on 2007 plans for VFD installations and facility expansions, barriers to VFD usage, etc.

Since 15 facilities from the 2007 M&T survey were surveyed again in 2009, the results presented for this year's M&T combine the 2007 and 2009 samples to avoid sampling bias. To this end, the 2009 M&T results for market activity are based on 15 facilities contacted in 2007 and 31 facilities contacted in 2009 (16 facilities contacted only in 2009, and 15 facilities contacted in 2007 and

then updated in 2009) for a total of 46 unique facilities. Per-unit energy savings results are only reported for 2009 respondents, since the line of questioning regarding savings was introduced only for the 2009 survey.

Defining the Unit of Transformation

The population of units for this study is defined as all of the refrigerated warehouse facilities in Idaho, Montana, Oregon, and Washington. *Since a refrigerated warehouse facility may consist of more than one warehouse and contain more than one warehouse type*, this report looks at the population of refrigerated warehouse in terms of facility capacity, which can be aggregated in a more meaningful way than the number of facilities. For purposes of the market activity discussion below, capacity is presented as warehouse volume (in cubic feet) to maintain consistency with the information available in the USDA refrigerated warehouse census.[94] This volume is converted to evaporator fan capacity (in horsepower) to report the final energy savings for the initiative.

The Data from the USDA's biennial census of refrigerated warehouses in the United States is split into two major sectors: 1) apple and pear storage, collectively known as "fruit storage" and 2) refrigerated-only general cold storage.

The first sector, fruit storage, is further divided into *controlled atmosphere (CA)* rooms and *refrigerated-only fruit* storage rooms. A CA room is one in which the chemical content of the atmosphere in the storage room is controlled to reduce fruit spoilage. In general, the CA rooms are used as long-term storage, while the refrigerated-only fruit storage rooms are used while the fruit is being transitioned from the field to long-term storage.

The second major sector consists of *refrigerated-only general* cold storage. General cold storage is used to store all other refrigerated products, such as dairy, meat, seafood, vegetables, etc. General cold storage can be publicly or privately owned,[95] and may be either freezer or cooler space.[96]

This report discusses the energy usage and existing capacity of refrigerated warehouses in the context of *controlled atmosphere* versus *refrigerated-only* storage rooms. Although refrigerated-only fruit storage rooms store different products (i.e., apples and pears) than refrigerated-only general storage and are seldom located in the same facilities, their energy consumption and operating profiles are assumed to be more similar in nature than to controlled atmosphere

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[94] USDA, *Capacity of Refrigerated Warehouses: 2009 Summary*, January 2010.
[95] Public storages are defined as "refrigerated facilities maintained for others at specified rates [prices] per unit." Private/semi-private general storages are defined as "refrigerated facilities maintained by an operator to facilitate his principal function as a producer, processor, or manufacturer of food products. The space is used to store the owner's products, although some space may be used by others at specified rates per unit stored." Source: Ibid.
[96] Cooler space is defined as space that maintains temperatures between 0 and 50 degrees Fahrenheit. Freezer space is defined as space that maintains temperatures at 0 degrees Fahrenheit or lower. Source: Ibid.

rooms. Accordingly, the per-unit energy savings are only applied based on whether the facility is controlled atmosphere or refrigerated-only and do not make the distinction between fruit versus general, public versus private, or freezer versus cooler. Thus, the 2009 M&T limits the discussion of the refrigerated warehouse population to controlled atmosphere versus refrigerated-only storages, unless otherwise appropriate.

7.3 Findings

Updating the per-unit energy savings was the primary focus of the 2009 M&T research for the evaporator fan VFD initiative. Therefore, unlike other M&T chapters, the discussion of per-unit savings is presented first—prior to the discussions of market and baseline activity.

7.3.1 Per-Unit Energy Savings

The update of per-unit savings was performed by reviewing the assumptions and methods used by Cascade to develop the original savings rates, and surveying refrigerated warehouses to refine the values of key inputs. This effort resulted in a 6% decrease in the per-unit savings rate for refrigerated-only cold storage and a 4% decrease for CA storage.

Inputs to Previous Savings Estimates

The previous per-unit savings assumptions were that refrigerated-only cold storage annual energy savings were 3,500 kWh per horsepower of evaporator fan VFD capacity, while controlled atmosphere refrigerated warehouse annual energy savings were 2,400 kWh per horsepower of evaporator fan VFD capacity. These values were based on field trials conducted in 1998 and 1999 by Cascade in 15 refrigerated warehouses with controlled-atmosphere rooms and six warehouses with refrigerated-only cold storage rooms. Each field trial consisted of measuring the evaporator fan power consumption at five-minute intervals in a control room without VFDs and in another room that had evaporator fan VFDs installed. The difference between the instantaneous fan power in the control room and the VFD room was averaged over the storage period to determine the *average VFD kW savings*. These savings were then multiplied by the total *number of operating hours* for the evaporator fan and an *interaction factor* to find the *annual kWh savings* from evaporator fan VFDs, as shown in the equation below:

Annual kWh Savings = Average kW Savings x Number of Operating Hours per Year x Interaction Factor

Where:

- The *average kW savings* represent the difference between the instantaneous fan power measured in the control rooms and the VFD rooms, averaged over the storage period
- The *number of operating hours per year* is based on the number of days the evaporator fans are used in an average year. For controlled atmosphere storage, the number of operating hours is assumed to be the annual number of storage days a controlled atmosphere

room is sealed (not including the product loading and unloading time periods) times 24 hours per day. For refrigerated-only cold storage, the number of operating hours is equivalent to the annual number of days the temperature is maintained[97] times 23 hours per day. The choice of 23 hours per day accounts for one hour of defrost time each day and is discussed more below.

» The *interaction factor* accounts for the additional refrigeration system savings. Cascade assumed this factor to be 20% of the direct evaporator fan savings, which is a typical engineering assumption for system efficiencies and equates to a refrigeration system (compressor and condensers) with a coefficient of performance (COP) of five.[98]

The same algorithm was used for both controlled atmosphere rooms and refrigerated-only cold storage. Since Cascade's initial assessment of the average kW savings was fairly rigorous and the firm's initial choice of interaction factor is still consistent with standard industry assumptions, **the 2009 M&T team identified the number of operating hours as the energy savings input with the greatest uncertainty.** Thus, operating hours were the focus of the facility surveys.

Updating the Assumed Operating Hours

During the 1998-1999 field trials, Cascade assumed that temperatures in the six general refrigerated-only cold storage facilities were maintained 365 days per year, as is consistent with the typical use profiles of a general cold storage facility. Although documentation of this specific input was unavailable, Cascade advised assuming that the evaporator fans did not run for an hour per day to defrost. This assumption leads to *operating hours equivalent to approximately 350 days per year for refrigerated-only cold storage* (i.e., 8,395 versus 8,760 hours per year). Further, Cascade documented that the 15 fruit storage facilities with *controlled atmosphere rooms had an average number of 197 storage days per year* (not including loading and unloading days), averaged across the rooms with and without VFDs installed.[99] Cascade did not perform any field trials in refrigerated-only cold storage rooms at fruit facilities.

For the 2009 update, the average annual number of storage days (and, in turn, operating hours), were estimated through the survey of facility operators. Specifically, respondents were asked to estimate:

» the average number of days they were cooling their storage rooms,

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[97] Cooler space is defined as space that maintains temperatures between 0 and 50 degrees Fahrenheit. Freezer space is defined as space that maintains temperatures at 0 degrees Fahrenheit or lower. Source: USDA, *Capacity of Refrigerated Warehouses: 2009 Summary*, January 2010.

[98] Personal communications with Mike McDevitt, Cascade Energy Engineering, January 2010.

[99] Cascade Energy Engineering, "Evaporator Fan VFD Initiative," Study Results, http://www.cascadeenergy.com/energy_evapvfd_main.asp.

- the size (in mcf) of their storage rooms
- whether the rooms were controlled atmosphere or refrigerated-only cold storage, and
- whether or not the rooms had evaporator fan VFDs.

After incorporating Cascade's findings[100] and adjusting the refrigerated-only storage results for defrost time,[101] the 2009 M&T estimates an average of 332 storage days per year for refrigerated-only cold storage capacity and 190 storage days per year for controlled atmosphere capacity (Table 7-2).

[100] Ibid.

[101] To maintain consistency with the prior methodology, the refrigerated-only cold storage operating hours for the 2009 survey respondents were decreased by an hour a day to account for defrost times (e.g., a room that is maintained for 365 days per year would be included as the equivalent of 350 days, a room maintained for 200 days per year would be included as 192 days, etc.). The average kW savings estimated during the field trials may incorporate defrost cycles in the savings; however, the absence of documentation on the methods used for the refrigerated-only cold storage field trials makes inclusion of defrost time a more conservative approach. For controlled atmosphere facilities, it is assumed that defrost is incorporated into the average kW savings and the hours are not adjusted for defrost.

Table 7-2. Average Annual Number of Storage Days for Refrigerated-Only and Controlled Atmosphere Storage

Facility and Storage Type	1998-1999 Cascade Field Trials		2009 M&T Survey Results		2009 M&T Recommended Values
	Number of Days	Number of Field Trials	Number of Days	Number of Survey Respondents	Average Annual Number of Days
Refrigerated-Only Cold Storage	-		332	31	**332***
General Refrigerated-Only Cold Storage	*350*	*6*	*350*	*14*	*350*
Fruit Refrigerated-Only Cold Storage	*-*	*-*	*289*	*17*	*289*
CA Storage	197	15	184	15	**190**

* The 2009 M&T recommended value for refrigerated-only cold storage days is a weighted average, based on the relative capacities of general cold storage capacity versus fruit cold storage for the population (i.e., 72% and 28% of the refrigerated-only capacity in the Northwest, respectively), rather than the relative number of facilities in the sample.

Source: Navigant Consulting 2007 and 2009 refrigerated warehouse surveys; Cascade Energy Engineering

It is worth noting that, on average, respondents indicated using controlled atmosphere rooms *without* evaporator fan VFDs almost 10% *less* (by number of storage days) than the respondents *with* evaporator fan VFDs. The findings for refrigerated-only cold storage in fruit facilities also indicated a shorter annual storage duration for rooms without VFDs, although the difference for these facilities was around 3%. Differences in operating hours for rooms with and without evaporator fan VFDs are not taken into account for this analysis, since it assumed that the storage duration of a room is dependent on product-specific factors (e.g., length of growing season, demand for product, etc.) and facility operators selectively choose the rooms with the highest energy consumption for VFD installations. The effect of this approach is that the per-unit energy savings presented below are relatively conservative.

Revised Per-Unit Savings Values

Adjusting the per-unit energy savings proportionally to reflect the recommended adjustment in evaporator fan operating hours suggests decreasing the savings from 3,500 and 2,400 kWh/hp-yr, for refrigerated-only cold storage and CA storage, respectively, to approximately 3,300 and 2,300 kWh/hp-yr (Table 7-3). Since Cascade's original per-unit energy savings only included two significant digits, the proposed updated savings are also rounded to the nearest hundred. For both refrigerated-only and controlled atmosphere storage, the evaluation used the weighted average of the 2009 results and Cascade's results as the basis for the rounding, since it is

assumed Cascade's original findings have been made more robust with the additional data points, rather than invalidated.

Table 7-3. Adjusted Per-Unit Energy Savings for Refrigerated-Only and Controlled Atmosphere Storage

Storage Type	Per-Unit Energy Savings (kWh/hp-yr)			
	1998-1999 Cascade Field Trials	With 2009 M&T Survey Results	With Weighted Average of 2009 M&T Survey Results and Cascade Field Trials	2009 M&T Recommended Per-Unit Energy Savings
Refrigerated-Only Cold Storage	3,500	3,327	3,327*	**3,300**
CA Storage	2,400	2,249	2,324**	**2,300**

* Because the operating hours for refrigerated-only cold storage are weighted based on the proportion of general versus fruit storage capacity for the population of refrigerated warehouses in the Northwest (see Table 7-2), inclusion of the Cascade field trial results have no incremental effect on the calculated savings rate.

** The weighted average of the 2009 survey results and the Cascade field trials for controlled atmosphere storage are weighted by the number of responses.

Source: Navigant Consulting 2007 and 2009 refrigerated warehouse surveys; Cascade Energy Engineering

The 2009 findings are within 10% of the values from Cascade's 1998-1999 field trials. As expected, all survey respondents with general refrigerated-only cold storage reported maintaining the temperature in their warehouse 365 days per year. In contrast, only nine of the 16 survey respondents with refrigerated-only storage in a fruit facility reported maintaining room temperature year-round. According to the facility operators, the use of refrigerated-only storage at the other seven facilities is closely tied to the amount of fruit the facility has stored and has sold. Some of these facilities indicated that they may have one room running through the year, but another room may only store product one or two months.

Refrigerated-only storage. Since assumptions relating to refrigerated-only cold storage operations at *fruit* facilities have not been previously incorporated in the per-unit energy savings, despite attributing these savings to fruit facilities in previous MPER and M&T reports, incorporating these findings is expected to improve the accuracy of the estimated savings. It is recommended that the reduction in the refrigerated-only per-unit energy savings to 3,300 kWh/hp-yr be applied retroactively to prior-year savings.

Controlled atmosphere storage. Like the refrigerated-only storage at fruit facilities, the storage duration for controlled atmosphere rooms is dependent on the amount of product put in at the beginning of the season and the rate that the fruit is taken out of storage to sell. In contrast to the number of storage days at a general refrigerated-only cold storage facility (i.e., 365 days per year), the average number of storage days for a controlled atmosphere room varies significantly—year to year, as well as room to room. Because of this variability, *the survey findings for controlled atmosphere contain a greater degree of uncertainty than the refrigerated-only data*.

To account for this uncertainty, the 2009 M&T analysis used the weighted average of the 2009 findings and Cascade's findings to achieve a larger sample size. This approach suggests reducing the per-unit energy savings for controlled atmosphere capacity to 2,300 kWh/-hp-yr. Compared to refrigerated-only storage, it is less clear whether or not the updated savings for CA should be applied retroactively, since it is possible that some market influence has changed the average storage duration since the 1998-1999 field trials (e.g., the typical amount of stored product has decreased). However, in the absence of findings that indicate that significant changes have occurred, it is recommended that prior-year savings be updated based on the new data.

7.3.2 Market Activity

Quantitative Market Penetration Survey Results

The 2009 M&T survey findings are consistent with the 2007 M&T findings that a majority of facilities use evaporator fan VFDs, and suggest an increase in evaporator fan VFD penetration over the 2007 M&T report.

Table 7-4 shows the breakout by sector of ***facility operators*** *reporting evaporator fan VFDs* in at least some of their refrigerated warehouse facilities.[102] Thirty out of the 46 facility operators surveyed (65%) have VFDs installed on at least some of their evaporator fans. Consistent with previous findings, a higher proportion of fruit storage facilities have evaporator fan VFDs installed than general refrigerated warehouses.

Table 7-4. Facility Operators with At Least Some Evaporator Fan VFDs (Survey Sample)

Facility and Storage Type	Total Refrigerated Warehouse Facilities in Sample	Facilities in Sample With At Least Some VFDs	Percent of Facilities With At Least Some VFDs
General Refrigerated-Only Cold Storage	21	13	62%
All Fruit Storage	25*	17*	68%
Fruit Refrigerated-Only	*21*	*13*	*62%*
Fruit CA	*21*	*16*	*76%*
Total All Refrigerated Warehouses	**46**	**30**	**65%**

* Many fruit storage facilities have both refrigerated-only and CA warehouses. As a result, these sub-categories sum to greater than the number of fruit storage facilities identified here.

Source: Navigant Consulting 2007 and 2009 refrigerated warehouse surveys

The M&T project team also asked the interview respondents to estimate the total ***volume*** *of their refrigerated warehouse space for which evaporator fans are controlled by VFDs*. More than half of the refrigerated warehouse volume represented in the survey sample is served by evaporator fan VFDs. This result is not evenly distributed by storage type, however, as 69% of the CA storage

[102] Some facility operators maintain facilities with multiple warehouses that represent more than one refrigerated warehouse type (i.e., refrigerated-only and controlled atmosphere).

volume is served by evaporator fan VFDs as compared to 44% and 36% in the general and fruit refrigerated-only cold storages. Table 7-5 shows the breakdown of refrigerated warehouse volume served by evaporator fan VFDs as reported by the surveyed facility operators.

Table 7-5. Volume of Refrigerated Warehouses with and without VFDs (Survey Sample)

	Millions of Cubic Feet		
Facility and Storage Type*	**Total Refrigerated Warehouse Volume in Sample**	**Sample Volume Controlled by VFDs**	**Percent of Volume Controlled by VFDs**
General Refrigerated-Only Cold Storage	79.2	34.9	44%
All Fruit Storage	70.0	44.9	64%
*Fruit Refrigerated-Only**	*10.4*	*3.7*	*36%*
Fruit CA	*59.6*	*41.1*	*69%*
Total All Refrigerated Warehouses	**149.2**	**79.7**	**53%**

* One general cold storage facility reported having a 60,000 cubic foot (<1% of facility capacity) controlled atmosphere loading dock with evaporator fan VFDs. For ease of reporting, this facility is classified as a general refrigerated-only facility, but the capacity is included in the total for "Fruit CA."

Note: Totals may not be accurate to the first decimal place due to rounding.

Source: Navigant Consulting 2007 and 2009 refrigerated warehouse surveys

Extrapolating Survey Results to the Population

The 2009 project team extrapolated the results from the survey sample to the refrigerated warehouse population in the Northwest by comparing the survey findings with the total refrigerated warehouse volume reported by the USDA for each storage type.[103] The sample of 46 facilities surveyed in 2007 and 2009 accounts for about 17% of the total population volume, and this survey data provided information about the use of VFDs in refrigerated warehouse facilities in the Northwest.

[103] USDA, *Capacity of Refrigerated Warehouses: 2009 Summary*, January 2010.

Two strata-weighting approaches were utilized for the analysis of market penetration, one based on the *count of respondents* who use VFDs, and another based on the *volume of facilities* for which respondents use VFDs. Table 7-6 compares the analysis results from these two different approaches. Based on weighting by the count of respondents using VFDs, 67% of all refrigerated warehouse capacity in the Northwest (583 million cubic feet) uses VFDs on evaporator fans. Weighting by volume of facilities using VFDs results in a market share estimate of 52%, or 451 million cubic feet. **Since the volume-based approach provides the lower, more conservative value, this approach is adopted in the subsequent analysis below.**

Table 7-6. Volume Controlled by VFDs - Extrapolation of 2009 Survey Results

Facility and Storage Type	Refrigerated Warehouse Volume in the Northwest (*millions of cubic feet*) (A)	Extrapolation by Respondent Count		Extrapolation by Facility Volume	
		Share of Survey Respondents Using VFDs* (B)	Refrigerated Warehouse Volume Controlled by VFDs (*mcf*) (A * B)	Share of Sample Facility Volume Controlled by VFDs* (C)	Refrigerated Warehouse Volume Controlled By VFDs (*mcf*) (A * C)
General Refrigerated-Only Cold Storage	382.8	62%	236.9	44%	168.5
Fruit Refrigerated-Only	151.3	62%	93.7	36%	54.0
Fruit CA Storage	330.8	76%	252.1	69%	228.3
Total All Cold Storage*	**864.9**	**67%**	**582.7**	**52%**	**450.8**

*The share of survey respondents using VFDs and the share of facility volume controlled by VFDs are taken from Table 7-4 and Table 7-5.

Source: USDA; Navigant Consulting analysis of 2007 and 2009 refrigerated warehouse survey data

Compared to the 2007 M&T assessment, the 2009 M&T findings show a 10% increase in the volume of refrigerated warehouse evaporator fans controlled by VFDs, despite a 4% decrease in the overall market size (Table 7-7).[104] This market downsize is offset by **a 6% nominal (14% relative) increase in VFD market penetration compared to the 2007 M&T estimate.** This increase is primarily due to an increase in the share of general and fruit refrigerated-only

[104] While general cold storage capacity in the Northwest has increased 7% since 2007, fruit storage has decreased 11%, for an overall decrease in total refrigerated warehouse capacity of almost 4%. Source: USDA, *Capacity of Refrigerated Warehouses: 2009 Summary*, January 2010.

capacity controlled by VFDs, while the percent of the controlled atmosphere market controlled by VFDs (69%) has not changed substantially within the past two years.

Table 7-7. Comparison of 2009 Extrapolated Results with 2007 Findings

Facility and Storage Type	2007 M&T	2009 M&T	% Change from 2007 to 2009*
Refrigerated Warehouse Volume in the Northwest (mcf)			
General Refrigerated-Only Storage	356.7	382.8	+7%
Fruit Refrigerated-Only	169.5	151.3	-11%
Fruit CA Storage	370.3	330.8	-11%
Total All Refrigerated Warehouses*	**896.5**	**864.9**	**-4%**
Estimate of Refrigerated Warehouse Volume in the Northwest Controlled by VFDs (mcf)			
General Refrigerated-Only Storage	124.3	168.5	+36%
Fruit Refrigerated-Only	29.9	54.0	+81%
Fruit CA Storage	255.4	228.3	-11%
Total All Refrigerated Warehouses*	**410**	**451**	**+10%**
Estimated Percent of Refrigerated Warehouse Volume in the Northwest Controlled by VFDs			
General Refrigerated-Only Cold Storage	35%	44%	+9%
Fruit Refrigerated-Only	18%	36%	+18%
Fruit CA Storage	69%	69%	+0%
Total All Refrigerated Warehouses	**46%**	**52%**	**+6%**

* Changes from 2007 to 2009 may be due to the use of a larger sample; thus, changes may not necessarily reflect an increase (or decrease) in market activity during the past two calendar years.

Source: USDA for warehouse volume data; Navigant Consulting analysis for VFD penetration

The increase in market penetration of evaporator fan VFDs suggests that existing facilities *without* VFDs in 2007 either installed new VFDs or they were more likely to go out of business than facilities using VFDs, or a combination of the two. Although the 2009 M&T efforts did not rigorously address the market forces driving the market activity, responses to the follow-up interviews and open-ended portion of the phone surveys support the quantitative finding that the market penetration of evaporator fan VFDs increased, and suggest that at least some of the growth in market activity is from new installations. Out of the 31 surveys conducted in 2009, five facilities indicated recently installing evaporator fan VFDs. Four facilities indicated in the open-ended portion of the survey that they had recently installed additional evaporator fan VFDs. For example, one facility operator mentioned that they had built twenty-four CA rooms and retrofitted three existing CA rooms in the past two years, and installed VFDs in all of them.

Additionally, one of the facilities from the 2007 survey that indicated they were seriously considering installing VFDs is now set to begin running 20 new evaporator fan VFDs. Another facility is still planning to install VFDs once a decision is made regarding a change in location, and another facility cited cost as a continuing barrier.

Additional note on comparisons between the 2007 and 2009 M&T findings: As shown in Table 7-7, the updated 2009 findings indicate that the proportion of VFDs installed in *general refrigerated-only storage* increased from 35% to 44%. The 2009 combined findings (including the 2007 data) likely provide a more representative portrayal of the population than the 2007 estimates, since the sub-sample size has been increased from 12 to 21.

The 2009 findings indicate that the market penetration for evaporator fan VFDs in *fruit refrigerated-only storage* is approximately double the estimate from the 2007 M&T (18% to 36%), despite an 11% reduction in warehouse capacity across the population. The 2009 finding for facilities with fruit refrigerated-only capacity is regarded as a more accurate portrayal of the current population than the 2007 results since the 2009 surveys re-contacted eight of the 2007 facilities for updated information, and added seven new facilities to this sample. It should also be noted that this population is relatively small compared to the other warehouse types and is likely more sensitive to sample selection.

Since the market size for *fruit controlled atmosphere storage* has decreased since 2007, while the market penetration of installed VFDs has stayed constant, the change in market activity from 2007 to 2009 shows a net decrease for controlled atmosphere.

Conversion from Volume Served to Horsepower of Evaporator Fans

The analysis above estimated the *volume* of refrigerated warehouses using VFDs because the population data from the USDA is provided in cubic feet (volume) of storage space. However, energy savings rates (see Section 7.3.1) are based on installed horsepower of evaporator fans; thus, the market activity estimate is also presented in terms of horsepower in order to enable calculation of energy savings.

The conversion from cubic feet of refrigerated warehouse *volume* to the key indicator of *horsepower of evaporator fan capacity* controlled by VFDs yields a total of 47,246 hp across all market sectors (Table 7-8). The conversion from volume to evaporator fan capacity in general refrigerated-only cold requires disaggregation into cooler space and freezer space to account for different storage temperatures and usage patterns.

Table 7-8. Horsepower of Evaporator Fans Controlled by VFDs in the Northwest

Facility and Storage Type	*Volume Controlled By VFDs (million cubic feet)** [A]	*Connected Load Per Unit Volume*** (kW/ft³) [B]	*Universal Constant Conversion Factor (hp/kW) [C]*	*Evaporator Fan Capacity Controlled by VFDs (hp) A*B*C=D*
Refrigerated-Only Storage				
General Refrigerated-Only – Cooler Space	18.7	0.0000293	1.34	736
General Refrigerated-Only – Freezer Space	149.7	0.0000459		9,209
Subtotal General Refrig.-Only	*168.5*			*9,945*
Fruit Refrigerated-Only Storage	54.0	0.0000986		7,132
Subtotal Refrigerated-Only Cold Storage	***222.4***	***NA***	***NA***	***17,077***
Controlled Atmosphere Storage				
Fruit CA Storage	228.3	0.0000986	1.34	30,169
Subtotal Controlled Atmosphere Storage	***228.3***	***NA***	***NA***	***30,169***
Total All Refrigerated Warehouses	**450.8**	Implied 105 hp/mcf		**47,246**

* The figures for volume controlled by VFDs are taken from Table 7-6. Cooler and Freezer gross volume is derived from the Cooler/Freezer split for Oregon and Washington Public and Private storages, as reported in the 2009 USDA Capacity of Refrigerated Warehouses report. Navigant Consulting analysis indicates that general refrigerated storage in these states consists of 11 % cooler storage and 89% freezer storage.

** Estimates for the connected load of evaporator fans required per unit volume of storage capacity are based on analysis conducted by Cascade Energy Engineering and provided as part of Cascade's original proposal to NEEA. As reported in the 2007 M&T report, Cascade Engineering confirmed that the conversion factors from cubic feet to horsepower are still appropriate.

Sources: Cascade Energy Engineering; USDA; and Navigant Consulting analysis of 2007 and 2009 refrigerated warehouse survey data

7.3.3 Baseline Activity

Previous M&T efforts have demonstrated that the ACE model assumptions regarding baseline activity have been reasonable, and as noted in Section 7.2, a review of the baseline assumptions was not a focus of the 2009 M&T effort for the Evaporator Fan VFD initiative. Consequently, the 2009 M&T analysis follows the same baseline methodology applied in the 2007 M&T report.

This approach uses the initial estimates of baseline activity and growth provided by Cascade in the early phases of the VFD Initiative and assumes that any growth beyond Cascade's initial estimates is a result of NEEA's initiative.

Cascade and NEEA initially estimated the evaporator fan VFD capacity (in horsepower) in 1998 at approximately 9% of the total market, and further estimated the size of the market and the amount of VFD capacity that was added to the baseline in 1999, 2000, and 2001. Starting in 2002, the evaporator fan VFD capacity due to baseline activity was assumed to grow at 1.5% per year, measured as a share of the market.[105] Thus, the 11.8% baseline in 2001 (baseline VFD usage as a share of the total volume used for evaporator fans at refrigerated warehouse facilities, in mcf) would increase to 13.3% in 2002, 14.8% in 2003, and so on. By 2009, the baseline is assumed to be 23.8% of the 865 mcf market for evaporator fans, or roughly 206 mcf (Table 7-9).

In order to correspond with the current NEEA ACE model, the horsepower values for 2008 through 2009 have been converted to cubic feet using the conversion factor for evaporator fans *equipped with VFDs* of 105 hp/ft^3 from Table 7-8. This corresponds to 21,579 horsepower of baseline activity in 2009.

[105] Northwest Energy Efficiency Alliance, "Evaporator Fan VFD: Cost-Effectiveness Analysis Key Assumptions – Converted," January 26, 2005.

Table 7-9. Baseline Use of VFDs in the Northwest

	Total Market of Evap Fans (mcf) **[A]**	**Baseline VFD Usage as Share of Market Volume** (%) **[B]**	**Baseline VFD usage** (mcf) **[C = A * B]**	**Conversion** (hp/mcf) **[D]**	**Baseline VFD Usage** (hp) **[C * D]**
1998	737	8.1%	60	110	6,557
1999	748	9.1%	68	110	7,468
2000	760	10.6%	81	110	8,904
2001	771	11.8%	91	110	10,028
2002	792	13.3%	105	110	11,611
2003	813	14.8%	120	110	13,264
2004	834	16.3%	136	110	14,987
2005	855	17.8%	152	110	16,779
2006	876	19.3%	169	110	18,641
2007	898	20.8%	187	110	20,573
2008	881	22.3%	197	105	20,600
2009	865	23.8%	206	105	**21,579**

Sources: Baseline horsepower estimates and total market data for 1998 through 2001 are from NEEA and Cascade Energy Engineering, using a conversion factor from the 2007 M&T findings. Baseline VFD usage as a share of the total market is calculated directly from the table through 2001 and increased nominally by 1.5% per year from 2002 through 2009. The conversion factor for 1998-2007 is based on the 2007 M&T findings and has been updated for 2008-2009 based on 2009 M&T findings (Table 7-8).

The baseline value of 21,579 horsepower of VFD fan capacity was then apportioned into baseline values for refrigerated-only storage and CA storage according to the 2009 market activity (see Table 7-8), as shown below in Table 7-10.

Table 7-10. 2009 Baseline Activity by Storage Type

Storage Type	2009 VFD Market Activity (hp) [A]	2009 Share of Market Activity [B = A / A_{total}]	2009 Baseline Evaporator Fan VFDs (hp) [C]	2009 Baseline Evaporator Fan VFDs (hp) [B * C]
Refrigerated-Only	17,077	36%	21,579	7,800
CA Storage	30,169	64%		13,779
Total	**47,246**	**100%**	**21,579**	**21,579**
Source: Navigant Consulting 2007 and 2009 refrigerated warehouse surveys; NEEA; Cascade Energy Engineering				

As part of the survey/interview process, the 2009 M&T evaluation obtained a high-level indication of recent changes in baseline activity through the following interview activities:

- Re-interviewed facility operators contacted during the 2007 surveys to discuss changes to their facilities since 2007 and their current opinions on the evaporator fan VFD market in the Northwest.
- Asked all survey participants to describe any changes they have seen in the regional market for evaporator fan VFDs in the past five years and provide any additional thoughts they have on the current market.

A selection of the comments provided by respondents in 2009 is in Section 0.

Most of the facility representatives that commented on changes to the evaporator fan VFD market in the Northwest indicated seeing an overall shift towards energy efficiency, with VFDs included as a part of that trend. Respondents also pointed to utility incentives as a significant motivator towards VFD installations, with eight of the 31 survey respondents specifically mentioning incentives as playing a role in their decision to install, or not install, evaporator fan VFDs, despite no mention of incentives in the survey questions. While a prominent role for utility incentives may not indicate a change in baseline, the responses collected from these open-ended questions suggest that a more rigorous analysis of baseline activity would be warranted in future M&T efforts.

7.4 Conclusions and Recommendations

The 2009 M&T analysis included a survey of 31 refrigerated warehouse operators across the four states in the Northwest. Survey results were combined with the results from the 2007 M&T surveys to provide an updated and expanded snapshot of regional market activity for evaporator fan VFDs. The major conclusions of this work were as follows:

1. **The per-unit energy savings for evaporator fan VFDs in refrigerated warehouses are estimated to be about 4%-6% lower than previously assumed, depending on the warehouse type.** This finding is based on the average number of operating hours for evaporator fan VFDs. The savings for controlled atmosphere rooms are reduced based on data collected from a significantly larger sample than was used for the original estimates. The reduced savings in refrigerated-only cold storage represent the inclusion of fruit cold storage rooms, which have significantly fewer operating hours than general cold storage facilities. The 2009 M&T project team recommends applying these reduced savings values to both current and prior-year market activity.

2. **The overall market share of evaporator fans VFDs in refrigerated warehouses in the Northwest increased by 6%, despite a decrease in the overall market size.** While the USDA reports that refrigerated warehouse capacity in the Northwest declined by almost 4% between 2007 and 2009, the 2009 M&T findings indicate that evaporator fan VFDs are controlling a greater proportion of the remaining capacity (see Table 7-7). Specifically, for each refrigerated warehouse type:

    a. **The 2009 M&T findings suggest an increase in market activity for general refrigerated-only cold storage over the 2007 results.** This year's finding for general refrigerated-only warehouses likely reflects a more robust portrayal of actual market activity, as well as actual increases in capacity controlled by VFDs.

    b. **The 2009 M&T findings also suggest an increase in market activity for fruit refrigerated-only cold storage over the 2007 results.** The 2009 combined survey results indicate that the market penetration for evaporator fan VFDs in refrigerated-only cold storage at fruit facilities approximately doubled (18% to 36%), despite an 11% reduction in warehouse capacity across the population.

    c. **The market share of evaporator fan VFDs in controlled atmosphere rooms has not significantly changed since the 2007 M&T efforts. However, the estimate of market activity declined by 11% due to a decrease in the volume of CA storage in the region.** Controlled atmosphere rooms continue to show a higher percentage of installed evaporator fan VFDs relative to refrigerated-only cold storage. The growth of VFDs installed in refrigerated-only cold storage at fruit facilities may indicate that facility operators initially installed VFDs in controlled atmosphere rooms and have recently been adopting the technology in refrigerated-only cold storage at an increasing rate.

Table 7-11 summarizes recommendations for the values of key indicators. These values represent a snapshot of the current market, since M&T efforts estimated the *current number* of evaporator fan VFDs installed, but not *when* these VFDs were installed. These recommended indicators reflect a decrease in the per-unit energy savings and an overall increase in market activity (offset by a decrease in market size), for a negligible incremental difference over the cumulative savings reported by NEEA in 2007. Without additional market research, it is difficult to determine how much of the market activity reflected in Table 7-11 is due to new

activity in 2008 and 2009, versus how much is due to the refined market data; thus, no incremental savings are reported for the 2009 M&T.

Table 7-11. M&T Recommendations for Key Indicators

Key Indicators Reviewed	2008/2009 Incremental*	2009 Cumulative (Calendar year 2009 values due to all activity since program inception)	Source
Market Activity (Evaporator fan VFD capacity, in horsepower)			
Refrigerated-only storage	NA	17,077	Navigant Consulting 2007 and 2009 refrigerated warehouse surveys; see Table 7-8
CA storage		30,169	
Total Market Activity	*2,116*	*47,246*	
Baseline Activity (Evaporator fan VFD capacity, in horsepower)			
Refrigerated-only storage	NA	7,800	See Section 7.3.2 *Baseline Activity*
CA storage		13,779	
Total Baseline Activity	*1,006*	*21,579*	
Per-Unit Energy Savings (kWh/hp)**			
Refrigerated-only storage	3,300	3,300	See Section 7.3.3 *Per-Unit Savings*
CA storage	2,300	2,300	
Implied Energy Savings (aMW)***			
Refrigerated-only storage	NA	3.5	aMW = MWh divided by 8760 hours
CA storage		4.3	
Total Implied Energy Savings	*0.3*	*7.8*	

*The 2009 M&T recommendations reflect a snapshot of the current market, including updated estimates of market penetration and per-unit energy savings. No incremental market or baseline activity is explicitly estimated, since savings cannot be directly attributed to activity in a given calendar year. The incremental values presented here are for comparison purposes only and represent the differences between the cumulative values from the 2007 and 2009 M&T reports.

** Per-unit savings values have been adjusted from those presented in the 2007 M&T report and are recommended for use retroactively to all market activity. Prior values were 3,500 kWh/hp for refrigerated-only storage and 2,400 kWh/hp for CA storage.

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

Source: Navigant Consulting 2007 and 2009 M&T research

The 2009 evaluation team recommends that another M&T effort be conducted for 2011 and include the following activities:

1. **Conduct an expanded assessment of market activity.** Although the 2009 M&T report identified changes in market size and market activity, the reasons for these changes are unclear. Future M&T work should survey a different set of market actors, including regional trade allies, to assess the correlation between reduced facility capacity and the use of evaporator fan VFDs (e.g., are the facilities that shutdown typically facilities that have or do not have evaporator fan VFDs?). Additionally, augmenting the sample of cold storage facilities would allow for better identification of differences in market penetration across different market segments and could lend additional support for the finding that market activity is increasing.

2. **Revisit the baseline assumptions.** Although prior M&T work confirmed that the baseline values are still applicable, the open-ended responses to the 2009 M&T surveys and the increase in estimated market activity raise the prospect that influences beyond the NEEA initiative may be affecting adoption of VFDs. The survey of trade allies recommended above could help to address this issue.

3. **If facility operators are re-contacted in the future, incorporate previously provided facility-specific information into the survey.** Explicitly pointing to previous responses will validate or refine 2007 and 2009 findings, allow for direct comparison of market size and VFD penetration, and help minimize inconsistencies in responses (e.g., due to the facility operator referring to more than one facility).

4. **Update the database of refrigerated warehouse contacts in the Northwest, if the USDA indicates that regional warehouse capacity has significantly increased.** This activity would be of limited value in the absence of a significant increase in capacity.

7.5 Bibliography

International Association of Refrigerated Warehouses, Directory of Public Warehouses, http://www.iarw.org/directory/

Macro International, Inc., *Market Baseline Evaluation Report: Evaporator Fan VFD Initiative (Executive Summary),* April 1999.

Northwest Cherries, Growers/Shippers List, http://www.nwcherries.com/?q=industry/shipperslist, accessed November 20, 2007.

Northwest Energy Efficiency Alliance, "Evaporator Fan VFD: Cost-Effectiveness Analysis Key Assumptions – Converted," January 26, 2005.

Northwest Energy Efficiency Alliance, *NEEA ACE Model_Evap Fan Feb 2009 V3.xls.* Received from Christine Jerko, Planning Manager, March 15, 2010.

Pacific Energy Associates, Inc. and MetaResources Group, Evaporator Fan VFD Market Transformation Initiative: Market Progress Evaluation Report #3, prepared for Northwest Energy Efficiency Alliance, 2002.

Summit Blue Consulting, *2006 Long Term Monitoring and Tracking Report, Prepared for Northwest Energy Efficiency Alliance*, 2007.

Summit Blue Consulting, *2007 Long Term Monitoring and Tracking Report, Prepared for Northwest Energy Efficiency Alliance*, 2008.

Taiwan Bureau of Animal and Plant Health Inspection and Quarantine Council, List of August 2006 participants in Northwest Taiwan Apple Export Program, http://www.baphiq.gov.tw/public/Data/711716344371.pdf.

United States Department of Agriculture, *Capacity of Refrigerated Warehouses: 2009 Summary*, January 2010.

Washington State Department of Agriculture, Faxed List of Licensed Controlled Atmosphere Firms, November 13, 2007.

Wilcox, Marcus H. and Robert D. Morton, Cascade Energy Engineering, *The Evaporator Fan VFD Initiative*, 14th Annual Postharvest Conference, Yakima, Washington, March 10-11, 1998.

Yakima Valley Growers and Shippers Association, Letter to WSDA, October 20, 2005, http://www.wahort.org/Loveland%20Letter.pdf.

Section 8. MagnaDrive

In 1999, the Northwest Energy Efficiency Alliance (NEEA) formed a partnership with MagnaDrive Corporation (MagnaDrive) to accelerate the development and commercialization of MagnaDrive's proprietary adjustable-speed drive (ASD) for motors. MagnaDrive's technology is a coupling device that uses powerful rare-earth permanent magnets to transmit torque through an air gap from the motor drive to the load shaft. By varying the air gap spacing, the speed of the load can be adjusted by varying the torque transmitted, thereby reducing energy usage in low-load situations. With no mechanical connection between the motor drive and the load shaft, the MagnaDrive ASD also eliminates vibration transfer and harmonics; allows for soft starting and stopping; reduces maintenance costs; and improves safety.

The market transformation goal of the NEEA MagnaDrive project was not to replace VFDs, but instead to expand the motor speed-control market into applications where VFDs are not well suited. During the first phase of the project, NEEA funded performance and comparison testing between the MagnaDrive ASD and conventional VFDs, market research and assessment studies, and four industrial case studies. The second phase of the project focused on increasing MagnaDrive ASD sales in targeted market sectors, expanding the technology into the larger motor market, and penetrating the irrigation market. According to the 2004 Market Activities Report (MAR), MagnaDrive successfully completed its goals, and NEEA ceased funding in December 2004.

In 2007, the first Long-Term Monitoring and Tracking report for NEEA on the MagnaDrive ASD venture was completed based upon 2006 sales and data. A follow-up report was published assessing changes during 2007 and 2008, including increases in sales of fixed speed couplings relative to sales of ASDs. This report assesses further changes in market activity during 2009.

8.1 Assumptions and Indicators for Review

Energy savings from the MagnaDrive project are contingent on the level of both MagnaDrive ASD and coupling sales in the Northwest, as well as several key assumptions concerning the savings potential of the technology and the speed-control market. Specifically, the *gross* energy savings impact of the MagnaDrive project is the product of the total motor capacity (HP) controlled by MagnaDrive ASDs and couplings and the annual energy savings per unit capacity (kWh/HP/yr) for ASDs and couplings. As in the 2006 review of the 2005 ACE model and the review of 2007-2008 changes, the baseline remains zero activity and no influence on the broader speed-control market beyond that captured by MagnaDrive sales. This M&T assessment therefore continued to focus on tracking current activity in the market and quantifying market effects beyond MagnaDrive sales that are attributable to the MagnaDrive initiative. The 2006 review of the program included an assessment of the per-unit savings that has been used in this report as it was in the 2009 review.

Because of the minimal changes in the market and available assessments of the technology, no changes have been made to the assumptions or calculation methods used in previous reports. As mentioned in the previous review, the coupling market continues to grow in importance. Since the coupling technology is directly based upon that used in the ASDs, but without the in-situ adjustability, this market is a direct outgrowth of the ASD work which NEEA originally supported.

The following inputs to the cost-effectiveness calculation were reviewed, but focus was on changes in the market since the last report:

- MagnaDrive's current market activity in the Northwest, including the number of ASDs and couplings sold and the capacity (HP) of the motors on which they are installed.
- The level of baseline activity in the Northwest.
- The per-unit savings assumption (kWh/HP/yr), which is a function of several other assumptions.

8.2 Methodology

Previous M&T efforts focused on reviewing the per unit savings assumptions used by NEEA to estimate savings from MagnaDrive sales. Given the decreasing sales in 2008, much of the focus of this current review is on attempting to assess the current market for MagnaDrive. In addition, a literature search was conducted to determine if any new information was available to help assess a per-unit energy savings for couplings. Specifically, this report addresses:

- Decreasing sales of MagnaDrive in the Northwest;
- The increasing importance of coupling sales compared to the ASD market; and
- A review of the savings methodology for ASDs and couplings.

Research tasks were as follows:

Obtain sales data from MagnaDrive, specifically for the Northwest sales area.

Interview MagnaDrive and the MagnaDrive distributor in the Northwest to determine status of offerings and barriers to sales and distribution of MagnaDrive products. PumpTech Northwest has been a MagnaDrive distributor for several years and continues to cover the Washington, Oregon, and northern Idaho sales territories. In late 2008 Missmann Electric began covering the southern Idaho sales territory as a MagnaDrive distributor. However, they are no longer listed as a distributor and appear to be out of business so it was not possible to reach them for an interview. Due to the difficulty of reaching anyone at MagnaDrive and minimal information from the single distributor, interviews were also held with additional west coast distributors (Table 8-1).

Conduct a literature search for any new information on savings in both the variable speed drive market and MagnaDrive in order to determine if energy savings estimates due to MagnaDrive should be adjusted. The prior assumptions and review of per-unit savings from the 2006 and 2007-2008 reviews of the MagnaDrive program were reviewed and incorporated into savings estimates.

Table 8-1. Primary Data Collection

Interviewee Group	Number of Interviews	Topic/Issues
Northwest Distributors	1 telephone	MagnaDrive sales, coupling market, utility rebates
Other Distributors	2 telephone	MagnaDrive sales and market, competing technologies, utility rebate potential
Utilities	1 telephone	MagnaDrive savings and potential rebates

8.3 Findings

In many cases ASDs are used in areas where VFDs would not be used, such as where equipment is sensitive to electrical harmonic distortions and where vibration isolation is a primary concerned. Nevertheless MagnaDrive's ASDs continue to compete with traditional VFDs in applications where speed control is needed but equipment is not sensitive to harmonics or vibration. In addition to speed control ASD applications, MagnaDrive continues marketing fixed-speed couplings, and these sales by total horsepower now exceed those of the ASDs in the Northwest. Nevertheless, overall sales in the Northwest are weak even though NEEA was one of the few early supporters of MagnaDrive technology. Much of this is due to the current economic downturn, which has affected couplings less than ASDs because of their lower cost.

8.3.1 Market Activity

The MagnaDrive market continues to shift from primarily ASD sales, to an increasing proportion of fixed speed couplings. These use the same technology as the MagnaDrive ASDs, but without the ability to vary the gap and therefore the speed of the drive while the system is active. These couplings provide a method to tune down the speed of a motor without permanently trimming an impeller or resheaving a fan, while also providing the vibration and alignment advantages of the MagnaDrive ASD at a significantly lower cost. This is accomplished by adding or subtracting shims to adjust the air gap, but only when the system is shut down.

Table 8-2 shows MagnaDrive sales for 2009. Couplings now constitute more than three quarters of total sales by horsepower, in contrast to years prior to 2008 in which they were not even tracked.

Table 8-2. MagnaDrive Sales in the Northwest for 2009

HP	2009 ASDs	2009 Couplings
10	3	
20	2	
25		11
30	2	6
60		3
85		4
100	2	
125	2	
195		5
200		1
250	1	2
300		1
315		1
350		2
400	1	
610		1
OEM	3	10
Total HP	1,514	5,811

Source: MagnaDrive

As seen in Table 8-3, Northwest ASD sales in 2009 continue to drop relative to previous years, at 1,514 HP compared to twice that in 2008 and roughly 8,000 HP in each of the three previous years. This yields cumulative ASD sales of more than 47,000 HP, with an average of 171 HP. The average motor size for ASD applications has continued to decrease, and was already lower than was anticipated during planning stages of the project, at which time the market assessment report analyzing MagnaDrive's market opportunities predicted that the large horsepower ASD market (those over 500 HP) would represent the start-up's "principal opportunity." At the time of the 2008 M&T report only two ASDs of that size had been sold in the Northwest and none were sold in 2009. Additionally, the average horsepower of the ASDs has decreased since previous reviews. Although MagnaDrive has continued to increase the size of available couplings into the thousand horsepower range, sales of these large horsepower units has not taken off in the Northwest.

Table 8-3. MagnaDrive ASD Sales in the Northwest by Year

	MagnaDrive ASDs	
	Average Motor HP Per ASD Sold	Total Motor HP of ASD Sales
Pre-2001	100	2,994
2001	85	3,823
2002	124	4,726
2003	218	2,184
2004	159	3,680
2005	189	7,935
2006	229	8,946
2007	203	8,720
2008	134	3,086
2009	95	1,514
All Years	**171**	**47,608**

* In addition to the ASD sales identified here, MagnaDrive sold 6,679 HP of couplings averaging 181 HP in 2008 and 5,811 HP averaging 124 HP in 2009 in the Northwest. Coupling sales were not tracked prior to 2008.
Source: MagnaDrive

In the early developmental stages of the technology, some of the Northwest distributors had problems with some MagnaDrive installations and remain reluctant to promote the technology; however this reluctance does not appear to extend to couplings. Discussions with MagnaDrive distributors indicated that because of the significantly lower cost of couplings relative to ASDs, the 2009 drop in sales, which is largely due to the economic downturn, did not affect coupling sales as severely as it did ASD sales. It is notable that coupling sales in the Northwest accounted for more than three times the horsepower of ASDs in 2008. This is, in part, due to the lower price of couplings during the downturn. However, there are also indications that there is an increasing sales emphasis on couplings by distributors which can be expected to carry forward as the economy improves. In general, distributors indicated that customers were more open to using MagnaDrive technology in couplings where they could achieve vibration isolation along with energy savings, whereas they were already comfortable using traditional VFDs in many instances where MagnaDrive ASDs might also be applicable.

8.3.2 Baseline Activity

The ACE model continues to assume zero baseline activity for ASD sales. The 2006 M&T report concluded that quantifying the variables contributing to adjusting the baseline would be difficult and more costly than was justified under the circumstances. The 2008 M&T report concurred with this finding and recommended maintaining a zero baseline because other than NEEA and the Department of Energy's NICE3 program, no other work appeared to have been done to aid in the introduction of the MagnaDrive technology. Based on discussions with

distributors, it appears that there is very low demand for ASDs in the current economic climate. Couplings are less expensive and sales have suffered less, although they are still down.

As reported in previous studies only 130 fixed speed couplings had been sold as of 2006 according to MagnaDrive. More detailed numbers were not available for sales prior to 2008, but in 2008 alone, 37 of these couplings were sold in the Northwest and this increased to 47 in 2009. Furthermore, despite the earlier assumptions that these were lower horsepower units, their average horsepower in 2009 was 124 compared to 95 for ASDs, and their total horsepower was more than three times that of the ASDs. Although coupling sales have dropped since 2008, this decrease is not as severe as for ASDs.

According to MagnaDrive, there is no direct competition to the coupling technology. There are other ways to permanently tune down speed, such as trimming the impeller of a pump. However, unlike permanent turndown methods, the coupling based speed adjustment can be reversed simply by removing shims. In addition, one distributor reported that fluid couplings are sometimes used for vibration isolation, one function of MagnaDrive couplings. However this method does not save any energy and can actually increase power requirements. Given the ease of shifting fixed speed using a MagnaDrive coupling and the isolation advantages that it provides, it is not clear that these traditional methods are really in direct competition with couplings. *Because of the uncertainties in assessing alternatives to the fixed speed couplings, baseline for these is also assumed to be zero.*

8.3.3 Per-Unit Energy Savings

The per-unit energy savings of MagnaDrive ASDs were extensively reviewed in the 2006 M&T report, and the 2008 review focused on estimating coupling savings. The first calculations discussed below have been discussed for ASDs in previous MPERs and the 2006 M&T report, and an assessment of their applicability to couplings was provided in the previous report and is reviewed here.

Per-Unit Savings for ASDs

In addition to sales volume, measured in horsepower, another key input to the gross energy savings equation is the estimate of energy savings per-unit capacity. The value of 1,186 kWh/HP used in the ACE model for ASD sales was derived from a combination of sources and was calculated according to the following formula:

Per-Unit Annual Energy Savings for ASD Sales (1,186 kWh/HP/yr) =

(1) Average annual operating hours (6,466 hours/year)

x (2) Average energy savings percentage (24.6%)

x (3) Conversion factor (0.746 kW/HP)

where:

- **Average annual operating hours** is the assumed average full-load hours for motors on which MagnaDrive ASDs would be installed in the Northwest.
- **Average energy savings percentage** is the average energy savings achieved by installing a MagnaDrive ASD in the place of no speed control.
- **Conversion factor** is the standard HP-to-kW conversion, equal to 0.746 kW/HP.

The 2006 M&T report included a review of the per-unit energy savings assumptions and methodology. Of the inputs, both the average horsepower of MagnaDrive sales and the average energy savings percentage have been adjusted for this 2008 report. The average horsepower has changed with additional sales. Additionally, the primary adjustment recommended in the 2006 report was increasing the percentage savings from 24.6% to 29.1%. The 29.1% savings value has been used for ASD calculations in this report based on the previous analysis.

The average horsepower of all years of MagnaDrive sales in the Northwest through 2009 is 171 HP, as shown previously in Table 8-3. Using the average hours of operation for all motors shown in Table 8-4, and weighting for total horsepower in each year of sales, gives an average of 5,611 hours of motor operation per year. Combining this with 29.1% savings results in 1,218 kW/HP/yr:

Per-Unit Annual Energy Savings for ASDs = 1,218 kWh/HP/yr = 5,611 h/yr*0.291*0.746 kW/HP

Table 8-4. Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 – 5 HP	4,550	3,380	1,257	2,435	**2,745**
6 – 20 HP	4,316	4,121	2,131	2,939	**3,391**
21 – 50 HP	5,101	4,889	3,528	3,488	**4,067**
51 – 100 HP	6,151	5,667	4,520	5,079	**5,329**
101 – 200 HP	5,964	5,126	4,685	5,137	**5,200**
201 – 500 HP	7,044	5,968	6,148	6,102	**6,132**
501 – 1,000 HP	8,013	6,829	6,156	7,328	**7,186**
1,000+ HP	8,167	6,955	7,485	7,173	**7,436**
All Motor Sizes	**5,988**	**5,211**	**5,476**	**4,692**	**5,083**

Source: US Industrial Electrical Motor Systems Market Opportunities Assessment

Per-Unit Savings for Couplings

As in the previous review, the increasing importance of couplings in the Northwest as a percentage of MagnaDrive sales makes it increasingly important to accurately estimate the savings due to these units. Unfortunately no comprehensive review of savings has yet been performed. Case studies published by MagnaDrive appear accurate, but are unlikely to be representative of installations as a whole. Consequently, it remains difficult to accurately assess the savings due to typical couplings without more extensive, systematic data. Specifically, there remain two major unknowns that make accurately assessing savings on couplings highly difficult to assess:

1. The average turn-down percent for fixed couplings is unknown. Standard practice recommends downsizing motors if they are operating at less than 60% load, and the most efficient operation is at 90% load. Based on this, a typical turn-down of 15% is assumed for calculation purposes.

2. The actual savings at a given speed reduction for MagnaDrive units is also not well documented. The 2008 M&T assessment compared the savings claims of MagnaDrive based on product literature to the available studies (see References) and was not able to completely reconcile them. However, 14% savings has been used since it is a conservative savings estimate as explained below.

Similar to the 2008 M&T analysis, the following inputs were used:

- The 2009 sales data for couplings.
- The average hours of operation by horsepower from the US Industrial Electrical Motor Systems Market Opportunities Assessment.
- The average savings of MagnaDrive ASD installations at given speed reductions.
- Typical practice for motor sizing.

The previous review estimated savings using 14% energy savings and a 5% speed reduction. This was based on comparisons among the affinity law, MagnaDrive literature, an Oregon State University testing report, and a Pacific National Labs technology demonstration. It should be noted that although this value has been used again for this report because no additional information was available for adjustments, there remain significant unknowns in this estimate.

Based on the average 124 horsepower of couplings, average annual operational hours of 5,200 were used for calculations. Combining this with the 14% savings results in annual per-unit energy savings of 543 kWh/HP/yr, the same as in 2008:

Per-Unit Annual Energy Savings for couplings = 543 kWh/HP/yr = 5,200 h/yr*0.14*0.746 kW/HP

8.4 Conclusions and Recommendations

NEEA projects supporting MagnaDrive have significantly accelerated the transformation of the variable speed drive market. The following are major conclusions of this M&T research:

- The Northwest has seen a significant reduction in MagnaDrive sales, probably due to the economic downturn.
- Couplings have become a major portion of sales and savings from the MagnaDrive technology.

MagnaDrive forecast 2009 sales of 4,127 horsepower for ASDs in the Northwest. The 2009 ASD horsepower total value of 1,514 is significantly less than the predicted sales. This is partially due to the economic downturn, but may also be indicative of continuing poor Northwest sales overall. Coupling sales have not suffered as significantly, totaling 5,811 horsepower in 2009 compared to a prediction of 7,844 horsepower. The total of both ASD and coupling horsepower in the Northwest in 2009 was 7,325 horsepower, significantly less than the 11,972 horsepower predicted by MagnaDrive.

Table 8-5 summarizes the key indicators recommended by this report for 2009. There has been an increase of just over 1,500 hp in cumulative ASD installations, and sales have been significantly reduced compared to previous years. However, coupling sales have seen far less

reduction (from more than 6,660 hp in 2008 to just over 5,800 hp in 2009) and now comprise more than three quarter of sales by horsepower. The coupling savings are conservatively estimated at around half the per-unit savings of ASDs. Additionally, a small decrease in per-unit ASD savings is recommended based on the fact that the 2009 sales data show a slight reduction in average horsepower of drives. The result is incremental savings in 2009 of approximately 0.6 aMW, for a cumulative savings through 2009 of 7.4 aMW.

Table 8-5. M&T Recommendations for Key Indicators

Key Indicators	**2009 Incremental** (Due to *new* activity occurring in 2009)	**2009 Cumulative** (Calendar year 2009 values due to all activity since program inception)	Source
Market Activity			
HP of new MagnaDrive ASD installations	1,514	47,608	MagnaDrive Northwest Sales data See Section 8.3.1
HP of new MagnaDrive coupling installations	5,811	12,490	
Total HP of new installation	7,325	60,098	
Baseline Activity for ASD and Coupling Installations			
Number of MagnaDrive installations (ASD and couplings)	0	0	See Section 8.3.2
Per-Unit Energy Savings			
kWh/HP per year for ASDs	1,156	1,218	See Section 8.3.3
kWh/HP per year for couplings	543	543	
Implied Energy Savings*			
Implied Energy Savings (aMW) from ASDs	0.2	6.6	aMW = MWh divided by 8760 hours
Implied Energy Savings (aMW) from Couplings	0.4	0.8	
Total Savings	0.6	7.4	

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

Source: MagnaDrive and Navigant Consulting Analysis

It is recommended that no assessment be conducted for the 2010 M&T report, and that additional assessments focus on better quantifying the savings due to couplings. The most important unknown in this is an estimate of the typical turn down achieved with a coupling installation, which could be reported by distributors to MagnaDrive. Although this was not the original focus of the NEEA project, it is a direct offshoot of the MagnaDrive ASD technology and is rapidly becoming a significant portion of MagnaDrive sales.

Coupling savings for a given speed reduction should be the same as for an equivalent MagnaDrive ASD operating at that same speed. There are two factors which determine savings: 1) savings at various speed reductions, and 2) typical speed reductions in coupling applications. The savings at a given speed reduction has not been verified by the project team, and depends upon conditions, such as vibration and system misalignment, in a given installation. In addition, according to distributors, some couplings are used solely for vibration isolation and do not provide energy savings. As noted in the previous review, the typical speed reduction implemented for couplings still needs to be studied. There is still no data available on what typical turn down percentage can be expected for a coupling installation in part because no other previous product offered this capability. MagnaDrive distributors and OEMs should be encouraged to report turn down values for installations in the future.

On a continuing basis, it is recommended that the M&T analysis be conducted for 2011 and then every two years and include the following activities:

- Continuing assessment of actual savings of MagnaDrive products. This remains an issue since the couplings market has not been adequately assessed.
- Distributors should be encouraged to report turn down values of coupling installations along with horsepower. This would help significantly in estimating savings.
- Interviews with any Northwest distributors to determine if sales have improved.

8.5 Bibliography

Long Term Monitoring and Tracking Report on 2006 Activities, Summit Blue Consulting for Northwest Energy Efficiency Alliance, April 16, 2007.

Long Term Monitoring and Tracking Report on 2008 Activities, Summit Blue Consulting for Northwest Energy Efficiency Alliance, July 8, 2009.

Product Testing: Magna Drive, Report No. 1, Motor Systems Resource Facility, Oregon State University, Report #00-048, March 2000.

United States Industrial Electric Motor Systems Market Opportunities Assessment, Xenergy, Inc., December 1998.

Magnetically-Coupled Adjustable Speed Drive Systems, Chvala, William D. and David W. Winiarski, Pacific Northwest National Laboratory, October 2002.

Personal communications with Don Jacques, MagnaDrive Corporation, 2010.

Personal communications with Craig Dewolf, Kamloops Precision Machining, March 2010.

Personal communications with Steve Manwell, PumpTech NW, February-March 2010.

Personal communications with AHM, Hayward, California, March 2010.

Personal communications with Cowlitz PUD, Washington, March 2010.

http://www.magnadrive.com.

http://www.coyoteinc.com/.

http://www.voithturbo.com/.

Energy-Efficient Motor Systems: A Handbook on Technology, Program, and Policy Opportunities, 2nd edition, Nadel, et. al., ACEEE 2002.

Section 9. Verdiem Network Energy Management Software

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 product is a network software tool that enables network administrators to remotely control the power management functions of personal computers (PCs) linked to the central network. The initiative was designed to lower the projected growth in energy consumption caused by the rapid expansion of computers and associated technology in the workplace. The explicit goal of the NEEA-Verdiem partnership was 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.[106]

The market for this class of products is experiencing 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 have contributed more than $31.7 million into Verdiem since its founding in 2001, including $4.7 million in early 2010.[107] By comparison, NEEA invested nearly $1 million in the effort through its investment in Verdiem, associated evaluation studies, and general administration of the program.

This is the third monitoring and tracking (M&T) effort undertaken to examine the development of the market for network energy management software in the Northwest. The initial M&T project was undertaken in 2005 to begin to uncover the answers to questions about the per-unit energy savings and sales data. The second M&T effort updated those data for Verdiem's updated products and dug deeper into the extent to which the NEEA-Verdiem partnership spurred innovation by additional companies and created broader market transformation. This M&T effort again updates the per-unit energy savings assumptions and Verdiem sales in the region, and it addresses the baseline activity that would have occurred in this market in the absence of the NEEA-Verdiem partnership.

9.1 Assumptions and Indicators for Review

In assessing the energy savings attributable to the NEEA-Verdiem partnership, the M&T team took a bottom-up approach, using Verdiem's sales data and input from its competitors to determine the current energy savings in the market. The Alliance's Cost-Effectiveness (ACE)

[106] Quantec, LLC. January 15, 2005. "Market Progress Evaluation Report 2: Surveyor Software." Prepared for NEEA.
[107] Cook, John. 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.

model was used as a foundation for conducting this evaluation. The M&T focuses on verifying the ACE model's assumptions about the following inputs:

- sales data for Surveyor
- relative sales levels for similar network power management software,
- baseline activity, and
- per-unit energy savings.

A more formal equation for the network 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 network energy management software licenses in use in the Northwest – the cumulative unit sales, adjusted downward for anticipated retirements (which are assumed to occur after five years of use); and
- **Per-unit capacity energy savings** is the annual energy savings per computer with 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 network power management software firms into the market. These market effects are also considered in this analysis.

9.2 Methodology

The 2009 M&T effort for the NEEA-Verdiem partnership focused on updating information about the baseline level of market activity. Given the elevated level of attention given to energy use by information technology (IT) infrastructure, the drivers behind the market activity called for examination. In addition, the 2009 effort collected the information necessary to update per-unit energy savings and regional sales of network energy management software.

This effort builds on previous M&T efforts. The 2005 M&T evaluation team concluded that the baseline and per-unit savings assumptions for network energy management software solutions were reasonable. The 2007 M&T effort revisited the per-unit energy savings and expanded the market to include other actors beyond Verdiem. At the time, however, only Verdiem claimed a significant presence in the Northwest.

Research for the 2009 M&T effort involved the following steps:

- Review of the 2007 M&T findings;
- Brief phone interviews with five of Verdiem's competitors[108] to determine their level of activity in the Northwest and awareness of the NEEA-Verdiem partnership;
- Identification of utilities in the Northwest that are offering rebates for network energy management software;
- Email exchange with a Verdiem representative to gather information about product pricing, per-unit energy savings, and sales data;
- Comparison of the per-unit energy savings in the ACE model to those in ENERGY STAR's online energy savings calculator for network energy management software; and
- Review of recent trends in IT energy management practices.

Together, these steps provided the evaluation team with the information needed to assess the level of market activity, the baseline, and the per-unit energy savings for network energy management software. A summary of primary data collection activities is included in Table 9-1.

Table 9-1. Primary Data Collection

	Number of Interviews / Surveys	Topic Issues
Verdiem's competitors	5 phone surveys	Current level of activity in and attention to the Northwest market, awareness of NEEA's Verdiem initiative
Verdiem staff	2 via email exchange	Verification of assumptions about product sales and use
Utility staff	2 professional conversations	Opportunities to leverage the NEEA-Verdiem partnership by providing incentives

9.3 Findings

Attention to the market for network energy management software (NEMS) solutions in the Northwest continued to grow during 2008 and 2009. In addition to Verdiem, several other providers were actively marketing competing solutions in the region. Overall market activity estimates continue to rely on Verdiem sales data, however, because it was not possible to obtain

[108] Five companies that offer products that compete with Verdiem's Surveyor were interviewed. Faronics and Big Fix were willing to be credited in this report, while the other three companies preferred anonymity.

sales data for these competitors. Per-unit energy savings also remain constant even though these estimates are significantly lower than ENERGY STAR estimates; Verdiem's savings data are based on actual monitoring, whereas ENERGY STAR's data are based on a model.

The major change to the ACE model involves an increase in the baseline estimate from 10% to 50% due to the market being driven by forces outside of NEEA's area of influence, including a stronger business case for the technology, a growth in sustainability commitments, improving product quality, and the availability of capital to fund NEMS investments.

9.3.1 Market Activity

Network energy management software solutions increased in visibility significantly in the past two years both throughout the country and specifically in the Northwest. The 2007 M&T effort only uncovered one competitor to Verdiem in the Northwest,[109] even though most of the companies interviewed for the 2009 M&T indicated that their products have been available for the past three to four years. More than half of the companies interviewed indicate that they have already enhanced their marketing efforts in the Northwest or plan to do so in the next two years.

The companies' own efforts to increase visibility have been supplemented by ENERGY STAR and utility programs to promote network energy management software solutions. ENERGY STAR's Commercial Power Management program has developed a one-stop shop for identifying the options for solutions, estimating energy savings, and learning about other organizations' experiences with different solutions. Putting the ENERGY STAR brand behind this product class provides it with credibility and enhances its accessibility for most end users. In addition, utilities in the Northwest have introduced incentives for network energy management solutions (Table 9-2) Many of these utilities list a subset of qualifying products on their websites, providing yet another source for end users to learn about the technology.

[109] It should be noted that identifying competitors was not one of the main areas of focus of the 2007 effort.

Table 9-2. Northwest Utilities Offering Incentives for Network Energy Management Software

Utility	Program Name
Snohomish PUD	C&I Program / Network PC Power Management Software Rebate
Seattle City Light	Efficient Desktop Computing
Energy Trust of Oregon	Existing Commercial Buildings
Bonneville Power Administration	Network Computer Power Management
Puget Sound Energy	PC Power Management
BC Hydro	Computer Power Management
Avista	Power Management for PC Networks
Idaho Power	Business - Easy Upgrades Program
Source: Program websites, as specified in the Bibliography.	

Providers besides Verdiem are now actively marketing in the region. Of the five competitors interviewed, all are marketing in the Northwest. They see the Northwest market as "strong and growing," driven mostly by changes in the market in the past couple of years (see Baseline Activity for more detail); one interviewee even indicated that the Northwest was the second strongest market in the country behind California. For these competitors, utility rebates play an important role in their business plan. Only one respondent indicated that the Northwest was not a priority region because it was Verdiem's home territory.

It is possible that these other providers have significant sales in the Northwest. Most of Verdiem's competitors offer power management as one component of a larger product platform. For example, Big Fix's Power Management software is a component available through the Big Fix Platform, which offers solutions for security, maintenance and virtualization. ScriptLogic offers an element called Power Schemes as part of its Desktop Authority platform, which enables remote management of personal computers. It is possible that these platforms (or others like them) are already supporting enterprises throughout the Northwest and that the energy management solution has been added to some of them.

Obtaining sales data from Verdiem's competitors, however, is unlikely. The competitive advantage created by such information makes it unlikely that organizations without direct ties to NEEA will share such information for the purposes of M&T efforts. Without sales data from these other organizations, it is difficult to estimate how many computers in the Northwest are controlled by network energy management software. It may be worth noting that the interviewees focused on their marketing efforts rather than on increasing sales in the region.

For this M&T effort, market activity was based on Verdiem sales during 2008 and 2009 (Table 9-3) due to an absence of defensible market-level data. Utilities' data on rebates may indicate that there is a higher level of activity in the region than what is reported here. If that is the case, these estimates should be increased upwards to reflect those additional sales. The interviews indicate that few, if any, sales are taking place in the absence of rebates.

Table 9-3. Sales of Verdiem's Surveyor During 2008 and 2009

Year	Reported Sales in the Northwest	Anticipated Retirements in the Northwest*
2008	[redacted]	[redacted]
2009	[redacted]	[redacted]

Source: Sales data provided by Verdiem.

*NEMS are assumed to have a five-year life before retirement.
Note: Sales data have been redacted for public consumption

Two specific changes were made to the ACE model for Verdiem:

- All units sold in 2007 were reported in 2007. Previously, some 2007 unit sales were reported in 2008 because of the timing of reporting of 2007 sales data. Those units were moved back to 2007 so that retirements would be correctly accounted for in the future.
- The number of units sold in 2008 was corrected. Verdiem's sales data indicate [redacted] licenses sold in the Northwest in 2008, but the ACE model previously reported [redacted].

9.3.2 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. This section provides a brief history of how NEEA's initiative coincided with the development of the market for network energy management software, outlines the drivers, explores the influence of the NEEA-Verdiem partnership on them, and recommends a new estimate of Baseline Activity.

NEEA's partnership with Verdiem began in 2001. The NEEA-Verdiem partnership had a three-part strategy:

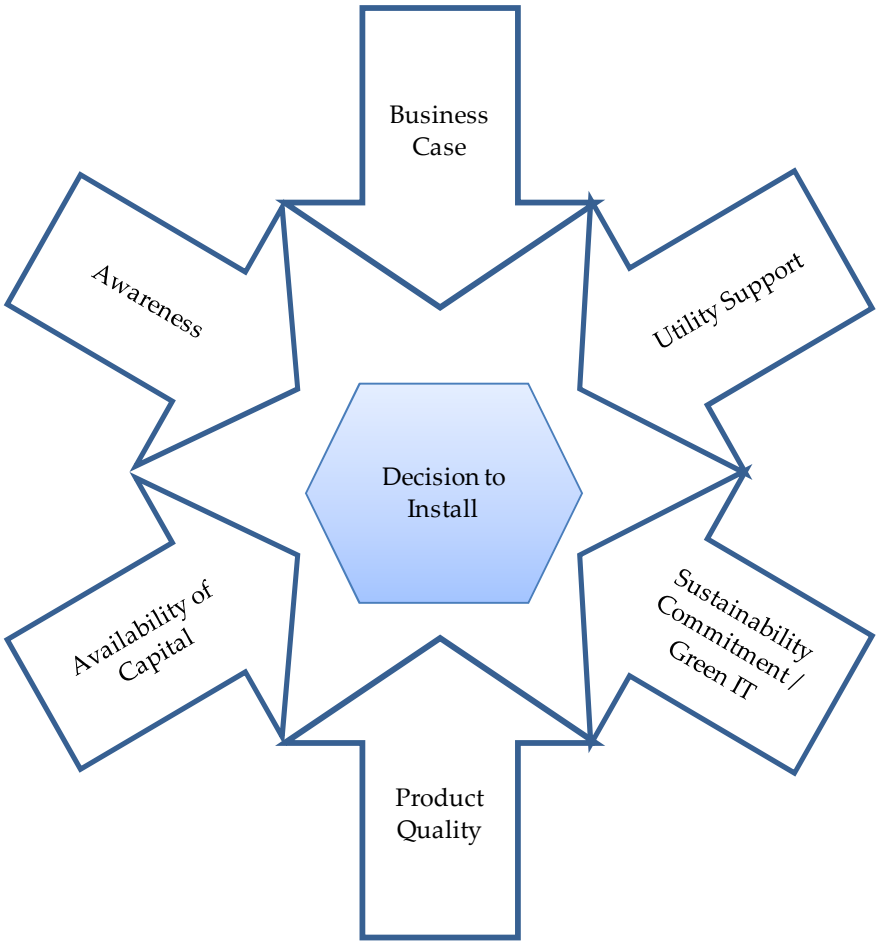
1. To introduce Surveyor to the market;
2. To establish Verdiem as a financially viable private-sector entity to sell Surveyor; and
3. To sell approximately 18,000 units in the region by the end of 2003.[110]

[110] Quantec. January 19, 2005. *Surveyor Network Energy Manager: Market Progress Evaluation Report #2*. Prepared for NEEA. Report #E05-136.

The NEEA-Verdiem strategy focused on one company in the private sector, but the initiative did not create the technology. At this time of the partnership's inception, comparable products were available in the market. Notably, an open-source solution had been developed for ENERGY STAR and was offered, free of charge, in 2001. During the partnership and after, the number of private companies offering comparable products continued to grow. Today, two dozen competitors have been included in ENERGY STAR's list of available products; these are included in Appendix F.1.

From the customer perspective, a variety of factors external to Verdiem's specific products and marketing influence the decision to purchase network energy management software (Figure 9-1) These decisions include factors related to internal organizational needs, access to solutions to address these needs, and the business case for the solutions. Typically, all of these factors must align in order for a customer to implement network energy management solution.

Figure 9-1. Drivers Affecting Decision to Install Network Energy Management Software



Source: Navigant Consulting analysis

A brief explanation of each driver, as it relates to the adoption of NEMS, follows:

- **Business Case:** IT Managers are under increasing pressure to reduce the cost of IT energy costs.[111] This was of heightened importance during late 2008 and most of 2009, a time when corporate profitability was achieved by cost reductions rather than top-line revenue growth.[112] The viability of investments in network energy management software has two components: (1) payback period for the investment and (2) annual energy cost savings. Payback period should be short, and annual energy cost savings should be significant.
- **Utility Support:** Providers report that the absence of rebates will kill their organization's decision to enter a market.[113] Utility rebates can significantly lower the cost of this solution. This is an important enough aspect of the payback period to be recognized as its own driver. In addition, utilities can increase awareness of the solution and serve to validate the credibility of the products and providers. A number of utilities in the Northwest have initiated incentive programs for these solutions during the past two years, increasing their visibility in the region (Table 9-2).

- **Sustainability Commitment / Green IT:** Sustainability has been a growing concern across corporate America for the past several years, and green IT has become a visible component of those efforts.[114, 115] A 2008 survey revealed that 75% of respondents thought that "eco-friendly" computing was an important part of their IT operations.[116] In a 2009 survey of IT professionals, 59% of respondents indicated making some type of effort to improve the energy efficiency in desktop computing.[117] These initiatives are often closely tied to the business case cost-reduction driver.

- **Product Quality:** The quality of the network energy management software solutions is another critical input to the decision to purchase. Among other factors, the product's ability to interface with existing systems, to mitigate the impact on users, to adapt to unique circumstances within the organization, and to quantify the energy saving benefits help to convince customers that the solution is worthwhile.[118] If the product fails to meet the needs of the customer, the investment typically does not go through. Many

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[111] Marsan, C.D. July 7, 2008. "Under Pressure: 10 Sources Pushing CIOs to Go Green." *Network World.* Available: http://www.networkworld.com/news/2008/070708-green-cios-pressure.html

[112] Ansberry, C. March 2, 2010. "Companies Map Routes to Recovery." *Wall Street Journal.*

[113] Navigant Consulting interviews with providers of network energy management solutions.

[114] Marsan, C.D. July 7, 2008. "Under Pressure: 10 Sources Pushing CIOs to Go Green." *Network World.* Available: http://www.networkworld.com/news/2008/070708-green-cios-pressure.html

[115] Hiner, J. December 8, 2008. "IT Trends: The Top Five Developments of 2008." ZDNet.com. Available: http://blogs.zdnet.com/BTL/?p=11128

[116] Singh, A. April 17, 2008. "Enterprises, Vendors Paying More Attention to Green Technology." www.GreenTMCnet.com.

[117] CDW. August 31, 2009. *2009 Energy Efficiency IT Report: The Power of Prioritization.* Available: http://newsroom.cdw.com/features/feature-08-31-09.html

[118] A series of case studies were used to inform this discussion: LanDesk, Brevard Public Schools; BigFix, Miami-Dade Public Schools; 1E, Dell; Verdiem, Lake Washington School District; ScriptLogic, Bonneville Joint School District No. 93.

of the prominent solutions, including Verdiem's Surveyor, Faronics' PowerSave, and 1E's Nightwatchman, have upgraded their products in the past two years; although not guaranteed, it is likely that these upgrades improved the quality of the solution.

» **Availability of capital:** Like other energy efficiency investments, network energy management software requires a substantial up-front investment for which capital must be available. During 2008 and 2009, capital expenditure fell across the economy as companies preserved cash to ensure that they could meet their obligations during a time when financing was difficult to access.[119] Network energy management solutions are competing for capital with a range of investment opportunities, including investments in the core business. The business case must be at least as compelling those of the alternative investments in order to receive the capital needed to implement the solution.

» **Awareness:** There are a variety of network energy management solutions available, some of which are open-source, some of which are embedded in existing platforms, and some of which can be purchased from third-party vendors. An organization can access the solution through any of these pathways, but they must know what the problem is and how to solve it first.

Table 9-4 summarizes each of these market drivers and the assessed level of influence that NEEA currently has on each one.

[119] Denning, L. December 7, 2009. "Pressure on Companies to Spend Again." *Wall Street Journal.*

Table 9-4. Level of NEEA Influence over Drivers to Product Adoption

Driver	Description of NEEA Influence	Level of NEEA Influence
Business case	NEEA has no control over the existing systems of use in the marketplace; these pre-existing systems dictate the amount of energy cost savings, which heavily influences the payback period.	Low
Utility Support	It is likely that the utilities in the region became aware of this option for achieving energy savings as a result of the NEEA-Verdiem partnership. Utilities may be contacted about this in future research efforts.	High
Sustainability commitments / Green IT	Sustainability commitments are much broader than just the issues addressed through the NEEA-Verdiem partnership. Further, the increases in energy cost that drive many of the Green IT initiatives are outside of the realm of the NEEA-Verdiem partnership.	Low
Product quality	The evaluation of the NEEA-Verdiem partnership did report customer satisfaction with Verdiem's Surveyor solution,* which may have informed other firms' development efforts. However, each company is responsible for developing and maintaining its own solution; these ongoing efforts are much more comprehensive than the initial evaluation report. Further, one competitor indicated that customer demand drove their development of the tool; this indicates that additional products would have been developed even in the absence of the NEEA-Verdiem Partnership.	Low
Availability of capital	The availability of capital for investment in network energy management software solutions or other investment alternatives is in the hands of the organizations making the decision. NEEA's intervention in the marketplace did not address issues related to the availability of capital.	Low
Awareness	The NEEA-Verdiem partnership helped to build early relationships between Verdiem and regional partners. The partnership also developed case studies that could communicate the results of early pilots more widely. These efforts may have helped to build awareness about Verdiem's product specifically and about the concept of network energy management more generally. On the other hand, four of the five providers interviewed indicated that they promote their products across the Northwest. These activities likely have a more significant effect on regional awareness than the residual effects of the NEEA-Verdiem partnership.	Medium

* Quantec. January 19, 2005. *Surveyor Network Energy Manager: Market Progress Evaluation Report, No. 2.* NEEA Report E05-136.

The analysis in Table 9-4 indicates that a significant increase in the baseline estimate is appropriate. NEEA had an important role in developing Verdiem's solution, but there have been other areas of innovation and market development that would have pushed the market in any event. In other words, in recent years, *the market is being driven by forces outside of NEEA's area of influence:* a stronger business case for the technology, a growth in sustainability commitments, improving product quality, and the availability of capital to fund network energy management system investments. NEEA's influence over the region's awareness of this solution is distant in time, but it remains as one potential influence over the market. It was assumed, however, that NEEA (either through direct influence or through its investment in Verdiem) heavily influenced utility decisions to offer incentives for NEMS; this factor was the main driver behind keeping the baseline as low as 50%.

This change was anticipated during the previous Verdiem M&T effort, which took place in 2007-08. The 2008 report stated,

> "[Revisiting the baseline estimate] will be an important component of future M&T efforts because of the new focus on energy used by information technology systems that may have driven the creation of a separate network energy management software tool even without NEEA's participation in the market."

The analysis undertaken as part of this year's M&T efforts suggests that other network energy management software solutions would have evolved in the absence of the NEEA-Verdiem partnership. Further, it indicates that other market forces, including the compelling business case for this solution, have driven further adoption of this type of solution in the region. If not for the assumed role of NEEA's influence *in the creation of utility incentive programs* (Table 9-4) for network energy management software, the baseline figure would likely have been considerably higher.[120]

In addition, the M&T team recommends making one specific change to the ACE model to more accurately reflect baseline activity. The calculation for the Net Incremental Baseline should be adjusted. The share of retirements reduced from the Gross Incremental Baseline should reflect the share of market activity that was considered baseline in the year that the retired units went into service. For example, 10% of the units that went into service in 2003 and were retired in 2008 should be subtracted from the Gross Incremental Baseline in 2008, even though the 2008 baseline is now 50%. This change accounts for the fact that only 10% of those units were originally counted in the baseline calculation in 2003.

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[120] The evaluation team has anecdotal evidence in support of this assertion, though future M&T efforts may survey utilities and other providers of incentives directly to confirm it. The evaluation team has had conversations with staff at Bonneville Power Administration and Energy Trust of Oregon that indicate that the NEEA-Verdiem partnership was a factor in the development of incentive programs to promote network energy management software. These conversations were not directly related to the 2009-10 M&T effort but were considered in the analysis.

9.3.3 Per-Unit Energy Savings

As discussed in the previous M&T reports, per-unit energy savings for network energy management software are dependent on many factors, making it difficult to develop an "average" per-unit energy savings estimate. The volatility in the per-unit energy savings estimate is caused by significant differences in savings based on the type of technology used (e.g., CRT vs. LCD monitors, desktops vs. laptops), baseline user habits and company policies, and aggressiveness of the energy management savings applied. These vary significantly from one context to another.

Sources outside of NEEA provide significantly higher savings estimates than those currently claimed by NEEA (200 kWh/license/year). A recent report by Beacon Consultants, for example, indicates that the program managers it interviewed for the report consider the 200 kWh/license/year savings estimate used by NEEA is "at the low end of the average savings spectrum."[121] In support of this fact, the report cites other savings claims in the industry, such as 1E's estimate of 395 kWh/license/year, which applies to computers that were previously left on during nights and weekends. The report also cites a study conducted by Southern California Edison on the Verdiem software that indicated 330 kWh/license/year of average savings; this report was reviewed as part of the 2005 M&T efforts.

In addition, the ENERGY STAR calculator for network energy management software provides significantly higher estimates of per-unit energy savings under some system configurations (Table 9-5). This range accounts for the type of computer (desktop vs. laptop), whether or not the workstation is qualified for ENERGY STAR, the types of protocols already in place for monitor shut down and system standby/hibernate, and the amount of time that the unit is actually switched off. The two most important assumptions in the model are the type of computer and the amount of time that the computer is switched off.[122]

[121] The information in this paragraph is sourced from Walker, J.M. July 14, 2009. "Power Management for Networked Computers: A Review of Utility Incentive Programs." Beacon Consultants. Available: http://www.beaconconsultants.com/Utility-Incentives-for-Computer-Power-Mgmt.pdf

[122] Conversation with Robert Huang, Cadmus Group; Mr. Huang serves as a consultant to ENERGY STAR for this program.

Table 9-5. Annual Energy Savings Per Workstation as Projected by ENERGY STAR Savings Calculator

System Configuration	Desktop Savings	Laptop Savings
ENERGY STAR Computer	191 kWh/yr	44 kWh/yr
ENERGY STAR Computer + Standby	417 kWh/yr	76 kWh/yr
ENERGY STAR + Monitor Shut Down	322 kWh/yr	78 kWh/yr
ENERGY STAR + Standby + Monitor Shut Down	547 kWh/yr	109 kWh/yr
Baseline Computer + Standby	338 kWh/yr	49 kWh/yr
Baseline Computer + Monitor Shut Down	169 kWh/yr	52 kWh/yr
Baseline Computer + Standby + Monitor Shut Down	507 kWh/yr	100 kWh/yr

Notes: Baseline Computer is a unit that is not qualified for ENERGY STAR. These calculations use the basic assumptions included in the ENERGY STAR calculator model (as downloaded o 3/18/2010) with one exception: Machine turned off 36% of the time (not 0%).

Source: ENERGY STAR Computer Power Management Savings Calculator. Available: http://www.energystar.gov/ia/products/power_mgt/LowCarbonITSavingsCalc_v26_with_5_0v2.xls

In spite of these other savings estimates, the M&T team believes that the data collected by Verdiem continues to be the best estimate for per-unit energy savings available. Verdiem's data are based on actual monitoring of the systems on which they are installed. Such data are more reliable than modeled estimates because they reflect the actual configuration and operating conditions of the systems on which they are installed. It is possible that Verdiem's customers had already implemented some energy efficient measures for their IT operations before implementing a network energy management software solution; as such, their baseline energy use would be lower than those predicted in models such as the ENERGY STAR online calculator.

This is an issue that was raised in the initial M&T effort in 2005. The conclusion and the reasoning in 2009 are similar to that in 2005: "Overall, the evaluation team places more faith in the per-unit energy savings from Verdiem's own specific case studies and M&V than the estimates of savings from other power-management software products."[123] The M&T team suggests that NEEA continue to use energy savings based on Verdiem's M&V efforts until more widespread evaluation studies are conducted on utility incentive programs.

That said, the M&T team re-visited the two factors that also affect per-unit energy savings:

- *The number of licenses that are actually deployed in the Northwest at the time of purchase.* Some clients that purchase network energy management software have operations outside of the Northwest but purchase the software for workstations in all states. In addition, some clients purchase more licenses than they immediately need so that licenses are available as the organization grows.

- *Per-unit energy savings for each installed license.* As discussed earlier, the amount of energy saved per license varies depending on several factors. The M&T team followed up to inquire about any changes to the average energy savings for licenses that were installed.

Verdiem confirms that the values used for each of these factors in the 2007 report are still valid in 2009: 95% of licenses purchased are immediately installed in the Northwest, and 200 kWh/license continues to serve as a reasonable average. These data remain the same in the ACE model.

9.4 Conclusions and Recommendations

The past two years represented a continued growth opportunity for network energy management software. This time period was marked by concerted efforts by Verdiem's competitors to increase their presence in the Northwest. Driven largely by utility incentives and increased customer awareness of the cost-saving opportunities associated with the solution, providers of network energy management increased their visibility and marketing efforts in the region. These drivers resulted in an increase in the baseline activity for network energy management software during this period.

NEEA's influence over the region's awareness of this solution was important in its early development, but many other forces have become more important in further building that awareness, offering solutions, and driving demand in more recent years. It was assumed that NEEA (either through direct influence or through its investment in Verdiem) heavily influenced utility decisions to offer incentives for NEMS; this factor was the main driver behind keeping

[123] Summit Blue Consulting. April 18, 2006. *Long-Term Monitoring and Tracking Report on 2005 Activities*. Prepared for the Northwest Energy Efficiency Alliance. Available: http://www.summitblue.com/attachments/0000/0534/r40_-_Long_Term_Monitoring_and_Tracking_Report_on_2005_Activities.pdf

the baseline as low as 50%. As implied, several major utilities in the Northwest began offering incentives for network energy management software in the past two years. These programs played a major role in growing the market and are recognized as an important result of the NEEA-Verdiem partnership.

One additional recommendation involves the way that NEEA accounts for retirements in its ACE model. The simple change to the ACE model which is outlined in Appendix F.2 – would better document the energy savings achieved in the region. As the market for network energy management software expands, the consistency created by the recommended change will ensure the accuracy of savings reported.

Table 9-6 summarizes the calculation of implied energy savings from NEEA's partnership with Verdiem. Annual sales in the region continued to vary from one year to the next without a consistent growth pattern. The M&T team suggests increasing the baseline to 50% and holding the per-unit energy sales for new units constant with previous M&T recommendations. Together, these forces decreased the implied energy savings anticipated from this program relative to previous estimates.

Table 9-6. Recommended values for Network Energy Management Software

Key Indicators Reviewed	**2008 Incremental** (Due to *new* activity occurring in 2008)	**2009 Incremental** (Due to new activity occurring in 2009)	**2009 Cumulative** (Calendar year 2009 values due to all activity since program inception)	**Source**
Market Activity				
NEMS unit sales in the Northwest	52,887	38,239	125,676	Verdiem Sales Data (Section 9.3.1)
Baseline Activity				
NEMS sales in the Northwest	(50%) 26,444	(50%) 19,120	49,018	Interviews, secondary research (Section 9.3.2)
Per-Unit Energy Savings				
Installing NEMS on workstation (kWh/year)*	190	190	184	Verdiem Monitoring Data, Section 9.3.3. See note below.
Implied Energy Savings (aMW)**				
Installing NEMS on workstation	0.6	0.4	1.6	

* Per-Unit Energy Savings is a weighted average based on the balance of products in the market (net market effects) that count toward NEEA savings in a given year.

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

Source: Navigant Consulting Analysis

The M&T team recommends that NEEA continue the M&T effort for the market for network energy management software solutions in two years. The highest priority should be to gather broader data about the market to determine the actual prevalence of network energy management software, moving beyond the sales data provided by Verdiem. There are several options for activities to add to the next M&T effort, varying in cost and in the quality of data that can be gathered. Viable options include the following:

- The next M&T effort could include a survey of Verdiem's competitors in the areas of (1) per-license purchase price, (2) per-license annual maintenance fees, (3) documented per-unit energy savings, and (4) annual sales data. The last item will be difficult to obtain, but the M&T effort may consider proxies for actual sales data, such as percentage of each competitor's customers that are implementing network energy management software solutions (which could be a component of a top-down market estimate); this is an appropriate approach, given that most of Verdiem's competitors offer platform solutions that integrate the energy management solutions.

- The next M&T effort could include a survey of IT managers throughout the region to estimate the market penetration of network energy management software. Recruitment for this effort would be difficult, but the data would probably be the best source of information about actual market penetration for this class of products.

- The next M&T effort may also include a survey of utility staff to determine the level of NEEA's influence in developing incentive programs for NEMS. The assumption that the NEEA-Verdiem partnership did influence this decision was an important factor in the baseline assumption. Although this was not a priority item during this 2009-10 M&T effort, it warrants further exploration in the future.

- In addition, future M&T efforts may leverage evaluations of utility programs that offer incentives for network energy management software. This could be especially productive if such evaluations include direct monitoring of network energy management solutions that have been implemented throughout the region.

9.5 Bibliography

1E. Undated. "Dell: Focusing on Energy Efficiency." Available: http://www.1e.com/download/whitepapers/dell_case%20study_us.pdf

Ansberry, C. March 2, 2010. "Companies Map Routes to Recovery." *Wall Street Journal.*

Avista. "Power Management for PC Networks." Available: http://www.avistautilities.com/business/rebates/washington_idaho/Pages/incentive_14.aspx

BC Hydro. "Computer Power Management." Available: http://www.bchydro.com/powersmart/technology_tips/managing_energy_costs/computer_power_management.html

BigFix, 2007. "Miami Dade County Schools: BigFix Power Management Lowers Power Bills and Shrinks Carbon Footprint." Available: http://www.energystar.gov/ia/products/power_mgt/MDCPS_Power_Mgt.pdf

Bonneville Power Administration. October 1, 2009. *Energy Efficiency Implementation Manual.* Available: http://www.bpa.gov/Energy/N/archives/pdf/October_2009_Implementation_Manual_FINAL.pdf

CDW. August 31, 2009. *2009 Energy Efficiency IT Report: The Power of Prioritization.* Available: http://newsroom.cdw.com/features/feature-08-31-09.html

Cook, John. 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.

Denning, L. December 7, 2009. "Pressure on Companies to Spend Again." *Wall Street Journal.*

Energy Trust of Oregon. "Existing Buildings: IT/Power." Available: http://energytrust.org/business/incentives/data-centers/existing-building/Software/it-power/

Hiner, J. December 8, 2008. "IT Trends: The Top Five Developments of 2008." ZDNet.com. Available: http://blogs.zdnet.com/BTL/?p=11128

Conversation with Robert Huang, Cadmus Group; Mr. Huang serves as a consultant to ENERGY STAR for this program.

Idaho Power. "Easy Upgrades Program: Plug Loads." Available: http://www.idahopower.com/pdfs/EnergyEfficiency/EasyUpgrades/worksheet_Plug.pdf

LanDesk. 2008. Brevard Public Schools Case Study. Available: http://secureit.landesk.com/pdf/landesk_BrevardSchools_en-US.pdf

Marsan, C.D. July 7, 2008. "Under Pressure: 10 Sources Pushing CIOs to Go Green." *Network World.* Available: http://www.networkworld.com/news/2008/070708-green-cios-pressure.html

Martin, R. November 5, 2007"Want to Save the Planet? Turn off that PC." *Information Week.*

Navigant Consulting interviews with providers of network energy management solutions. These individuals asked not to be named in this report.

Puget Sound Energy. "Efficiency Programs and Rebates: Rebates: PC Power Management." Available: http://www.pse.com/solutions/forbusiness/pages/comRebates.aspx?tab=5&chapter=2

Quantec, LLC. January 15, 2005. "Market Progress Evaluation Report 2: Surveyor Software." Prepared for NEEA.

ScriptLogic, Undated. "Desktop Authority Makes the Grade at Bonneville Joint School District No. 93." Available: http://www.scriptlogic.com/CaseStudies/Download/Bonneville-Joint-School-District-Case-Study.pdf

Seattle City Light. "Efficient Desktop Computing for City Light Customers." Available: http://www.seattle.gov/light/conserve/business/cv5_comp.pdf

Singh, A. April 17, 2008. "Enterprises, Vendors Paying More Attention to Green Technology." www.GreenTMCnet.com.

Snohomish PUD. "Network PC and Power Management Software Rebate." Available: http://www.snopud.com/Site/Content/Documents/ci/CI_PCrebate409web.pdf

Summit Blue Consulting. April 18, 2006. *Long-Term Monitoring and Tracking Report on 2005 Activities*. Prepared for the Northwest Energy Efficiency Alliance. Available: http://www.summitblue.com/attachments/0000/0534/r40_-_Long_Term_Monitoring_and_Tracking_Report_on_2005_Activities.pdf

Verdiem, 2008. "Case Study: Lake Washington School District Lowers Greenhouse Gas Emissions and Saves over $200,000 Annually." Available: http://www.verdiem.com/docs/LWSD_CaseStudy.pdf

Walker, J.M. July 14, 2009. "Power Management for Networked Computers: A Review of Utility Incentive Programs." Beacon Consultants. Available: http://www.beaconconsultants.com/Utility-Incentives-for-Computer-Power-Mgmt.pdf.

Appendix A – Commissioning

A.1 Summary of LEED Policies in Washington and Oregon

Table A-1. State, County, and Municipal LEED Requirements

Location	Type of Government	Buildings Affected by LEED Requirement/Incentive	Requirement or Incentive	Year Passed
Washington	State	New and renovated state-funded buildings including K-12 schools	LEED Silver required	2005
King County, WA	County	All new municipal buildings and remodeling projects >$250,000	Highest achievable LEED certification required	2005
Bellingham, WA	Municipal	Privately owned new construction projects	Incentive for LEED Silver certification	2005
	Municipal	New municipal buildings >5,000 ft²	LEED Silver certification required	2005
Bothell, WA	Municipal	Privately-owned new construction projects	Incentives (reduced permitting fees) for buildings seeking LEED certification	2009
Everett, WA	Municipal	New municipal buildings >5,000 ft²	LEED Silver certification required	2007
Issaquah, WA	Municipal	All new construction projects seeking LEED certification	Incentives/ability to move to front of line for permitting if seeking LEED certification	2004
Seattle, WA	Municipal	Private buildings seeking to build beyond specific height or square footage requirements in downtown zones	LEED Silver certification required	2006
	Municipal	New and majorly renovated municipal buildings <5,000 ft²	LEED Silver certification required	2002
Whatcom County, WA	County	New and renovated county buildings >5,000 ft²	LEED Silver certification required whenever possible	2005
Oregon	State	Any privately-owned new construction project seeking LEED Silver, Gold, or Platinum certification	Financial incentive provided through Business Energy Tax Credit (BETC)	
Multnomah County, OR	County	All new county buildings and renovations >10,000 ft²	LEED Gold certification required	2008

Location	Type of Government	Buildings Affected by LEED Requirement/Incentive	Requirement or Incentive	Year Passed
Eugene, OR	Municipal	New municipal buildings <10,000 ft²	LEED New Construction guidelines to be followed, but certification not required	2006
	Municipal	New municipal buildings >10,000 ft²	LEED Silver certification required	2006
Portland, OR	Municipal	Privately owned new buildings >10,000 ft² receiving any public agency funding	LEED Silver certification required	2005
	Municipal	All occupied, existing municipal buildings	LEED-EB Silver certification required	2005
	Municipal	New municipal buildings	LEED Gold certification required	2005
Source: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1852				

A.2 BCA Member Online Survey

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, the 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.**

This survey will take no more than 5-10 minutes and contains approximately 15 questions. Even if you are not currently engaged in commissioning activity, we are still interested in your responses.

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.*

Retrocommissioning (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

Survey 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

4. **In your opinion, how has the quantity of Commissioning activity, including Retrocommissioning, changed in the past two years?**

   - ☐ 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 commissioning activity changed between 2007 and 2009 (as measured in percent change in square footage of building space)?**

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

6. **In your opinion, in what ways has the quality and type of commissioning activity in the Pacific Northwest changed in the past two years? Please describe.**

   [OPEN ENDED]

7. **Have any of the following factors influenced the trends that you've observed?**

   ☐ The decline in the economy

   ☐ Availability of federal stimulus funds (American Recovery and Reinvestment Act)
   ☐ New state/local policies
   ☐ Others

   Please describe the influence of these factors:

   [OPEN ENDED]

8. **How do you foresee the quantity of Commissioning activity, including Retrocommissioning, changing in the next two years?**

   ☐ Increasing

   ☐ Decreasing
   ☐ Staying the same
   ☐ Don't know

9. **If you answered either "increasing" or "decreasing" to the question above: By about what percent do you predict commissioning activity will change between 2009 and 2011 (as measured in percent change in square footage of building space)?**

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

10. **What changes do you foresee occurring in the next two years with respect to the quality and type of commissioning activity in the Northwest?**

    [OPEN ENDED]

11. **What are the major drivers likely to influence those trends?**

    [OPEN ENDED]

12. **Approximately how many commissioning projects, including retrocommissioning, did your organization perform in the Pacific Northwest (OR, WA, MT, ID) in 2009?**

    [OPEN ENDED]

13. **Approximately what percent of these projects were retrocommissioning of existing buildings?**

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

14. **What are the three major types of buildings that your organization performs commissioning services on?**

    ☐ Offices (private)

    ☐ Hospitals
    ☐ Other Health
    ☐ K-12 Schools
    ☐ Universities
    ☐ Grocery Stores
    ☐ Other Retail
    ☐ Hospitality
    ☐ Restaurants
    ☐ Warehouse
    ☐ Government
    ☐ Other

15. **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]

16. **Do you have any comments or questions for NEEA?**

    [OPEN ENDED]

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!

Appendix B – Drive Power

B.1 Market Activity for NEMA Premium Motors

Since detailed discussion of the estimation of NEMA Premium™ sales have been presented in previous M&T reports, only a summary of market activity is presented in the Findings (Section4.3.1) above. Additional detail is presented below in this appendix.

Motor *sales data* are not widely collected and are difficult to obtain, but *shipment data* is reasonably available and can be used as a proxy for estimating sales. National shipment data for NEMA Premium™ motors dates back to 2001, with 2007 the most recent year covered.[124] Regional data were not tracked until 2004, and the reporting sources were not consistent until 2005; and even then one motor manufacturer dropped out of the reporting, requiring an adjustment to reported data in order to estimate the true number of motor shipments beyond 2004.

In summary, the M&T analysis used national trends to estimate the the M&T analysis estimated *Northwest* sales of NEMA Premium™ motors as follows:

1. Northwest premium motor sales for 2001 were based on *national* shipments in 2001 and on the share of motors sold in the region versus all of the United States (using the three years of available data, 2005 through 2007).
2. Sales for 2002 through 2004 were projected by linear interpolation between the 2001 estimate and the 2005 estimate (see below).
3. Sales for 2005 through 2007 were based on available data, adjusted to account for data deficiencies described in Appendix A.[125]
4. Sales for the two most recent years (2008 and 2009 for the 2009 M&T report) are assumed to be flat, rather than increasing over the last year of available data according to a projected growth curve (as was done in the 2007 M&T analysis).

National Sales

Northwest premium motor sales for 2001 were based on *national* shipments in 2001 and on the share of motors sold in the region versus all of the United States (using the three years of available data, 2005 through 2007).

The raw national shipment data, as reported by NEMA, indicate that national shipments of premium motors increased steadily between 2001 and 2006, dropping in 2007. The raw data for

[124] NEMA premium motors shipment data were provided by CEE and NEEA.
[125] Only non-OEM motor shipments were reported from 2004 onwards; and one major manufacturer no longer reported shipments after 2004.

2004 to 2007 are incomplete because the records include motors only from original equipment manufacturers (OEMs), and at least one of these manufacturers (Baldor Electric Company) pulled out of the motor surveys sometime in 2004.[126] The data for 2005 through 2007 represents only non-OEM motors and the same set of manufacturers, Hence, they can be compared to study motor sales trends change in that time period.

Table B-1. Reported Shipments of NEMA Premium™ Motors, 2001-2004*

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

* Data on standard efficiency motors was not reported prior to 2005.
Source: NEMA

Table B-2.
Reported Shipments of NEMA Premium™ and Standard Efficiency Motors, 2005-2007

	2005				2006				2007			
	Premium	Non Premium	Total	% Premium	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%	13,347	9,833	23,180	58%
Montana	(Included in Idaho)				(Included in Idaho)				(Included in Idaho)			
Washington	1,926	7,787	9,713	20%	4,048	9,975	14,023	29%	3,185	10,522	13,705	23%
Oregon	1,801	10,020	11,821	15%	6,536	9,753	16,289	40%	3,216	11,981	15,197	21%
Northwest	12,404	26,030	38,434	32%	19,316	29,156	48,472	40%	19,746	32,336	52,082	38%
Nation	216,853	668,522	885,374	24%	238,098	807,795	1,045,893	23%	267,604	838,631	1,106,235	24%

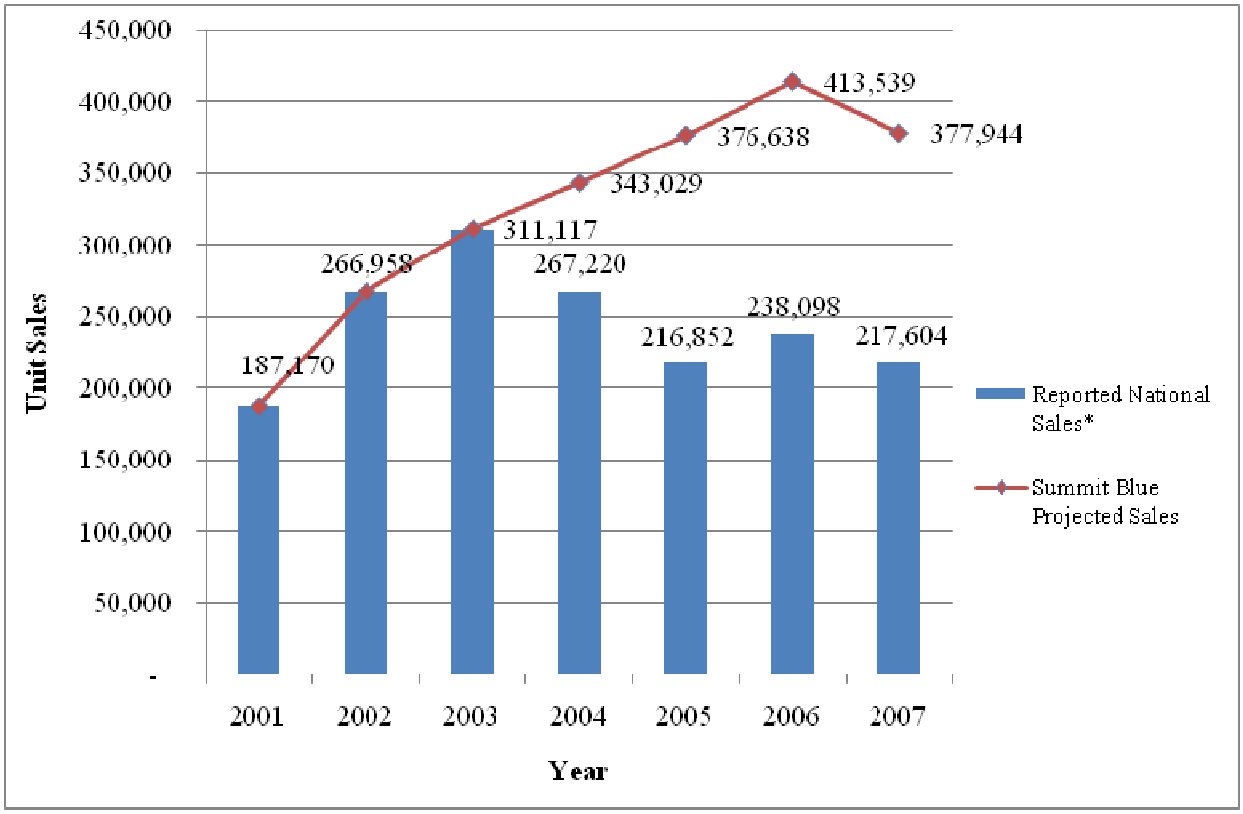
As in previous M&T reports, motor shipment data in the nation, generated by NEMA, were collected from the CEE and used to estimate sales data for each year from 2001 to 2007. Due to the data deficiencies described above, the total number of NEMA Premium™ units shipped in 2005 through 2007 needed to be estimated from the available data. This estimation was performed in the following steps:

1. **2004 NEMA Premium™ shipments.** The annual growth rates for the period from 2001 to 2003 and for 2005 to 2007 were calculated for motor shipments. The average of these two growth rates was applied to 2003 reported shipments to get an estimate of motors shipped in 2004.

[126] Source: 2007 interviews with the Green Motors Practices Group and Baldor Electric Company.

2. **2005-2007 NEMA Premium shipments.** The annual growth rate between 2005 and 2007 (using the partial shipment data excluding OEMs) was applied to the 2004 motor shipment estimate to calculate motors shipped in 2005 through 2007. The result is an estimate of 377,944 motors shipped in 2007 (Figure B-1).

Figure B-1 National NEMA Premium™ Shipments, 2001-2007



* Only non-OEM motor shipments were reported from 2004 onwards; and one major manufacturer no longer reported shipments after 2004.

Source: NEMA and Navigant Consulting projections

Regional Sales

Regional shipment data for NEMA Premium™ motors was not tracked until 2004, but market activity in the region in prior years was estimated using the national figures discussed above. The number of NEMA Premium™ units shipped in 2005 through 2007 to the Northwest was reported to be 12,404, 19,316, and 19,746 respectively. Similar to the national data, the regional data for these years does not include non-OEM motors or shipments from Baldor Electric Co. Therefore, adjustment factors were applied to each year's data for the Northwest. These adjustment factors equaled the ratio of projected national shipments to reported national shipments for 2004, 2005 and 2006, as presented above. For example, the adjustment factor for

2004 was 1.28 (343,029 divided by 267,220) and resulted in an estimate of more than 13,600 NEMA Premium™ motors shipped in that year.[127]

The adjustment factor in 2005 through 2007 was larger (1.7), owing to the fact that Baldor Electric Company dropped out of the survey in 2005.[128] The result is an estimate of more than 21,000 NEMA Premium™ motors shipped in 2005, rising to more than 34,000 per year between 2007 and 2009. This relatively large increase in regional shipments of NEMA Premium™ motors is supported by the raw data comparing national and Northwest shipments of premium motors. Whereas national shipments of NEMA Premium™ motors, *as reported by NEMA,* dropped by an average of 19% between 2004 and 2007 (owing to the factors discussed previously), reported shipments of premium motors in the Northwest increased by 86%. This suggests that premium motor sales in the Northwest have been trending upward at a significantly higher rate than they have nationally.

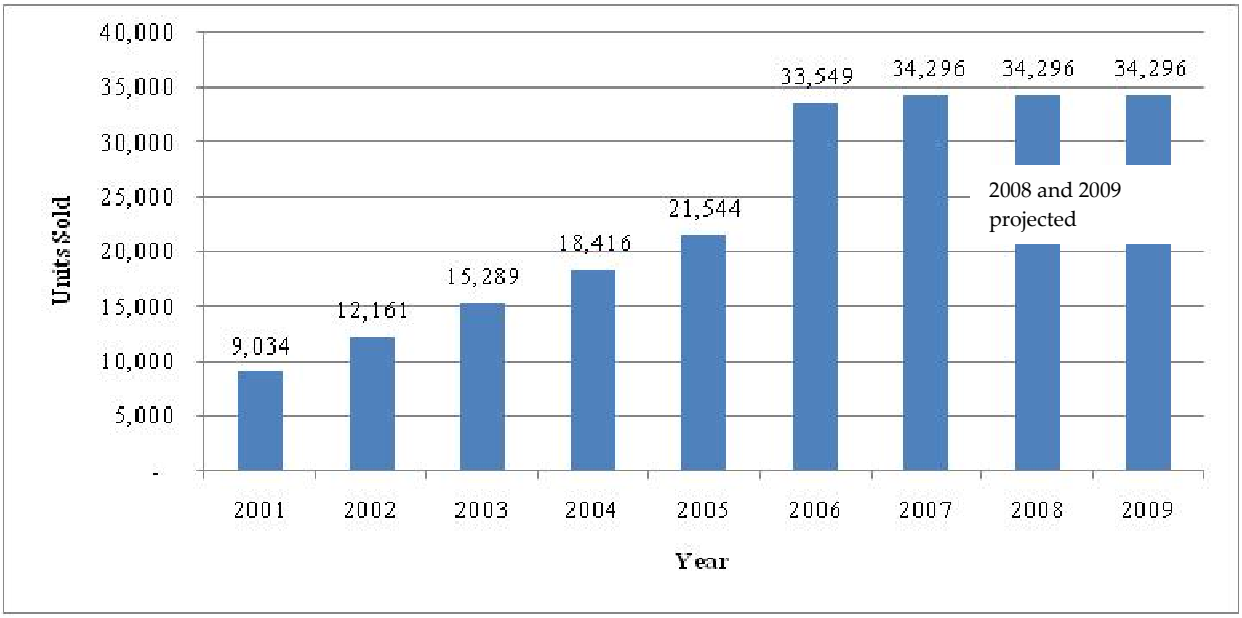
The discussion above presents an estimate of regional sales from 2004 to 2007, the only years for which regional shipment data is available. In order to estimate sales for prior and subsequent years, the project team considered the fact that previous research (from MPERs and M&T reports) indicated that NEEA's influence on the sale of NEMA Premium™ motors was minimal in 2001, the first year for which data is available.[129] Therefore, motor shipments in the Northwest in 2001 were estimated based on national shipment data in 2001 and the ratio of total motors (premium and non-premium) shipped in the Northwest to total motors shipped nationally. This ratio of 4.8% was based on the same data used for the 2008 M&T report (from 2005 and 2006, which were the only years for which shipment data on all motors was available. This translates into an estimate of approximately 9,000 NEMA Premium ™ motors shipped in the Northwest in 2001.

Using this value for 2001 and the previously estimated value for 2007, an average compound annual growth rate of 25% was calculated and used to estimate unit sales values for 2002 and 2003. (Sales in 2004, 2005, and 2006 were estimated above.) Using the approach from past LTMT analyses, the values for 2008 and 2009 would be estimated using the compound growth rate as applied to the 2007 estimate. However, given that reported shipments of NEMA Premium™ motors to the Northwest increased by only 2% between 2006 and 2007, a more conservative estimation approach was applied that held premium motor sales in 2008 and 2009 at 2007 levels (Figure 4-1). Based on these assumptions, total sales since 2001 are estimated to be more than 210,000 units. The current economic downturn may be dampening demand for new motors, a

[127] The methodology used to determine adjustment factors implicitly assumes that the ratio of OEM to non-OEM motors and the ratio of Baldor to non-Baldor motors is the same nationally and in the Northwest.
[128] The 2005 adjustment factor value of 1.7 is less than the 1.8 that was predicted in the last M&T report. This is due to the fact that 2007 data, which shows a decline in growth, is now available to update the growth trend estimates.
[129] 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.

fact that should be considered in subsequent M&T analyses if the most recent available data is also from two years prior to the calendar year being assessed.

Figure B-2. Estimated NEMA Premium™ Motor Sales in the Northwest, 2001-2009 *



* Values are projected based on reported regional shipment data from 2005 through 2007 and national data from 2001 through 2007. Premium motor sales are assumed to remain flat between 2007 and 2009.

Source: NEMA; and Navigant Consulting projections

For 2005 through 2007 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. The market share of NEMA Premium™ motors in 2007 was 38% in the Northwest, with larger motor sizes generally tending to have a greater market penetration.

Table B-3. NEMA Premium™ Shipments in the Northwest by Size, 2007

	1-5 HP	6-20 HP	21-50 HP	51 - 100 HP	101 - 200 HP	201-500 HP	Total
NEMA Premium™ Motors	9,843	6,663	1,938	723	433	146	19,746
Non NEMA Premium™ Motors	20,179	8,235	2,518	700	382	322	32,336
Total Motor Shipments	30,022	14,898	4,456	1,423	815	468	52,082
NEMA Premium™ Share of All Motors	33%	45%	43%	51%	53%	31%	38%

* The figure of 19,746 for total NEMA Premium™ motors shipped in 2007 is taken directly from the NEMA data. As discussed above, the M&T analysis has estimated the total to be 34,296, which accounts for missing data for non-OEM motors.

Source: NEMA

B.2 Motor Service Center Survey Instrument

[Conducted by phone by Navigant Consulting staff]

[Numbering in the online version of the survey does not correspond with the numbering in this Appendix]

INTRODUCTION

Hi, my name is _____, and I'm from Navigant -Summit Blue Consulting. I'm calling on behalf of the NW Energy Efficiency Alliance. We're conducting a study to determine the ongoing energy savings resulting from the NEEA's Drive Power Initiative, which promoted used of premium efficiency motors and encouraged efficient motor rewinds amongst other measures. As part of our study, we're talking to a few motor service centers in the Northwest to better understand the services offered for motor rewinds. I'm hoping that you might be able to take a few minutes to talk – is this a good time to speak?

[IF YES, CONTINUE WITH SURVEY]

[IF NO BECAUSE IT'S A BAD TIME, TRY TO RESCHEDULE]

[IF NO BECAUSE DON'T WANT TO PARTICIPATE, READ THE YELLOWED SENTENCE BELOW]

[If needed: The information that you provide is completely confidential, and the results of our findings will be aggregated so that no individual company's data will be shown. **All information you provide is confidential and will not be publicly associated with you or your organization in any way.]**

Respondent Information [Confirm]

Name:

Title:

Company:

Phone:

Email:

Member of Green Motors?

Number of employees: [GMPG Database]_____ Response _____

Motor Rewind Activity

For this study, we are interested only in MOTOR REWINDS IN THE PACIFIC NORTHWEST, which includes **Washington, Oregon, Idaho, and Montana**.

1. In which of the following states do you have customers for whom you rewind motors? [CIRCLE EITHER "YES" OR "NO" PER STATE]

Washington	Yes	No
Oregon	Yes	No
Idaho	Yes	No
Montana	Yes	No

Since we're trying to estimate market penetration of energy efficient rewinds in the Pacific Northwest as a whole, we would like to get a sense of your relative size in the market.

2. [Ask only if service center does rewinds <u>in more than one state</u>]

   Can you estimate the percentage of your Northwest rewinds that are performed for customers in each state? [Fill in Table below]

Table B-4. Percent of Northwest rewinds by state

State	Percent of Company's Northwest Rewinds Performed (%)
Washington	
Oregon	
Idaho	
Montana	

3. Can you tell me ***approximately*** how many total rewinds you performed in the Northwest in 2009? _____ [# rewinds]
    a. How has this number changed in the past 3 years?
    b. [Probe for average annual increase/decrease] _____ %

EASA Tech Note Compliant Rewind Activity

Now I am going to use the term "energy efficient rewind" in the next several questions. In general, this term refers to motors retaining their operating efficiencies when rewound. [This is from EASA Tech Note 16, which interviewer will have in hand.]

4. Do you make a distinction between a standard rewind and an energy efficient rewind?
    a. Yes
    b. No
    c. No – all of our rewinds are energy efficient
    d. Don't know

    a. [If yes, probe for an explanation:]

5. [If Q4=a or c] Can you estimate the percentage of motors you rewound <u>in the Pacific Northwest in 2009</u> that **you consider** to be "energy efficient" rewinds?
    a. _____% [strongly encourage a response]
    b. Don't know/declined
    c. [Comments/caveats, if offered]:

6. **[**If respondent does "efficient" rewinds (Q4=a or c)]
    What specific actions do you take to ensure efficient rewinds?
    [Allow respondents to answer and check off "Unprompted" boxes as appropriate. Then say:]
    "And are there any common rewind practices that you intentionally **avoid doing** as a part of energy efficient rewinds? [Check off additional <u>unprompted</u> "Don'ts" as appropriate.]
    [Do Unprompted only. Prompted will be done as part of Question 9.]

Table B-5. Key: R= Routinely; S = Sometimes; N= Never.

Dos			Don'ts		
Practices	Un-prompted	Prompted [Ask for Q99.c]	**Practices**	Un-prompted	Prompted [Ask for Q9.c]
Quality assurance program	❒	R S N	Overheat the stator core	❒	R S N
Calibration program to regularly assess the accuracy of equipment	❒	R S N	Use and open flame for stripping	❒	R S N
Stator core test before and after stripping	❒	R S N	Sandblast the iron core WITH SAND	❒	R S N
Repair or replace all defective laminations	❒	R S N	Short the laminations when grinding or filing	❒	R S N
Evaluate the impact on efficiency before changing winding design	❒	R S N	Increase the air gap	❒	R S N
Measure and record winding resistance and room temperature	❒	R S N	Increase the resistance of the stator winding	❒	R S N
Measure and record anperes and voltage during the final test	❒	R S N	Knurl peel or paint bearing fits	❒	R S N
	❒	R S N	Make mechanical modifications without the customer's prior approval.	❒	R S N
Other/Comments:					

7. What percentage of motors you rewound in the Pacific Northwest in 2009 qualify as "energy efficient" rewinds according to guidelines from the Electrical Apparatus Service Association, or EASA?

    a. _____%

    b. Not at all familiar with EASA guidelines

    c. Not sure enough of what the guidelines are to answer this question

    d. Don't know/declined

8. [If they are familiar with EASA guidelines]

    a. On a scale of 0 to 10, with 0 being "not at all familiar" and10 being the "very familiar," how familiar are you with the EASA guidelines for energy efficient rewinds?

        0 1 2 3 4 5 6 7 8 9 10

    b. [If Q7>0] Do you know which EASA Tech Notes relate to efficient rewinds?
        i. Yes.
        ii. Somewhat
        iii. No

            a. [If Yes or Somewhat, then prompt for a more detailed answer:]

    c. To the best of your knowledge, what are the major elements of the EASA guidelines?
    [Record open-ended response]

9. To clarify, EASA's Tech Note 16 recommends a variety of do's and don'ts for energy efficient rewinds.

    a. I am going to read a list of the EASA recommendations. Please let me know if you **R**outinely, **S**ometimes or **N**ever perform these actions [if respondent claimed in Q4 to do efficient rewinds (Q4=a or c), add:] when doing an energy efficient rewind.

        [Fill in the "Prompted" column in Table 2 above for practices employed by the service center. Do not read actions they already talked about unprompted from Question 5.]

    b. [Record comments on use of EASA practices from Question 8A]

    c. [If Q5 is answered] Earlier you mentioned that you consider about X% of your total rewinds in the Northwest to be "energy efficient" rewinds. On a scale of 0 to

10, **how compliant would you consider your typical "energy efficient" rewind to be?** In this case, 0 is "not at all compliant" and 10 is "totally compliant" with EASA guidelines.

a. 0 1 2 3 4 5 6 7 8 9 10

b. [If response similar to: "Don't have a "typical" energy efficient rewind. Depends on a variety of factors such as size and age of motor, what the motor is used for, and customer preferences." then ask:

i. Given that you estimated that approximately X% of your total rewinds in the Northwest may be considered energy efficient (Question 4), **can you estimate, on average, how compliant these rewinds are with EASA guidelines?** Again, I'm looking for a scale of 0 to 10, where 10 is maximum compliance with EASA guidelines.

a) 0 1 2 3 4 5 6 7 8 9 10

b) Don't know

ii. And when you intend to perform a truly energy efficient rewind, how **compliant would you say these rewinds are with EASA guidelines?** [Again on a scale of 0 to 10, where 10 is maximum compliance with EASA guidelines.]

1. 0 1 2 3 4 5 6 7 8 9 10

2. Don't know

c. Don't know

d. [Ff Q5 is answered, ask, "Out of all the "energy efficient rewinds that you perform",

Otherwise ask, "Out of all the rewinds that you perform"]
what percentage would you say are fully compliance with EASA Tech Note 16?
_____%

e. And how has your use of energy efficient rewinds changed over the past 3 years. In particular:
   i. Are you doing more energy efficient rewinds?
      1. Yes
      2. No
      3. Don't know

   ii. How are your practices changing to become more or less compliant with the EASA guidelines.?

   iii. What factors have led to these changes?

f. What are the main reasons that you perform standard, non-efficient rewinds? [Prompt: What reasons are cited by customers to opt for non-efficient rewinds?]

Market for Energy Efficient Rewinds

[Note: the next two questions may have been answered in the previous question. Use judgment in whether or not these next two questions are needed]

10. How has the general awareness of Energy Efficient rewinds among customers changed over the last three years? [prompt for responses]
    a. Increased significantly
    b. Increased somewhat
    c. No change
    d. Decreased somewhat
    e. Decreased significantly
    f. Don't know

[If changed]

i. What are the changes you have observed (Open Ended)?

ii. In your opinion, what are the reasons for this change in attitude towards energy efficient rewinds?

11. How has the general awareness of Energy Efficient rewinds among the motor service centers changed over the last three years?
    a. Increased significantly
    b. Increased somewhat
    c. No change
    d. Decreased somewhat
    e. Decreased significantly
    f. Don't know

[If changed]

i. What are the changes you have observed (Open Ended)?

ii. In your opinion, what are the reasons for this change in attitude towards energy efficient rewinds?

12. Regarding EASA Tech Note 16 guidelines, how familiar do you think the typical motor service center is about these guidelines?
    (0 to 10 where 0 is not at all and 10 is very familiar)

0 1 2 3 4 5 6 7 8 9 10

a. How has awareness of these guidelines among motor service centers changed over the past three years?
   i. Increased significantly
   ii. Increased somewhat
   iii. No change
   iv. Decreased somewhat
   v. Decreased significantly
   vi. Don't know

Drive Power Initiative

13. Prior to the call, how familiar were you with NEEA's Drive Power (Electric Motor Management) initiative?
   i. Not at all
   ii. Somewhat
   iii. Very

[If answer to the above is "not at all", then skip to Question 14. Else, ask following-]

a. Would the number of efficient rewinds being performed today be different without the Drive Power Initiative (Electric Motor Management)?
   i. Yes
   ii. No
   iii. Don't Know

b. What impact do you think the Initiative has had? [Probe for comments on question 11 A]

c. Would the number of efficient rewinds be increasing anyway due to other market forces?

   i. Increasing significantly
   ii. Increasing somewhat
   iii. No change
   iv. Decreasing somewhat
   v. Decreasing significantly
   vi. Don't know

d. [Probe for comments on Question 13C]

14. In your opinion, does an energy efficient rewind actually increase the efficiency of a motor relative to a "normal" rewind?
    i. Yes
    ii. No
    iii. Don't Know

    a. If answer is "YES", then to what degree [Probe for explanation]?

15. Do you have any other comments regarding the use of efficient rewinds?

16. [Other comments for NEEA or interview notes]

Thank you very much for participating in our survey. This information will help NEEA determine the ongoing impacts of the Drive Power Initiative.

Appendix C – ENERGY STAR Home Products

C.1 Current Practices in Tracking

RECOMMENDED MARKET AND BASELINE ACTIVITY USING CURRENT ACE MODEL METHODOLOGY

Table C-1 and Table C-2 report market activity using the methodology currently included in the ACE model.

Table C-1. Clothes Washer Unit Sales in the Northwest: Current Methodology

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
ENERGY STAR Market Share	8%	13%	12%	19%	21%	32%	43%	38%	46%	48%	44%	26%	26%
ENERGY STAR Units Sold	21,820	37,100	37,114	58,142	66,919	106,064	152,365	144,005	177,938	184,157	173,087	102,584	102,584
Tier 1 Market Penetration	8%	13%	12%	19%	21%	32%	43%	38%	46%	48%	44%	26%	26%
Tier 2 Market Penetration	5%	10%	11%	17%	20%	30%	41%	38%	46%	48%	44%	26%	26%
Tier 3 Market Penetration	-	-	-	-	-	-	10%	15%	24%	25%	44%	26%	0/26%
Tier 4 Market Penetration	-	-	-	-	-	-	-	-	-	-	19%	13%	11%

Source: Navigant Consulting analysis of ENERGY STAR data from http://www.energystar.gov/index.cfm?c=manuf_res.pt_appliances

and 2008 AHAM data provided by NEEA

Notes:

16. Market share for 2009 was assumed to be the same as for 2008.
17. Unit sales were estimated by multiplying the assumed market share by the total unit sales (based on AHAM data).
18. This table includes updates to the data included in the 2007-08 M&T report for 2006 and 2007 sales; these changes are based on the most current data reported for those years by AHAM and ENERGY STAR.

Table C-2. Clothes Washer: Baseline Activity in the Northwest: Current Methodology

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
ENERGY STAR Market Share	3%	4%	7%	8%	8%	13%	18%	27%	34%	38%	42%	24%	24%
Tier 1 Market Penetration	3%	4%	7%	8%	8%	13%	18%	27%	34%	38%	42%	24%	24%
Tier 2 Market Penetration	2%	3%	6%	7%	7%	12%	17%	27%	34%	38%	42%	24%	24%
Tier 3 Market Penetration	-	-	-	-	-	-	4%	11%	18%	20%	42%	24%	0/24%
Tier 4 Market Penetration	-	-	-	-	-	-	-	-	-	-	19%	13%	11%

Source: Navigant Consulting analysis of ENERGY STAR data from http://www.energystar.gov/index.cfm?c=manuf_res.pt_appliances and 2008 AHAM data provided by NEEA

Notes: Market share for 2009 was assumed to be the same as for 2008.

ALTERNATIVE: ADD A COLUMN DISPLAYING TOTAL ENERGY STAR MARKET SHARE

In the event that the recommendation to revise the tracking of market activity is not acted upon, the M&T team recommends adding a column in the ACE model that explicitly states the total penetration of ENERGY STAR clothes washers. This approach would also enhance transparency by providing a concrete fact to check against ENERGY STAR penetration data, as reported by the ENERGY STAR program. It would also make it easier to understand the distribution of sales across the tiers.

This addresses a current shortcoming in the model in which market penetration of ENERGY STAR clothes washers is sometimes over-reported. For example, in 2007, the total ENERGY STAR penetration for clothes washers was 44.5%. Yet, the ACE model reports that Tier 3 penetration was 92%, which likely reflects the share of incentives awarded in the region for purchases of clothes washers in Tier 3 and Tier 4. It is likely that 92% of the 44.5% of ENERGY STAR models sold in the region were in Tiers 3 or 4, but the model does not currently reflect that.

C.2 Relevance of Findings of Audits of ENERGY STAR to NEEA Savings Estimates

Each of the four government reports that examined the credibility of the ENERGY STAR program outlined a concrete set of shortcomings. This appendix briefly examines the shortcomings examined in each report and explores their relevance to NEEA's savings estimates.

One important fact: clothes washers, dishwashers, and refrigerators are all included in DOE's ENERGY STAR program. EPA's ENERGY STAR program includes a host of other products but not any of the products included in NEEA's ESHP program.

Table C-3. Summary of Findings from 2007 GAO Report and Relevance to ESHP

Finding	Relevance to NEEA		Recommended Action for M&T
	Relevance for ESHP Products	Effect on Per-Unit Energy Savings	
ENERGY STAR criteria for some products are based on something other than total annual power consumption.	This was not the case for any of the ESHP appliances.	This would not affect per-unit energy savings, only customer understanding of ENERGY STAR.	No adjustment to savings needed.
DOE relies mostly on manufacturers' self-reporting of energy savings and policing by competitors to identify false claims.	All of the ESHP appliances are subject to some market assessment (a form of verification) by EPA, which provides moderate protection against false claims.[a] The 2007 report documented two cases in which energy savings for clothes washers were mis-labeled.	Widespread failures may affect actual savings achieved in the field, but documentation is insufficient to determine the extent to which this is occurring.	No changes recommended for current M&T cycle. Monitor progress during next M&T cycle to determine if adjustments are appropriate.
Computerized controls in some appliances may be able to detect test setting and reduce energy use under these circumstances in order to meet ENERGY STAR criteria.	This was raised as a concern with a refrigerator model.	Widespread gaming of the testing protocols may affect actual savings achieved in the field, but documentation is insufficient to determine the extent to which this is occurring.	No changes recommended for current M&T cycle. Monitor progress during next M&T cycle to determine if adjustments are appropriate.

Source: U.S. Government Accountability Office (GAO). September 2007. *Energy Efficiency: Opportunities Exist for Federal Agencies to Better Inform Household Consumers.* GAO-07-1162.

Note: [a] The report found some deficiency with EPA's market assessment procedures but did not quantify the extent to which the shortcomings affect performance in the field.

Table C-4. Summary of Findings from 2008 EPA Inspector General's Report and Relevance to ESHP

Finding	Relevance to NEEA		Recommended Action for M&T
	Relevance for ESHP Products	Effect on Per-Unit Energy Savings	
The 2008 EPA Inspector General report focused on issues encountered with ENERGY STAR programs administered by EPA.	ESHP products are administered by DOE, not EPA. Therefore, the results of this report were not relevant for NEEA.	No effect.	No adjustment to savings needed.

Source: U.S. Environmental Protection Agency (EPA) Office of Inspector General. December 2008. *Evaluation Report: Improvements Needed to Validate Reported ENERGY STAR Benefits.* 09-P-0061.

Table C-5. Summary of Findings from 2009 DOE Inspector General's Report and Relevance to ESHP

Finding	Relevance to NEEA		Recommended Action for M&T
	Relevance for ESHP Products	Effect on Per-Unit Energy Savings	
DOE had not yet established a formal quality assurance program to ensure adherence to specifications	This became a visible issue for refrigerators when 21 LG models were removed from the ENERGY STAR list because they failed to meet ENERGY STAR specifications.[b]	Widespread failures may affect actual savings achieved in the field, but documentation is insufficient to determine the extent to which this is occurring.	No changes recommended for current M&T cycle. Monitor progress during next M&T cycle to determine if adjustments are appropriate.
DOE had not improved its monitoring of the use of the ENERGY STAR label	The report cited four refrigerator models that had been mis-labeled, but the issue had not been resolved as of the time of the report.	Widespread mis-use of the label may affect actual savings achieved in the field, but documentation is insufficient to determine the extent to which this is occurring.	No changes recommended for current M&T cycle. Monitor progress during next M&T cycle to determine if adjustments are appropriate.
DOE had not yet formalized procedures for establishing and revising product specifications and for documenting related decisions	Dishwashers were one of the products whose specifications were noted as in need of update. The update for dishwashers took effect in 2009.	None. NEEA should continue to account for savings related to the sales of ENERGY STAR products in the region, regardless of the rigor of the criteria.	No action needed.

Source: U.S. Department of Energy (DOE) Office of Inspector General Office of Audit Services. October 2009. *Audit Report: The Department's Management of the ENERGY STAR Program.* DOE/IG-0827.

Note: [b] Source: ENERGY STAR. January 20, 2010. "ENERGY STAR Removed from 21 LG Refrigerator Models."

Table C-6. Summary of Findings from 2010 GAO Report and Relevance to ESHP

Finding	Relevance to NEEA		Recommended Action for M&T
	Relevance for ESHP Products	Effect on Per-Unit Energy Savings	
ENERGY STAR's controls for preventing fraudulent use of the ENERGY STAR label were ineffective.	The audit team was able to secure ENERGY STAR qualification for 15 bogus products, including a clothes washer, dishwasher, and refrigerator.	If the current portfolio of ENERGY STAR-approved products includes as many false claims, energy savings could be significantly affected. However, as with the claims in previous reports, documentation is insufficient to determine the extent to which this is occurring. It could be as little as 1% of unit sales or as high as 100%.	No changes recommended for current M&T cycle. Monitor progress during next M&T cycle to determine if adjustments are appropriate.

Source: U.S. Government Accountability Office (GAO). March 2010. *ENERGY STAR Program: Covert Testing Shows the ENERGY STAR Program Certification Process is Vulnerable to Fraud and Abuse.* GAO-10-470.

The overall finding from this analysis is that sufficient evidence does not exist to warrant reductions to NEEA's energy savings *at this time*. NEEA and the M&T team should continue to monitor additional findings related to these issues. If further research is conducted to quantify the extent to which these shortcomings have resulted in energy savings that are less than the test results claim, then NEEA should consider reducing the per-unit energy savings appropriately. Depending on the findings, those reductions may be taken in future years only or may be applied retroactively. If no further research is conducted to quantify the extent to which these shortcomings affect energy savings, NEEA may either let the matter rest or may ask a future M&T team to conduct additional primary research to get a ballpark estimate of the effect; due to anticipated budget and timing constraints, it is likely that the M&T team would only be able to conduct high-level research, such as interviews with ENERGY STAR program staff, other experts in the field, or trade associations.

Appendix D –ENERGY STAR Windows

This chapter presents tables showing market activity for all years tracked. Similar tables are presented in section 2.3.1, but only for activity for 2007 through 2009.

Table D-1. Fenestration Products Shipped in the Northwest from 2001-2009 (thousands)

Year	New Construction			Existing Homes		
	Windows	*Skylights*	*Patio Doors*	*Windows*	*Skylights*	*Patio Doors*
1997-2000	Data Not Available[130]					
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	1,158	39	92	1,630	46	116
2005	1,257	39	97	1,661	43	119
2006	1,139	33	88	1,634	42	116
2007	999	29	79	1,534	39	109
2008	667	19	53	1,378	30	97
2009	387	11	31	1,200	25	85
Source: Summit Blue analysis of Ducker Research market reports (2004 and 2007and 2008)						

[130] 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 M&T project team.

Table D-2. Total Area of Windows Shipped in the Northwest from 1997-2009 (thousand square feet)

	New Construction	Existing Homes	Total
1997	*	*	48,709
1998	*	*	48,709
1999	*	*	48,709
2000	*	*	48,709
2001	22,316	26,053	48,369
2002	21,533	27,494	49,027
2003	21,046	29,048	50,094
2004	23,913	29,083	52,996
2005	21,385	28,631	50,015
2006	20,225	27,079	47,304
2007	18,427	24,673	43,100
2008	14,662	19,633	34,295
2009	11,171	14,958	26,130
Total	*	*	***596,166***

Source: Summit Blue calculations of data in Table 6-1 and assumptions regarding average area per window

* Data disaggregated by vintage was not available to the M&T project team for 1997-2000.

Table D-3. Market Share of ENERGY STAR Windows Shipped in the Northwest from 1997-2009

	ENERGY STAR Market Share (%)	New Construction (sqft x 1,000)	Existing Homes (sqft x 1,000)	Total (sqft x 1,000)
1997	13%	*	*	6,218
1998	41%	*	*	19,971
1999	47%	*	*	22,893
2000	54%	*	*	26,303
2001	75%	16,737	19,540	36,277
2002	81%	17,442	22,270	39,712
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%	18,809	25,184	43,993
2007	95%	17,505	23,439	40,945
2008	95%	13,929	18,651	32,580
2009	95%	10,613	14,210	24,823
Total		*	*	***430,477***

Source: Summit Blue analysis of interview data applied to gross window areas from Table 6-2

* Data broken out by vintage was not available to the M&T project team for 1997-2000.

Table D-4. Area of Windows Shipped to Homes with Electric Space Heating from 2001-2009 (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	1,518	4,897	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	1,720	2,837	1,706	6,312	3,016	1,664
2007	1,601	2,641	1,588	5,875	2,807	1,549
2008	1,274	2,101	1,264	4,675	2,234	1,233
2009	970	1,601	963	3,562	1,702	939

Source: Summit Blue analysis of Ducker Research market reports (2004, 2007 and 2009) and data from the NW Council

* Data broken out by vintage was not available to the M&T project team for 1997-2000.

Table D-5. Area of Windows Shipped to Homes with Gas Space Heating from 2001-2009 (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	1,701	253	8,014	285	138
2002	9,354	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	10,088	1,912	284	10,329	367	178
2007	9,389	1,779	265	9,613	341	166
2008	7,471	1,416	211	7,649	272	132
2009	5,692	1,079	160	5,828	207	101

Source: Summit Blue analysis of Ducker Research market reports (2004,2007 and 2009) and data from the NW Council

* Data broken out by vintage was not available to the M&T project team for 1997-2000.

Table D-6. Area of Windows Shipped to Homes with Central Air Conditioning from 2001-2009 (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	1,170	785	3,824	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	5,009	1,262	846	4,325	408	494
2007	4,662	1,175	787	4,025	379	460
2008	3,710	935	627	3,203	302	366
2009	2,826	712	477	2,440	230	279

Source: Summit Blue analysis of Ducker Research market reports (2004.2007 and 2009) and data from the NW Council

* Data broken out by vintage was not available to the M&T project team for 1997-2000.

Appendix E – Evaporator Fan VFDs

E.1 Detailed Methodology

Developing the Survey Sample

The USDA report *Capacity of Refrigerated Warehouses: 2009 Summary* specifies the storage volume and number of facilities by state for general refrigerated-only cold storage, refrigerated-only fruit cold storage, and controlled atmosphere (CA) fruit storage. Relevant data from the USDA report are presented in Table E-1. and used in this M&T work as indicative of the characteristics and size of the population of refrigerated warehouses in the Northwest.

Table E-1.. Refrigerated Warehouse Volume in the Northwest (million cubic feet)

State	General Cold Storage	Fruit Storage		Total All Refrigerated Warehouses
	Refrigerated-Only	*Refrigerated-Only*	*CA*	
Idaho	60.2	2.0	1.5	***63.6***
Montana	1.0	0.0	0.0	***1.0***
Oregon	127.0	32.8	17.4	***177.3***
Washington	194.5	116.5	311.9	***623.0***
Total	**382.8**	**151.3**	**330.8**	**864.9**
	534.1			

* Not published to avoid disclosure of individual operations. Included in totals.

Source: USDA, National Agricultural Statistics Service, Capacity of Refrigerated Warehouses, 2009 Summary, January 2010

As compared to the 2007 USDA report, the total storage volumes reported in the 2009 USDA report decreased by 4% in the Northwest. This net decrease reflects an increase of 7% in general cold storage facilities and an 11% decrease in both the refrigerated-only and CA capacities of fruit storage facilities. Follow-up correspondence with the USDA indicates that the USDA reports a conservative estimate of refrigerated warehouse capacity, based on a monthly cold storage survey of *long-term facilities* (i.e., facilities that store product for longer than 30 days per year). As a result, the USDA report does not include facilities with *short-term* storage, such

as import/export facilities, distribution centers, some production facilities, and some fruit storage facilities that store product for less than 30 days in a year.

The USDA's survey of long-term facilities is also a conservative representation of the population, since not all facilities report to the USDA through the monthly survey. To address this, the USDA supplements the survey with other data sources, such as the International Association of Refrigerated Warehouses directory. The USDA cites a majority of the increase in reporting of refrigerated warehouse facilities between 2007 and 2009 to development of a more comprehensive list of facilities, but does not have information available on the magnitude of that increase or affected regions. While other resources list warehouse demographics, the biennial USDA report is the most comprehensive report available on warehouse capacity.

In light of this information, the 2009 M&T team determined that the USDA report continues to be the most appropriate source of market data available for the M&T efforts, and likely portrays a conservative view of the market. To develop the interview and survey samples for the 2009 M&T report, the M&T team used the database of refrigerated warehouses compiled for the 2007 M&T report. This database contains contact information for about 310 refrigerated warehouse locations in the Northwest, representing about 260 unique companies. Minimal changes were made to the 2007 database prior to the 2009 M&T efforts.

As part of the 2009 M&T efforts, the project team deployed a combination of web surveys and phone surveys to update the assumed average hours of operation for VFDs on evaporator fans and current level of market activity in cold storage warehouses and controlled atmosphere rooms. The sample frame consisted of refrigerated warehouse facilities in the Northwest for which contact information was available. The 2009 project team completed a total of 31 surveys to mirror the 2007 target sample size and to meet the following M&T objectives:

- Invite respondents from the 2007 M&T effort to participate in the 2009 survey to augment the information collected in 2007 and provide an opportunity to assess whether significant changes had occurred at the facility. Fifteen of the facilities contacted in 2007 responded again in 2009.
    - Nine of these respondents were asked the survey questions *and* two to five additional follow-up questions on some of the interesting results from the 2007 interviews (e.g., where a facility intended to install VFDs, but had not yet done so). The M&T team interviewer asked these questions to solicit high-level indications of changes to market and baseline activity.
- Maximize distribution of the survey by deploying an internet-based survey via email, in addition to conducting the phone surveys. Around 70 facilities in the refrigerated warehouse database had email addresses listed—these facilities were automatically included in the survey sample. About two-thirds of these email addresses came from the

International Association of Refrigerated Warehouses,[131] about a quarter came from the Washington State Department of Agriculture,[132] and the remainder came from yellow pages listings and other sources leveraged for the 2007 M&T.

» Contact a representative sample of facilities by state and facility type. This was achieved by randomly calling facilities that had not been previously contacted in 2007 nor had valid email addresses. These sixteen facilities also helped broaden the breadth of respondents and diversify the sample (beyond the 30 sampled in 2007). As shown in Table E-2, the final sample proportions roughly reflect the states and facility types across the entire population, according to USDA data (and survey findings were extrapolated based on the population by facility type).

Since fifteen facilities were contacted in 2009 on a selective basis (i.e., they had participated in the 2007 surveys), the results presented for this year's M&T combine the 2007 and 2009 samples to avoid sampling bias and present a fully random sample. To this end, the 2009 M&T results for market activity are based on 15 facilities contacted in 2007, 16 facilities contacted in 2009, and 15 facilities contacted in both 2007 and 2009, for a total of 46 unique facilities. Per-unit energy savings results are only reported for 2009 respondents, since this was not part of the 2007 efforts. Table E-2 shows the combined sample by state and facility type.

Table E-2. 2009 M&T Survey Sample by State and Facility Type*

State	General Refrigerated-Only Storage	Fruit Refrigerated-Only Storage	Fruit CA Storage	Total All Refrigerated Warehouses
Idaho	4	-	-	**4**
Montana	-	-	-	**0**
Oregon	5	3	2	**8**
Washington	12	18	19	**34**
Total	**21**	**21**	**21**	**46** **unique facilities****

*The sample for the 2009 M&T consists of the 30 surveys completed in 2007 and 31 surveys completed in 2009. Fifteen facilities occurred in both the 2007 and 2009 survey samples.

**The total number of respondents by warehouse type does not sum to 46, since 17 fruit facilities had both controlled atmosphere storage and refrigerated-only storage.

Source: Navigant Consulting analysis based on refrigerated warehouse facility data in Table E-1..

[131] International Association of Refrigerated Warehouses Directory of Public Warehouses, http://www.iarw.org/directory/

[132] Faxed list of licensed CA facilities, Washington State Department of Agriculture

Constructing the Survey Instrument

The primary goal of the 2009 survey was to determine the average number of operating hours of an evaporator fan in a year, with a secondary quantitative goal of updating the proportion of refrigerated warehouse capacity in the Northwest currently using evaporator fan VFDs. To achieve the former goal, survey participants were asked to provide the average number of days[133] they stored product in their controlled atmosphere rooms or refrigerated-only cold storage rooms. To achieve the latter goal, the survey asked the same questions asked in 2007 with regards to capacity (volume) of each storage type and the proportion of each storage type that was served with evaporator fan VFDs. The survey instrument can be found in Section 0.

An additional qualitative goal of the 2009 M&T research was to identify recent high-level changes in market or baseline activity through open-ended survey questions and more in-depth follow-up interviews with 2007 respondents. While the quantitative findings from the 2009 M&T research provided sufficient detail for updating market activity, these qualitative findings may be useful in future M&T updates for benchmarking baseline activity, as discussed in Section 7.3.3. Section 0 provides the questions asked in the follow-up interviews as a supplement to this report.

E.2 Data Collection Instruments and Verbatims

Survey Instrument

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, the 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. The survey is part of the evaluation of NEEA's initiative promoting variable frequency drives (VFDs) for evaporator fans, and it will inform NEEA about how VFDs are used in refrigerated storage in the Northwest. Your input will help NEEA determine the overall energy efficiency benefits associated with evaporator fan VFDs. Your information will be treated confidentially and your responses will not be associated with your name or organization in any report.

This survey will take no more than 5-10 minutes and contains approximately 10 questions (depending on your initial answers). Even if you do not have any VFDs on the evaporator fans in your facility, we are still interested in your responses.

If your company has multiple facilities, please answer the following questions for the facility with which you are most familiar.

[133] The "number of storage days" is used interchangeably with "operating hours" here, since it is assumed that the operating hours are approximately equivalent to 24 Hours x Number of Storage Days, unless noted otherwise.

General Information

In which state is this facility located?

What type (or types) of product is stored at this facility?

Is your facility public or private? (If both, is it primarily public or private?)

Does this facility have controlled atmosphere* rooms?

**Controlled atmosphere rooms are defined as sealed cooler space in which the oxygen and carbon dioxide content is controlled to extend the storage life of apples or pears.*

Controlled Atmosphere Rooms

What is the total capacity of your controlled atmosphere rooms at this facility? (in cubic feet, bushels, boxes, or bins)

Do you use VFDs to control the evaporator fans in your controlled atmosphere rooms? [IF NO, SKIP TO COLD STORAGE WAREHOUSES]

Controlled Atmosphere Rooms - With VFDs

What percentage of your controlled atmosphere capacity uses VFDs to control its evaporator fans?

For your controlled atmosphere rooms with evaporator fan VFDs: What is the total number of storage days in an average year (not including loading and unloading days)?

How confident are you in the accuracy of these answers (within +/- 10%)?

1) Very confident

2) Fairly confident

3) Somewhat confident

In general, do you operate your controlled atmosphere rooms with evaporator fan VFDs the same as the ones without VFDs? [IF YES, SKIP TO COLD STORAGE WAREHOUSES]

Controlled Atmosphere Rooms - Without VFDs

For your controlled atmosphere rooms without evaporator fan VFDs: What is the total number of storage days in an average year (not including loading and unloading days)?

How confident are you in the accuracy of these answers (within +/- 10%)?

1) Very confident

2) Fairly confident

3) Somewhat confident

Cold Storage Warehouses

Does this facility have cold storage warehouses? [IF NO, SKIP TO WRAP-UP]

What is the total capacity of your cold storage warehouses at this facility? (in cubic feet, bushels, boxes, or bins)

Do you use any VFDs to control the evaporator fans in your cold storage warehouses?

Cold Storage Warehouses - With VFDs

What percentage of your cold storage capacity uses VFDs to control its evaporator fans?

For your cold storage warehouses with evaporator fan VFDs: What is the average number of days per year that you maintain the temperature* in the warehouse?

**If warehouse is a cooler space, "temperature maintained" between 0 and 50 degrees Fahrenheit*

**If warehouse is a freezer space, "temperature maintained" at 0 degrees Fahrenheit or below*

How confident are you in the accuracy of this answer (within +/- 10%)?

1) Very confident

2) Fairly confident

3) Somewhat confident

In general, do you operate your cold storage warehouses with evaporator fan VFDs the same as the ones without VFDs? [IF YES, SKIP TO WRAP-UP]

Cold Storage Warehouses - Without VFDs

For your cold storage warehouses without evaporator fan VFDs: What is the average number of days per year that you maintain the temperature* in the warehouse?

**If warehouse is a cooler space, "temperature maintained" between 0 and 50 degrees Fahrenheit*

**If warehouse is a freezer space, "temperature maintained" at 0 degrees Fahrenheit or below*

How confident are you in the accuracy of this answer (within +/- 10%)?

1) Very confident

2) Fairly confident

3) Somewhat confident\

Wrap-Up

Within the past five years or so, have you noticed any changes in the number of VFDs being installed in your region or how they are being used on evaporator fans in refrigerated warehouses? If yes, what are those changes and what do you think is causing them?

Do you have any additional comments or observations that you would like to share about the market for evaporator fan VFDs in the Northwest?

Do you have any comments about this survey and how it could be improved to provide better information or to make it easier to complete?

Please provide the following information about yourself and your company (optional):

Name:

Position:

Company:

We conduct evaluations for NEEA on evaporator fan VFDs every other year. This research helps NEEA improve regional energy efficiency, which provides economic and energy savings benefits to the Northwest. Would you be willing to participate in future research regarding evaporator fan VFDs? If so, please provide the best contact information with which to reach you. We will not release this information or use it for any other purpose. (optional)

Phone:

Email:

Thank you very much for your time. If you would like more information about variable frequency drives and other energy efficient technologies, you can visit http://www.nwalliance.org/ourwork/industrial.aspx.

Follow-Up Interview Questions

To provide additional qualitative information about recent changes to the evaporator fan VFD market, nine facilities were asked the questions listed below, in addition to the survey questions. These facilities were selected based on their responses in 2007 that they were either considering changes to their facility's capacity, considering installing evaporator fan VFDs, or had opportunities to install VFDs at their facility but were not considering VFDs in 2007.

Depending on the 2007 responses, each facility was asked an appropriate subset of the following questions:

In 2007, you mentioned that you were considering [a retrofit project / new construction].

- What changes have you made in your facility since that time?
- Have any of these changes involved the installation of evaporator fan VFDs?
    - [If yes:] How much additional capacity now has evaporator fan VFDs installed?
- Do you have any additional plans for other upgrades, going forward?
    - [If not already answered:] Are you considering installing evaporator fan VFDs?
        - [If no:] What are the barriers preventing you from doing so?

In 2007, you indicated that you were [not using VFDs / only using VFDs in a portion of your facility].

- Is that still true?
- Do you have any plans to install evaporator fan VFDs as retrofits or in new capacity in the future?
    - [If no:] What are the barriers preventing you from doing so?

Selected Responses from Open-Ended Questions

"…there was a big push a few years ago, but hasn't seen much more going on lately."

"…has noticed an increase in the local area market. Got them for energy efficiency."

"…absolutely have noticed increase in energy efficiency measures, especially with VFDs."

"…seems like new construction is using them now and a big movement for energy efficiency…"

"All new storages are getting VFDs due to energy efficiency. Considering eventually installing VFDs on those that do not have it…"

"I hear more about them. The biggest change now is that if you're installing a new motor, you purchase a high efficiency VFD-capable motors."

"I think a lot of people have changed over for the electrical savings and PPL has incentives, so I think most of the facilities have changed over."

"…I have noticed how much they are going in. Causes: power consumption and money coming from the utilities, savings."

"…We have since opened a new company and location…it is a CA only plant with 14 rooms, all use VFD fans due to the proven capability from the first…location. If you know of or find out about any rebates or incentives for this, I would like to know; to date we have received no assistance (rebates or incentives) for this new project."

"…we're building new controlled atmosphere space, through REA applied for incentives."

"Biggest barrier to installing more VFDs is upfront cost, but nice that they have rebates on those."

"…we've built 24 CA rooms in past few years and refrigeration people we do business with said that's the way to go."

Appendix F – Verdiem

F.1 Companies Currently Included in ENERGY STAR's List of Commercial Providers of Network Energy Management Software

Table F-1. Companies Currently Included in List of Commercial Provicers

Company	Product
1E	Nightwatchman, Wakeup
Absolute (formerly LANrev)	Absolute Manage
Adaptiva	Companion
Apple	Remote Desktop
Avocent	LANDesk Management Suite
BigFix	Power Management
Centurion Technologies	Energy Saver
EDU Business Solutions	Energy Saver Pro
Enterprise Infrastructure Partners	eiPower Saver
Faronics	PowerSave
Intel	vPro
Kaseya	User State Management
KBOX	Systems Management Appliances
Lakeside Software, Inc.	SysTrack Power Management
Lightspeed Systems	Power Manager
Numara Software	Power Manager
ScriptLogic	Desktop Authority
SyAM	System Area Manager
Symantec	Altiris with Power Saver Plug-in
Triumfant	Green IT Power Management
Verdiem	Surveyor
Verismic	Power Manager
Source: ENERGY STAR, http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_comm_packages	

F.2 Accounting for Retirements in Energy Savings Calculations

The M&T team recommends revisiting how the calculation of energy savings in the ACE model considers retirements. The main concern about the current model is that the per-unit energy savings values used are not reflective of the actual fleet of products in the market. The per-unit energy savings for products sold in a given year is currently applied to all units, including both retirements and new market activity. This is not accurate for years in which the energy savings realized by new units sold are different than the energy savings realized by units being retired. The current model uses the following calculation for a given year's incremental energy savings is captured in Equation 1.

Equation 1. Current Calculation for Energy Savings in a Given Year

$$Net\ Market\ Effects\ Energy\ Savings_i = ((Market\ Activity_i - Retirements_{MA\,(i-5)}) - (Baseline\ Activity_i - Retirements_{B\,(i-5)})) * Energy\ Savings\ Per\ Unit_i$$

where
i = The year in which the calculation is made
MA = Market Activity
B = Baseline Activity

Instead, energy savings associated with retirements should reflect the actual performance of the units that are anticipated to be retired. The current model structure assumes that the units sold through new market activity save the same amount of energy as the units being retired, but that is not actually the case. Since the per-unit energy savings was increased from 125 kWh/year to 190 kWh/year in 2006, units that were retired in 2006-2010 have different energy-saving characteristics than the new units being added through a given year's market activity. In other words, the equation a given year's incremental energy savings should be as shown in Equation 2.

Equation 2. Suggested Calculation for Calculating Energy Savings in a Given Year

$$Net\ Market\ Effects\ Energy\ Savings_i = (Market\ Activity_i - Baseline\ Activity_i) * Energy\ Savings\ Per\ Unit_i - (Retirements_{MA\,(i-5)} - Retirements_{B\,(i-5)}) * Energy\ Savings\ Per\ Unit_{(i-5)}$$

Section 8.6 includes a suggested format for presenting this information in the ACE Model to more clearly present the information needed to perform this calculation.

Table F-2. Sample Format for SavingsTracker spreadsheet in Network Energy Management Software ACE Model

	Incremental					Retirements				Cumulative			
Year	Market Activity	Baseline (%)	Baseline (Units)	Energy Savings Per Unit (ESPU) (kWh/yr)	aMW	Retirements (Market Activity)	Retirements (Baseline)	Energy Savings Per Unit (kWh/year)	aMW from Retirements	Market Activity	Baseline	Per-Unit Energy Savings#	aMW
2001	10	10%	1	125	0.0	0	0		0.0	10	1	125	0.0
2002	1,546	10%	155	125	0.0	0	0		0.0	1,556	156	125	0.0
2003	22,500	10%	2,250	125	0.3	0	0		0.0	24,056	2,406	125	0.3
2004	24,100	10%	2,410	125	0.3	0	0		0.0	48,156	4,816	125	0.6
2005	7,900	10%	790	125	0.1	0	0		0.0	56,056	5,606	125	0.7
2006	500	10%	50	190	0.0	-10	-1	125	0.0	56,546	5,655	126	0.7
2007	26,150	10%	2,615	190	0.5	-1,546	-155	125	0.0	81,150	8,115	146	1.2
2008	52,887	50%	26,444	190	0.6	-22,500	-2,250	125	-0.3	111,537	32,309	166	1.5
2009	38,239	50%	19,120	190	0.4	-24,100	-2,410	125	-0.3	125,676	49,018	184	1.6