Long Term Monitoring and Tracking Report on 2008 Activities

PREPARED BY

Summit Blue Consulting, LLC

REPORT #E09-207
JULY 8, 2008

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LONG TERM MONITORING AND TRACKING REPORT ON 2008 ACTIVITIES

Submitted to:

Northwest Energy Efficiency Alliance

July 8, 2008

SUMMIT BLUE
CONSULTING, LLC

FINAL REPORT

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E. 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 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.

The 2008 M&T effort reviewed four NEEA initiatives, all of which were updates to previous M&T assessment. These four initiatives include the following (in order of greatest aMW saved in 2008):

1. Building Operator Certification
2. MagnaDrive
3. Drive Power Initiative
4. BacGen

Summit Blue developed a work plan for each M&T initiative under review for 2008, and these were provided to NEEA's M&T project manager for review in the fall of 2008. Data collection and analysis began shortly thereafter. For each initiative, the M&T project team focused on tracking activity in the market, critically examining NEEA's baseline assumptions (to varying degrees, depending on the initiative and past M&T efforts), and assessing energy savings. Sections 2 through 5 of this report present background, methodologies, findings, and recommendations for each NEEA initiative in the order listed above.

E.1 Results by Initiative

This section provides a brief summary of findings for each of the four initiatives reviewed as part of the 2008 M&T effort. Energy savings are calculated as the product of 1) market activity in excess of baseline activity and 2) per-unit energy savings. Savings values are described as "implied energy savings" since NEEA's actual savings estimates may be adjusted for the effects of utility incentives and other factors not taken into account in this M&T analysis.

Of the four initiatives assessed in the 2008 M&T, Building Operator Certification represents the greatest annual savings, at 12.6 aMW (down from an estimated of 14.4 aMW in 2007, as discussed in Chapter 2). The other initiatives all show increased energy savings in 2008 relative to previous years. Across the four initiatives, 2008 savings are estimated to be 26.9 aMW, an increase of 1.9 aMW over previous estimates (Table E-1).[1]

[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.

Table E- 1. Implied Energy Savings from the 2008 M&T Assessment (aMW)*

Initiative	2007 NEEA Cumulative Value*	2008 Recommended Cumulative Values	Change from 2007
BOC	14.4	12.6	-1.8
MagnaDrive	5.7	6.8	1.1
Drive Power	2.2	4.6	2.4
BacGen	2.7	2.9	0.2
TOTAL	**25.0**	**26.9**	**1.9**

* Implied Energy Savings represent estimated savings from market activity less estimated savings from baseline activity. Implied Energy Savings are presented for comparison purposes only between NEEA's 2007 values and the 2008 M&T findings. 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.

A summary of findings for each of the four initiatives is as follows:

Building Operator Certification

Building Operator Certification was awarded to 175 operators in 2008, with approximately 80% of the activity being conducted through the Northwest Energy Efficiency Council (NEEC). Due to the fact that some operators certified more than five years ago have not renewed their certifications (and are thus considered "retired"), the number of certified building operators in the Northwest increased in 2008 by 74, for an increase of 8% over 2007.

Despite the continued increase in certifications, the implied energy savings dropped by approximately 12% from 2007 to 2008, to 12.6aMW. The major reason for this decline in estimated savings is the rigorous analysis of the square footage data conducted for this M&T analysis, which suggested that the square footage managed by each certified operator is 20% lower than previously estimated. This resulted in a savings estimate of approximately 114,000 kWh per year for each certified operator.

MagnaDrive

NEEA's partnership with MagnaDrive Corporation was intended to accelerate the development and commercialization of MagnaDrive's proprietary adjustable-speed drive (ASD) for motors. Early support of the MagnaDrive technology has provided a significant boost for it in all geographic areas, although the Northwest is lagging behind many other areas in MagnaDrive adoption. In recent years, couplings using the MagnaDrive technology have become a major portion of savings.

Sales of ASDs in 2008 (3,086 hp) are significantly lower than in previous years. However, coupling sales, which were not tracked prior to 2008, have increased (more than 6,660 hp in 2008) to the point that their inclusion in savings estimates is warranted. A small increase in per-unit ASD savings is recommended based on 2008 sales data, and a value for coupling savings is conservatively estimated at approximately half the per-unit savings of ASDs. The result is an increase in cumulative savings from 2007 to 2008 of approximately 1.1 aMW, for a cumulative savings in 2008 of 6.8 aMW.

Drive Power

NEEA initiatives focusing on motors have led to a significant market transformation in the Northwest. The sale of NEMA Premium ™ motors has increased more than six-fold since 2001, and *regional growth in sales of premium efficiency motors has been at approximately 26% per year, versus 20% nationally*. Through 2008, estimated sales of NEMA Premium™ motors in the Northwest had reached more than 200,000 units. Baseline sales are estimated at approximately 142,000, nearly 70% of the total market activity. The cumulative energy savings implied by these figures is 4.6 aMW in 2008—more than double the 2.2 aMW estimated in 2007.

The estimated 4.6 aMW of energy savings are only due to *replacement* of standard efficiency motors by NEMA Premium™ motors. Savings from efficient *rewinds* may be significant, but they are more uncertain, and are addressed in an appendix to the Drive Power chapter.

BacGen

The NEEA initiative operated through BacGen Technologies aimed to reduce the energy consumption of small- to medium-sized wastewater treatment facilities by focusing exclusively on optimizing the wastewater treatment process at these smaller facilities. BacGen continues to perform wastewater optimization projects in the Northwest, although at a slower pace than in previous years. The market is slowly maturing but shows little indication of a major transformation. The three wastewater optimization projects completed in the Northwest in 2007-2008 represented a gross design capacity of 10.5 MGD and a 0.2 aMW increase (to 2.9 aMW) in the implied energy savings for 2008.

E.2 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 2008-2010 is shown in Table E-2, along with the M&T assessments from the past four years. The list of initiatives to have reviews conducted for 2009 will be discussed with the NEEA project manager and reviewed by the Cost-effectiveness Committee of the NEEA Board before the 2009 plan is finalized.

Table E- 2. Timeline for Conducting / Updating Long-Term Monitoring & Tracking

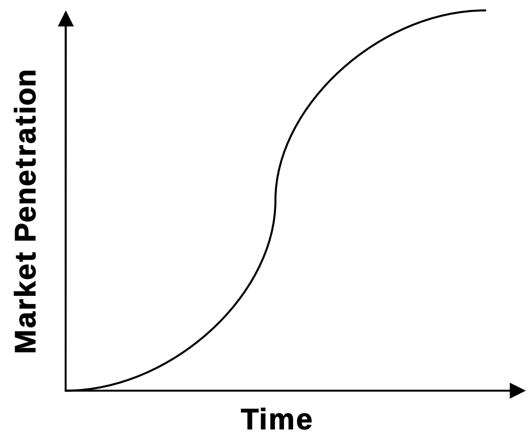
INITIATIVE	2005	2006	2007	2008	2009	2010
Energy Star Residential Windows	C		U		U	
Building Operator Certification (BOC)	C		U	U	U	
SAV-AIR	C	U		2008 M&T cancelled		
Just Enough Air	C	M&T Discontinued				
Evaporator Fan VFDs	C	U	U		U	
Siemens (Shell Solar)	C	U	U	Assess need annually		
BacGen	C	U		U		U*
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	
Optichill (Microelectronics)			C	Recommended to discontinue		
SIS/AM400		C	U	Recommended to discontinue		

NOTES: C = Conduct initial analysis; U = Update to initial analysis; U* = Need for update to be assessed

Shaded rows are initiatives addressed in this 2008 M&T report

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) 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 2008 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 for Initiative Year 2008

The 2008 M&T effort reviewed four NEEA initiatives, all of which were updates to previous M&T assessment. These four initiatives include the following (in order of greatest aMW saved in 2008):

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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 2008-2010 is shown in Table 1-1, along with the M&T assessments from the past four years. The list of initiatives to have reviews conducted for 2009 will be discussed with the NEEA project manager and reviewed by the Cost-effectiveness Committee of the NEEA Board before the 2009 plan is finalized.

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

INITIATIVE	2005	2006	2007	2008	2009	2010
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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	
Optichill (Microelectronics)			C	Recommended to discontinue		
SIS/AM400		C	U	Recommended to discontinue		

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2 BUILDING OPERATOR CERTIFICATION

Building Operator Certification (BOC), which was funded by NEEA from 1997 through 2003, was offered as a professional development initiative 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 *without* NEEA assistance through the Northwest Energy Efficiency Council (NEEC) and the International Building Operators Association (IBOA, formerly the Northwest Building Operators Association, NWBOA). The initiative 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 is intended to assess the current state of the market for certified building operators, including the following:

- Obtaining 2008 BOC tracking database updates directly from NEEC and IBOA for integration into an updated BOC tracking spreadsheet;
- Working with NEEA staff to modify the NEEA tracking spreadsheet to account for missing IBOA data (discovered during 2007 M&T);
- 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 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 office buildings and schools, which are among the most common facilities participating in the 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 2008 M&T effort did not reveal any additional assumptions or changes in the savings methodology, but did result in an update of the square footage per operator assumption. 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

At a high level, the 2008 M&T methodology does not differ greatly from the 2007 M&T methodology. The literature review and interviews included some different sources and a highly detailed analysis of square footage data from NEEC was added in 2008. The 2008 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 did not turn up anything new of value, as well as interviews of select individuals working in the area of building operator training. Interviews were conducted with key staff at NEEC, the Northwest Energy Education Institute (NEEI), and a commercial building energy efficiency education consultant working with NEEA and IBOA in Idaho. Interviewees provided primary insights into BOC in the Northwest and did not suggest any additional secondary literature for review. Certification data was collected directly from NEEC. IBOA certification data was collected through in cooperation with NEEA staff who are currently working with IBOA. Christine Jerko of NEEA was consulted during the analysis of this data to ensure that the work would be easily integrated into the existing ACE model. 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 2008. IBOA provided certification data to Kim Hughes.

    b. **Interviewed staff to assess views on BOC activity, drivers, impacts, and market perceptions.** Interviews were conducted with Cynthia Putnam of NEEC, Erik Westerholm of NEEI, and Ken Baker, a consultant working in Idaho with IBOA and NEEA.

2. **Conducted analysis of square footage data from NEEC:**

   The NEEC database includes estimates of square footage of buildings managed by BOC students. However, in some cases more than one operator from the same organization may report building size information for the same facility, or the operator may have entered non-numbers for square footage, like “>1 millionSF” or “26 schools.” Therefore, it was necessary to filter the data to develop numerical square footage values for as many students as possible and group the students by site. This filtering and grouping process was conducted as follows:

   <u>Step 1</u>: Sorted, filtered, and cleaned data. Using a set of SAS codes and an address standardization service, the data for each student from NEEC were processed into a form with a numerical square footage field and a standardized zip+4 format. The numerical filter was able to convert lots of text entries into numbers, i.e. “90k” to 90,000, “1-2 M SF” to 1,500,000, “10 acres” to 435,600, and flag remaining unconverted values, i.e. “26 schools” or “large campus.” The address standardizing service is an online processing tool which standardizes addresses at a small nominal fee ($10/1000 addresses). This turned all of the address variations into United States Postal Service addresses and zip+4 codes. Operators were then grouped by employer, zip+4, and square footage. This provided an initial indication of students representing the same facilities. Grouping by zip+4 eliminated multiple names for the same site (i.e. all variations of South Puget Sound Community College and SPSCC, with addresses of 2011 Mottman Rd. SE, 2011 Mottman Road SW, etc. are the same site).

   <u>Step 2</u>: Calculated square footage number for each site. The operator groups from Step 1 were further combined by hand where appropriate, to subjectively determine which operator groups were servicing the same sites. For example, a community college site had 9 operators total. 5 of them left square footage blank, 2 of them put down 421k, one of them put down 420k, and the last one put down 250,000. In this case, all of the operators were lumped into 2 building sites, one with 250,000 sf, and the other with 421,000 sf. This eliminated additional overlaps in the square footage accounting and provided a more conservative and reliable estimate of square footage controlled by each student. College campuses are particularly difficult to evaluate, because the staff oftentimes includes some building operations staff who serve many buildings that overlap with many other building operators. In most of these cases, the maximum value for any operator was taken as the total, which was divided amongst the

   <u>Step 3</u>: Compiled summary data for Northwest and Nation. The average square footage per site, average square footage per operator, and number of operators per site were calculated for operators in the Northwest. The NEEC database also includes operators nationwide, so these values were calculated for the nation as a whole to serve as a point of comparison.

3. **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 2007 Commercial Building Energy Consumption Survery (CBECS), conducted by the Department of Energy’s Energy Information Agency (EIA) will not be released in part until later in 2009, which will be the first new building energy consumption data since the 2004 CBSA.

4. **Reviewed evaluations of other BOC programs.** Programs reviewed included previous evaluations from the Northeast Energy Efficiency Partnership and programs operated by investor-owned utilities in California and Arizona.

2.3 Findings

2.3.1 Current Market Activity

Through 2008, NEEC had certified 1,134 building operators in the Northwest and IBOA 321. In total, 969 (64%) of the 1,514 operators that have been certified in the Northwest to date were still active at the end of 2007 (Table 2-1). "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 2004 and 2008, inclusive). To some degree, the declining trend in active operators observed in last year's M&T research was misleading. The large number of retirements observed in 2007 was a direct descendant of the large number of new certifications five years earlier. This "retirement bubble" combined with a modest number of new operators to create a one-year dip in "active operators." The same "retirement bubble" phenomenon happened in 2004, when a large cohort of building operators trained in 1999 retired and a modest number of new building operators were certified.

Table 2-1. 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	0		0	1	0	**1**
1998	45	0	46	7		7	52	0	**53**
1999	126	0	172	23	2	28	149	2	**200**
2000	124	0	296	24	2	50	148	2	**346**
2001	97	0	393	13	6	57	110	6	**450**
2002	155	1	547	45	2	100	200	3	**647**
2003	105	34	618	70	6	164	175	40	**782**
2004	58	62	614	41	17	188	99	79	**802**
2005	119	49	684	36	30	194	155	79	**878**
2006	75	67	692	62	57	199	137	124	**891**
2007	87	96	683	26	13	212	113	109	**895**
2008	142	59	766	33	42	203	175	101	**969**
Total	**1134**	**368**	**766**	**321**	**122**	**203**	**1514**	**545**	**969**

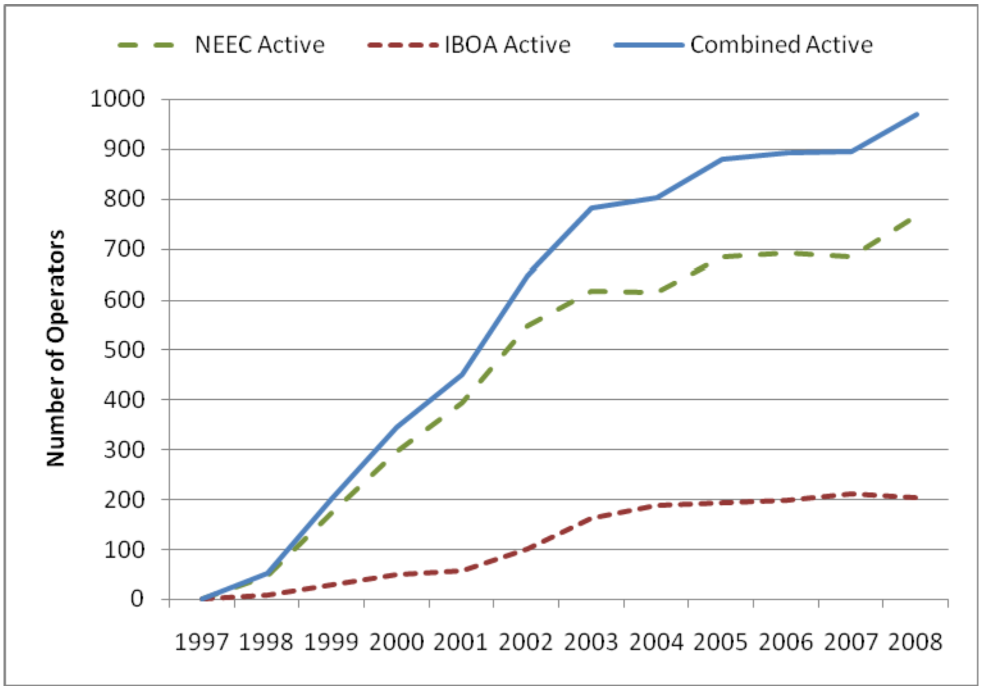
* Annual Retired refers to certified building operators whose measure lives have expired because they did not receive a new certification or renewal within five years of the year (table row) in which the data is presented. Annual retirements for IBOA operators were derived by applying the annual renewal rates of the corresponding cohort (by year) of NEEC operators to the IBOA operators.

** 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: Summit Blue analysis of 2008 NEEC certification database and 2007 ACE model, which includes IBOA certification database through 2006.

While new certifications continue at or near historical levels, with some variation from year to year, the number of certified operators who have *not* recertified within the past five years fluctuates in the same pattern as certification activities five years earlier. As a result, the number of active certified building operators does not show a clean trend from year to year. The slight decline in NEEC active certified building operators from 2006 to 2007 is being offset by a large increase from 2007 to 2008. 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, 1997-2008



Source: Summit Blue analysis of 2008 NEEC certification database and 2006 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 NEEC BOC program[2]. The NEEC 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. 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. 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 recession. The American Recovery and Reinvestment Act of 2009 (ARRA), signed in February, included a significant fund for energy efficiency job training, which BOC would clearly qualify for. Title VIII, the job training portion of the bill includes a clause that

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[2] *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

"$500,000,000 shall be for research, labor exchange and job training projects that prepare workers for careers in energy efficiency and renewable energy."[3]

2.3.2 Baseline Activity

The baseline activity for building operator certifications was clearly zero before NEEC and IBOA training started in the 1990s. They 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.[4] 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.

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. However, there is little evidence[5] in the current research to suggest that a non-zero baseline is warranted at this time.

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).
- Square footage per operator (in-depth analysis)

The area under management by each building operator is highly variable, with initiative participants reporting areas ranging from 4,000 square feet to four million square feet. The value used in the 2007 M&T report, 355,000 square feet per building operator, was based on the most recent MPER and supported by previous M&T assessments. For the 2008 M&T report, the best available data regarding the size of facilities managed by BOC students was analyzed to derive a new estimate of square footage per

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[3] *American Recovery and Reinvestment Act of 2009*, February, 2009

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

[5] 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.

operator. This analysis utilized a combination of automated data filtering and manual interpretation of values to clean the national NEEC database of certified building operators and calculate the average square footage per operator among operators in the Northwest.

The complete analysis involved the following steps:

Data cleansing

1. Obtain nationwide NEEC database. The database includes name, employer, address, and square footage field for most operators.

2. Clean square footage field using SAS code. Convert various text variations into a numerical square footage (e.g., “750 thousand” = “750k” = “750ksf” = “0.5-1 M SF” = 750,000 square feet) and flag remaining operators as blanks or uninterpreted text.

3. Standardize address and find zip+4. Using an online address processing service, find the standard USPS address and zip+4 for each operator.

Grouping operators by unique site

4. Group operators by common site. Using SAS code, sort operators into groups sharing a unique combination of zip+4. Grouping by zip+4 eliminates multiple names for the same site (i.e. all variations of South Puget Sound Community College and SPSCC, with addresses of 2011 Mottman Rd. SE, 2011 Mottman Road SW, etc. are the same site). Then subgroup and sort by square footage covered, with flags marking transitions between similar groups. In many cases, each subgroup represents a unique building subgroup. In some cases, these subgroups are overlapping (i.e. 2 people putting down 2 million square feet and 2 people putting down 1,900,000 square feet at the same address are likely overlapping.

5. Finalize site grouping by hand. Compare similar groups to determine if they are actually the same building (same employer with slightly different address or slightly different square footage). Operators with blank square footages were rolled into other building group at the same zip+4 area.

Determining square footage per site and per operator

6. Discard zip+4 groups without any square footage data.

7. Determine final square footage number for each unique site. Where operators were determined to be from the same site, use the cleaned square footage value shared by all of the operators at a given unique site. If the square footage values differ, subjectively determine the most appropriate square footage number for the site, either by adding up multiple square footage values if multiple buildings are being served or using the maximum value if it appears that one value likely represents the entire site.

8. Remove outlying sites from the dataset. Only one site was removed, because it had 465 million square feet and only 3 operators, roughly 3 orders of magnitude more square feet per operator than average.

9. Calculate total number of unique sites, square footage of unique sites, and number of operators contained in the subset of the database with sites in the Northwest.

The results of the analysis are shown in Table 2-2 below.

Table 2-2. Square Footage Per Operator Comparison

Northwest Only	2005 M&T	2008 M&T
Square footage per site	645,000	644,000
Operators per site	1.8	2.25
Square footage per operator	355,000	286,000

The square footage per site in the Northwest calculated as part of this year's M&T analysis is essentially the same as the square footage per site contained in the 2005 M&T report and in the last MPER. However, the number of operators per site has increased from 1.8 to 2.25. The resulting square footage per operator is roughly 20% lower at 286,000 square feet compared to a value of 355,000 square feet per operator used in previous M&T analyses. The reduction in building size managed by each student may reflect a trend in the Northwest where it is more common for multiple operators from a single facility to enroll in the BOC training. The lower average building size calculated in this 2008 M&T research likely is also a result of more rigorous analysis of the data, which identified more overlap between operators than had previously been possible.

A similar analysis of the nationwide data resulted in an estimate of 395,000 square feet per operator. This data likely reflects a maturing market for BOC in the Northwest, where organizations that value the training have trained large portions of their operator staff, while in portions of the rest of the country, BOC training is only just starting to gain a foothold, with only a few operators trained per organization.

Electricity Consumption per square foot

The 2005 M&T input value of 16 kWh/ft^2 for the annual electricity consumption at participating facilities is an appropriate value for use in the savings analysis. As discussed in the 2004 and 2005 M&T reports, this value was proposed by NEEA in March 2004, it was based on recently published data, and it is consistent with values for multiple relevant building types and from multiple sources.

Savings from certification

The assumed percent energy savings realized as a result of BOC certification is 2.5%. Multiplying this value by the assumed energy intensity (above) of 16 kWh/ft^2 yields an estimate of 0.4 kWh of savings per square foot, which is consistent with a study prepared for Northeast Energy Efficiency Partnerships (NEEP) by RLW Analytics,[6] 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

[6] RLW Analytics, *Impact and Process Evaluation: Building Operator Training and Certification (BOC) Program Final Report*, Prepared for Northeast Energy Efficiency Partnerships, June 2005

with the training, so they likely 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 kWh electricity consumption per square foot per year

x 2.5% savings

which equals 114,000 kWh of annual savings per operator. This is roughly a 20% reduction in savings per operator compared to the 2007 M&T report, due to the finding that the square footage managed by each operator is less than previously assumed.

Lifetime

The lifetime 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 or 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 much 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 seems reasonable to continue with the current assumptions for measure lifetime. If the rate of renewals among certified building operators continues to increase, the lifetime assumption will become less important.

2.4 Conclusions/Recommendations

Building Operator Certification activity in the Northwest increased in 2008 and appears to be poised for significant future increases as a result of increasing awareness and government grant programs. Specific findings from the 2008 M&T assessment include the following:

- **The number of certified building operators has started to rise again.** The flat number of certified building operators observed the last two years appears to be an aberration in an otherwise generally rising number of certified building operators.

- **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 also noted an increase in awareness of energy efficiency among policy makers, which manifested itself in the significant funding for general energy efficiency in the ARRA.

- **BOC delivery mechanisms are under development to reach groups of building operators that have been underserved to date.** BOC trainings generally occur at one site. BOC administrators are trying to find ways to run trainings at multiple sites. NEEI has been experimenting with distance learning using specially equipped classrooms to allow two-way video communication with students at other locations. This will allow them to offer trainings at more far-flung locations that are equipped with distance learning classrooms.

- **Increased public sector emphasis on energy efficiency job training will likely take advantage of existing BOC curricula.** Energy efficiency job training received a 500 million dollar carve out in the ARRA. The existing BOC curricula are exceptionally well-suited to provide this training. Federal funds should be available to sponsor additional BOC training during the next few years. While this boost of funding should drive up the demand for training, it is possible that this demand will outpace growth in the supply of qualified teachers of the BOC curriculum.

Table 2-3 shows that despite the continued increase in certifications, the implied energy savings dropped by approximately 12% from 2007 to 2008. The major reason for this decline in estimated savings is the rigorous analysis of square footage conducted for this M&T analysis, which suggested that the square footage managed by each certified operator is 20% lower than previously estimated (see Section 2.3.3). This resulted in a proportional decrease in the kWh savings assumed to be attributable to certification.

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

Key Indicators Reviewed	NEEA 2007 Cumulative Values*	2008 Recommended Cumulative Values	2008 Incremental Values (2008 minus 2007)	Source
Current Market Activity				
Number of Active Certified Building Operators	889	969	80	NEEC and IBOA; see Section 2.3.1
Baseline Activity				
Number of Active Certified Building Operators	0	0	0	Interviews; see Section 2.3.2
Per-Unit Energy Savings				
kWh/operator per year	142,000	114,000	-28,000	See Section 2.3.3, ACE Model.
Implied Energy Savings**				
Implied Energy Savings (aMW)	14.4	12.6	-1.8	aMW = MWh divided by 8760 hours

*NEEA 2007 values from Excel file “BOC_May_2008.xls”

** Implied Energy Savings represent estimated savings from market activity less estimated savings from baseline activity. Implied Energy Savings are presented for comparison purposes only between NEEA’s 2007 values and the 2008 M&T findings. 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: NEEA, CEE, and Summit Blue analysis

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

- Obtain annual BOC tracking database updates directly from NEEC and IBOA for integration into the spreadsheet model developed by Christine Jerko. 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. The IBOA data for 2007 and 2008 should be updated as soon as the database is obtained.

- Update energy savings assumptions every other year as potentially conclusive new data become available, such as through BOC evaluations for other programs. Updated building energy consumption data should be available later in 2009 or by 2010. At some point in time (perhaps in 2010), the baseline should be updated. This is a major undertaking, as it would likely require detailed surveys of non-certified building operators as well as certified building operators in order to detect differences in their energy efficiency practices. Certified building operators should also be surveyed about other sources of energy efficiency training they may have obtained before completing the BOC curriculum.

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3 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 initiative 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 initiative, 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 initiative 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 (M&T) report for NEEA on the MagnaDrive ASD venture based upon 2006 sales and data was completed. This report is a follow-up assessing changes during 2007 and 2008. Since one of the most notable changes is the increase in sales of fixed speed couplings relative to the number of ASDs, much of the focus of this report is on this portion of the MagnaDrive offerings.

3.1 Assumptions and Indicators for Review

Energy savings from the MagnaDrive initiative 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 initiative 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, 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 initiative included an assessment of the per-unit savings that has been used in this report.

It is important to note that the original focus of the MagnaDrive initiative was on ASD sales. However, due to significant growth in the coupling market since the last assessment, additional efforts were made to quantify savings in the coupling market. 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.

Specifically, the following inputs to the cost-effectiveness calculation were assessed:

- 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 per-unit savings assumption (kWh/HP/yr), which is a function of several other assumptions; and
- The level of baseline activity in the Northwest.

In accordance with the M&T work plan for 2008, the initiative team also investigated the likely magnitude of MagnaDrive's continued market activities in the Northwest.

3.2 Methodology

Previous M&T efforts focused on reviewing the per unit savings assumptions used by NEEA to estimate savings from MagnaDrive sales. Given the 2006 review of per-unit energy assumptions for MagnaDrive ASDs and the increasing importance of fixed speed coupling sales in MagnaDrive's product offerings, much of the focus of the current review was on attempting to assess a per-unit energy savings for the couplings in addition to continued tracking of MagnaDrive ASD sales in the Northwest. Specifically, this report addresses:

- Barriers to increased sales and distribution in the Northwest;
- The increasing importance of coupling sales compared to the ASD market;
- Determining coupling savings due to speed reduction; and
- Determining typical speed reduction in coupling installations.

Research tasks were as follows:

1. **Obtain sales data from MagnaDrive,** including for its two Northwest distributors.
2. **Interview MagnaDrive and the two MagnaDrive distributors 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. The company recently hired a former MagnaDrive employee to help with these offerings; however, the Portland and eastern sales territories are still largely covered by other representatives. In late 2008 Missmann Electric began covering the southern Idaho sales territory as a MagnaDrive distributor. At the time of the interview with Missmann Electric, the company had not yet sold any units, but had ordered three units at the time of this writing.
3. **Conduct a literature search** for previous reports and any additional information on savings in both the variable speed drive market and the MagnaDrive in order to estimate energy savings due to MagnaDrive specific savings. The prior assumptions and review of per-unit savings from the 2006 review of the MagnaDrive initiative were reviewed and incorporated into savings estimates.

3.3 Findings

In many cases ASDs are used in areas where VFDs would not be used, although MagnaDrive's ASDs continue to compete with traditional VFDs in some applications. The two primary reasons MagnaDrive is found suitable by end users where other VFDs would not be are that it provides vibration isolation and it does not introduce electrical harmonics into the power system. In addition to these ASD applications, MagnaDrive has begun heavily 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 relatively weak even though NEEA was one of the few early supporters of MagnaDrive technology.

3.3.1 Market Activity

The MagnaDrive market has begun shifting from primarily ASD sales, to also include a significant market for 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 3-1shows MagnaDrive sales for 2007 and 2008. Prior to 2008 MagnaDrive did not track coupling sales, so these data are not available and have not been included in the table. However, due to their increasing importance as a part of MagnaDrive's portfolio, 2008 numbers are included for comparison with the ASD market.

Table 3-1. MagnaDrive Sales in the Northwest for 2007 and 2008

HP	2007 ASDs*	2008 ASDs	2008 Couplings
10		1	
20		1	
25			4
30	8	2	5
60	3		2
75		4	
85			3
125	1	3	
140			1
195			5
200	2	2	1
220			2
250	14	5	
300			1
315			1
350	1		2
400	4		
500	1		
610			1
930			1
OEM	9	5	8
Total HP	8,720	3,086	6,679

** MagnaDrive did not track coupling sales prior to 2008.*
Source: MagnaDrive

As seen in Table 3-2, Northwest ASD sales in 2008 are greatly reduced relative to previous years, at 3,086 HP compared to roughly 8,000 HP in each of the three previous years. This yields cumulative ASD sales of more than 46,000 HP, with an average of 174 HP. The average motor size for ASD applications is significantly lower than was anticipated during planning stages of the initiative, 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 2006 tracking report only one ASD of that size had been sold in the Northwest, and only one additional unit has been sold in the Northwest since that time. MagnaDrive reports that large Horsepower ASDs have enjoyed greater demand in US markets outside the Northwest and in international markets. Additionally, the average horsepower of the ASDs has decreased since 2006. Although MagnaDrive has continued to increase the size of available couplings, sales of these large horsepower units has not taken off in the Northwest.

Table 3-2. 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
All Years	**174**	**46,094**

** In addition to the ASD sales identified here, in 2008 MagnaDrive sold 6,679 HP of couplings averaging 181 HP in the Northwest.*
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. Until recently these represented most of the Northwest territory. Because of this, awareness of the technology in the Northwest appears relatively low. However, one distributor has recently hired a former MagnaDrive employee who is focusing on the technology. Additionally, a new distributor is now working with MagnaDrive in Idaho. Nevertheless, a significant increase of awareness of this technology in the Northwest is needed to increase sales, and distributors have not been providing this.

Although the 2008 drop in sales is largely due to the economic downturn, it is notable that coupling sales accounted for more than twice the horsepower of ASDs in 2008. Sales numbers were not available for couplings in previous years, but MagnaDrive indicated that their sales had been increasing significantly and that this was the reason for the recent addition of their sales in the tracking data.

3.3.2 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 critical role played by NEEA in the development of MagnaDrive as an entrepreneurial company has been well documented in the four MPERs. Additionally, the Department of Energy NICE3 program worked with MagnaDrive early on to help launch this technology. However, literature searches have not located any other work that was done to aid in the introduction of the MagnaDrive technology. Because of this, the zero baseline was determined to be appropriate. However it is worth noting, that other regions appear to have benefitted more from this initial effort than the Northwest has. Based on discussions with distributors, it appears that the early sales of MagnaDrive in the Northwest may have actually hurt the current distribution in the area. Distributors reported some early problems with the drives in the company’s development phase and this has negatively influenced the perception of MagnaDrive’s reliability in the region. However, at the time of this writing, MagnaDrive has over 7,000 installations of its technology, and these early setbacks are no longer an issue.

In addition to the factors discussed in the 2006 M&T report, where MagnaDrive is often competing with traditional VFDs, the 2002 study by Chvala and Winiarski compared the Coyote PAYBACK drive as a competing and somewhat similar technology. These drives, which are also called "Eddy Current" drives, are still available and use an electromagnetic technology to achieve a similar effect as MagnaDrive's permanent magnet technology, however there is little mention of them in literature searches or local sales so they do not appear to be providing significant competition to MagnaDrive in a way that would affect the baseline assumptions.

As reported in the 2006 study only 130 fixed speed couplings had been sold overall 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. Furthermore, despite the earlier assumptions that these were lower horsepower units, their average horsepower in 2008 was 181 compared to 134 for ASDs, and their total horsepower was more than twice that of the 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. 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 has also been taken to be zero.

3.3.3 Per-Unit Energy Savings

The per-unit energy savings of MagnaDrive ASDs have been extensively reviewed in the 2006 M&T report; however, no work has been done on estimating coupling savings. As previously discussed, the early focus of MagnaDrive was on ASDs, and prior analyses have focused on estimating savings for these systems. Consequently, the first calculations discussed below have been discussed for ASDs in previous MPERs and the 2006 M&T report, but an assessment of their applicability to couplings is included here as well.

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 currently 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%. Although the ACE model includes these estimates in its inputs, the 24.6% value is still listed as well. 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 2008 is 174 HP, as shown previously in Table 3-2. Using the average hours of operation for all motors shown in Table 3-3, and weighting for total horsepower in each year of sales, gives an average of 5,620 hours of motor operation per year. Combining this with 29.1% savings results in 1,220 kW/HP/yr:

Per-Unit Annual Energy Savings for ASDs = 1,220 kWh/HP/yr = 5,620 h/yr*0.291*0.746 kW/HP

Table 3-3. 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

The increasing importance of couplings as a share of MagnaDrive's business in the Northwest makes it no longer possible to ignore these savings in estimating the long term impact of NEEA's support of the MagnaDrive technology. For several reasons, it is very difficult to accurately assess the savings due to typical couplings without more extensive, systematic data. Specifically, there are 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.

Despite these unknowns, the following inputs have been used:

- The 2008 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 affinity law provides that in an ideal system the power of a fan or pump is proportional to the cube of its speed. However in real systems the factor is typically decreased from a cube to around 2.5, although it can vary somewhat depending upon conditions. Using an average load reduction of 15% (assumed above) and the affinity law with a factor of 2.5 gives an average speed reduction of 6.3%:

Speed reduction ratio = 1 - (1-load reduction) ^ (1/2.5) = 0.063

MagnaDrive's literature provides for savings of 14% at 5% speed reduction and 27% at 10% speed reduction. The affinity law theory does not take into account the possibility of reduced system friction created by vibration transfer and shaft misalignment. Thus, MagnaDrive's couplings may provide additional load reduction in systems where vibration or misalignment is present. The 14% savings at 5% reduction has been used here to maintain a conservative estimate despite the many unknowns.

By comparison, the OSU product testing report (see References) shows around 15% power savings at 85% flow relative to either a baffled fan or a throttled pump valve. This is fairly close to the 14% value used for calculations here, although it corresponds to a greater speed reduction than MagnaDrive 5% claimed for this savings value. Notably, at 10% speed reduction, the OSU report estimates closer to 22% savings than the 27% claimed by MagnaDrive. It should be noted that the OSU study was under laboratory conditions and did not consider any energy effects of vibration transfer and misalignment.

In contrast, the PNL technology demonstration study reports savings relative to traditional VFDs rather than relative to no speed reduction. However, combining these results with typical VFD savings values corresponds to only around a 7% savings for a 10% speed reduction and basically no savings for a 5% speed reduction, significantly less than either the OSU report or MagnaDrive's claimed values. As previously mentioned however, MagnaDrive's vibration isolation may provide additional savings in actual installations relative to what is seen under laboratory conditions and this may account for some of the discrepancy. Since the 14% estimate using MagnaDrive's published data and the 15% estimate from the PNL report are fairly similar, 14% has been used as a conservative estimate here.

Based on the average 181 horsepower of couplings, average annual operational hours of 5,200 were used for calculations as shown in Table 2-3. Combining this with the 14% savings results in annual per-unit energy savings of 543 kWh/HP/yr:

Per-Unit Annual Energy Savings for couplings = 543 kWh/HP/yr = 5,200 h/yr*0.14*0.746 kW/HP

3.4 Conclusions / Recommendations

NEEA initiatives supporting MagnaDrive have significantly accelerated the transformation of the variable speed drive market. The following are major conclusions of this M&T research:

- NEEA's early support of the MagnaDrive technology has provided a significant boost for it in all geographic areas, and international markets comprise over 50% of MagnaDrive's revenue over the past two years.
- The Northwest is actually lagging behind many other areas in MagnaDrive adoption.
- In recent years, couplings using the MagnaDrive technology have become a major portion of savings.

The ACE model estimates 2007 sales of 8,688 horsepower and 2008 sales of 6,665 horsepower. The 2007 ASD horsepower total value of 8,720 is very similar to actual sales, but the 2008 value of 3,086 is less than half the predicted sales used in the ACE model. This is partially due to the economic downturn, but is also indicative of the poor Northwest sales overall. Increased coupling sales have made up for this decline, totaling 6,679 horsepower in 2008.The total of both ASD and coupling horsepower in the Northwest in 2008 was 9,765 horsepower, significantly more than the predicted 6,665 horsepower.

Table 3-4 summarizes the comparison between the NEEA 2007 estimates of key indicators and those recommended by this report for 2008. There has been an increase of more than 4,100 hp (about 10%) in cumulative ASD installations, although sales have been significantly reduced compared to previous years. However, coupling sales have increased (more than 6,660 hp in 2008) to the point that their inclusion in savings estimates is warranted. The coupling savings are conservatively estimated at around half the per-unit savings of ASDs. Additionally, a small increase in per-unit ASD savings is recommended based on 2008 sales data. The result is an increase in cumulative savings from 2007 to 2008 of approximately 1.1 aMW, for a cumulative savings through 2008 of 6.8 aMW.

Table 3-4. M&T Recommendations for Key Indicators

Key Indicators Reviewed	NEEA 2007 Cumulative Values*	2008 Recommended Cumulative Values	2008 Incremental Values (2008 minus 2007)	Source
Current Market Activity				
HP of new MagnaDrive ASD installations	41,945	46,094	4,149	MagnaDrive Northwest Sales data See Section 1.3.1
HP of new MagnaDrive coupling installations	0	6,679	6,679	
Total HP of new installation	41,945	52,773	10,828	
Baseline Activity for ASD and Coupling Installations				
Number of MagnaDrive installations (ASD and couplings)	0	0	0	See Section 1.3.2
Per-Unit Energy Savings				
kWh/HP per year for ASDs	1,186	1,220	+34	See Section 1.3.3
kWh/HP per year for couplings	Data not available	543	Not applicable	
Implied Energy Savings**				
Implied Energy Savings (aMW) from ASDs	5.7†	6.4	0.7†	aMW = MWh divided by 8760 hours
Implied Energy Savings (aMW) from Couplings	0	0.4	0.4	
Total Savings	5.7	6.8	1.1	

* NEEA 2007 Cumulative Values from MagnaDrive Mar 2007.xls spreadsheet

** Implied Energy Savings represent estimated savings from market activity less estimated savings from baseline activity. Implied Energy Savings are presented for comparison purposes only between NEEA's 2007 values and the 2008 M&T findings. 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.

† Values based on the NEEA 2007 ACE model. Based on actual numbers there would be 6.0 aMW through 2007 with 0.4 aMW added in 2008.

Source: MagnaDrive and Summit Blue analysis

It is recommended that another assessment be conducted for the 2009 M&T report to better quantify 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. Although this was not the original focus of the NEEA initiative, 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 initiative team, and may depend upon conditions, such as vibration and system misalignment, in a given installation. MagnaDrive provides estimates in its sales brochures; however the initiative team could not verify these numbers using the two available published reports on MagnaDrive. Also, the typical speed reduction implemented for couplings needs to be studied. There is currently no published data on what typical turn down percentage can be expected for a coupling installation in part because no other previous product offered this capability. Although it undoubtedly varies significantly in each application, MagnaDrive and OEMs should be encouraged to report turn down values for installations in the future.

Available turndown in a constant speed application is primarily dependent on several factors, which should be considered in any assessment of MagnaDrive coupling opportunities:

- the degree to which the system is overdesigned , specifically for centrifugal applications;
- the magnitude of vibration generated by the motor and transferred by the rigid/flexible coupling previously used or in the baseline system;
- the magnitude of misalignment present in the previously used or the baseline system; and
- the degree to which the magnetic coupling sized for the application has the capacity to achieve significant turndown.

On a continuing basis, it is recommended that the M&T analysis be conducted for 2009 and then every two years and include the following activities:

- Continuing assessment of actual savings of MagnaDrive products. This is particularly an issue since the couplings market has not been assessed or tracked in the past.
- Distributors should be encouraged to report turn down values of coupling installations along with horsepower. This would help significantly in estimating savings.
- Interviews with all Northwest distributors to determine sales barriers. The region continues to lag behind other areas in MagnaDrive ASD sales, and this appears to relate at least in part to problems during early adoption. However, the introduction of a new distributor in Idaho and a new representative focusing on MagnaDrive at the existing distributor may change this over the coming years and future distributor interviews should assess whether this is the case.

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4 DRIVE POWER INITIATIVE

The Drive Power Initiative (DPI) was an electric motor market transformation effort 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 decision.
- Help motor service centers improve their repair practices and expand their motor management services.

To achieve the aforementioned objectives, the initiative employed the following methods:

- Implementing a broad motor end-user *education program*, including seminars, a newsletter, a toolkit of printed information, motor database software (*EM2*), and a web site.
- Deploying *field consultants* to work with end users throughout the region and to develop success stories, executing a pilot demonstration of motor system optimization project. This was supplemented by leveraging initiative success stories and information through dissemination in various media.
- *Working with motor service centers* on improving repair methods, integrating motor operating costs into repair/replace decisions, and expanding motor management services. Before the initiative started working with motor service centers, only about 4% of the service centers even offered energy efficient rewinds, performed in a controlled environment according to a "best practices method" as specified by the Electrical Apparatus Service Association (EASA).
- NEEA helped fund the Green Motors Practices Group (GPMG), a nonprofit organization that promotes best practices for repairing and rewinding motors at motor service centers. The GMPG is still active and is involved in outreach activities with motor service centers in the Northwest. See Appendix A for more details.
- Coordinating *promotion of motor management efforts* with trade associations, utilities, government agencies, and organizations promoting energy efficiency.

The primary objective of the first M&T effort, conducted for the 2007 M&T report, 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 market. In particular, that effort focused on sales of NEMA Premium™ motors and the share of these sales that were influenced by NEEA. The 2008 M&T effort updates these figures and also quantifies the impact of new services and changes in practices at motor repair centers. Specifically, the 2008 M&T includes the following activities:

- A more robust projection of NEMA Premium™ motor sales in the Northwest. As of the 2007 M&T report, the Consortium for Energy Efficiency (CEE) had only released regional motor shipment data for 2005. The 2006 data (which has already been released), provided data for two full years and would allow better trend estimation. The additional data also allowed for a more extensive comparison of regional versus national sales, which was used to refine the previous baseline estimate.

- Interviewing prominent motor service centers in the Northwest to better understand what percentage of their services are energy efficient, how much effect DPI had on their practices and procedures, and the awareness levels of consumers that use their services.

4.1 Assumptions and Indicators for Review

To study the affect of the DPI on the motors market in the Northwest, Summit Blue 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. This year's M&T analysis includes an additional indicator quantifying the number of rewinds performed. Specific indicators identified were:

1. **Sales 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 has been trying to encourage customers to purchase NEMA premium motors.

2. **Change in motor repair practices and change in customer awareness of energy efficient rewinds.** Motor service centers in the Northwest are adopting energy efficient repair methods consistent with EASA best practices. This M&T research attempted to ascertain NEEA's role in encouraging them to do so and the extent to which the repair market has been transformed. Through these service centers, NEEA also tried to educate customers to request efficient rewinds**.** explained discussion of motor service centers and efficient rewinds in presented in Appendix A at the end of this chapter.

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 2008.

An important assumption underlying the analysis of savings from sales of new motors is a measure life of at least 10 years. 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.[7]

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. Two primary methods were used to obtain data: the first was to interview market actors that have either worked or are currently working closely with the motors industry in the Northwest; and the second was to review secondary sources that have documented savings or evidence of market transformation in the Northwest.

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[7] A measure life of 15 years is currently being used for energy efficiency program evaluations in California, up from an assumption of 10 just a few years ago. Source: *Database for Energy Efficient Resources (DEER),* a California Energy Commission and California Public Utilities Commission (CPUC) sponsored database "designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL)," Version 2008.2.05 December 16, 2008.

The following specific research tasks were undertaken in this M&T effort:

1. **Obtained motor sales data from CEE.** Motor *sales data* is not widely collected and is difficult to obtain, but *shipment data* is reasonably available and was used as a proxy for estimating sales. Shipment data for both standard and NEMA Premium™ motors was be obtained from CEE.

2. **Re-contacted and interviewed professionals active in efforts to promote efficiency in the motors industry.** In particular, several discussions and email exchanges were held with Dennis Bowns of the GMPG, and Ted Jones of CEE.

3. **Interviewed and surveyed motor service centers in the Northwest.** Summit Blue contacted 10 motor service centers, with the specific objectives of estimating the number of efficient rewinds being performed, assessing trends the rewinds market, and determining the likely prevalence of energy efficient rewinds without NEEA's influence. Additional information on this effort is provided at the end of this chapter in Appendix A.

4.3 Findings

4.3.1 Market Activity – Sales of NEMA Premium™ Motors

Motor *sales data* is not widely collected and is difficult to obtain, but *shipment data* is reasonably available and can be used as a proxy for estimating sales. National **s**hipment data for NEMA Premium™ motors dates back to 2001, with 2006 the most recent year covered.[8] Regional data was not tracked until 2004, so the M&T analysis used national trends and estimated Northwest data prior to 2005 based on the ratio of total motors sold in the region versus all of the United States in 2005 and 2006. The 2007 and 2008 regional sales figures were extrapolated based on sales growth in the first half of the decade, which the M&T research suggests has continued in recent years.

National Sales

Shipments of NEMA Premium™ motors, as reported by CEE for 2001 through 2006, are presented in Table 4-1, which indicates that national shipments of premium motors increased steadily between 2001 and 2003. The raw data for 2004 to 2006 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.[9] The data for 2005 and 2006 both represent only non-OEM motors and the same set of manufacturers, Hence, they can be compared to study motor sales trends change between 2005 and 2006,

[8] NEMA premium motors shipment data was provided to Summit Blue by CEE and NEEA.

[9] Source: Interviews with Dennis Bowns of the Green Motors Practices Group and John Malinowski of Baldor Electric Company.

Table 4-1. Reported Shipments of NEMA Premium™ and Standard Efficiency Motors, 2001-2006

	2001	2002	2003	2004	2005				2006			
	Premium			Premium	Premium	Non-Premium	Total	Percent Premium	Premium	Non-Premium	Total	Percent Premium
Idaho				4,736	8,677	8,223	16,900	51%	8,732	7,413	16,145	54%
Montana				326	(Included in Idaho)				(Included in Idaho)			
Washington				2,725	1,926	7,787	9,713	20%	4,048	5,322	9,370	43%
Oregon				2,834	1,801	10,020	11,821	15%	6,538	5,317	11,855	55%
Northwest	-			10,621	12,404	26,030	38,434	32%	19,318	18,052	37,370	52%
Nation	187,170	266,958	311,117	267,220	216,852	668,522	885,374	24%	238,098	465,420	703,518	34%

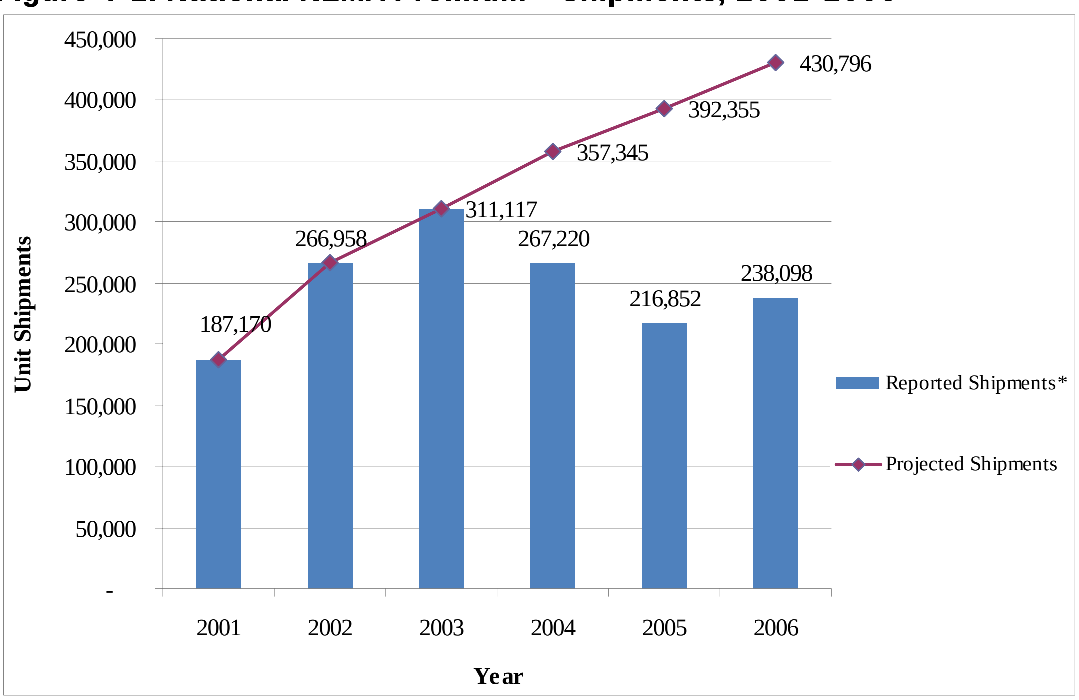
Source: CEE

Motor shipment data in the nation were collected from the CEE and used to estimate sales data from 2001 to 2006. Due to the data deficiencies described above, the total number of NEMA Premium™ units shipped in 2004 through 2006 needed to be estimated from the available data. This estimation was performed in the following steps:

1. The annual growth rates for the period from 2001 to 2003 and for 2005 to 2006 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.

2. The annual growth rate between 2005 and 2006 (using the partial shipment data excluding OEMs) was applied to the 2004 motor shipment estimate to calculate motors shipped in 2005 and 2006. The result is an estimate of 430,796 motors shipped in 2006. (Figure 4-1). The trend of increasing sales was supported by the interviews with GPMG and correspondence with the CEE.

Figure 4-1. National NEMA Premium™ Shipments, 2001-2006



* Only non-OEM motor shipments were reported in 2004, 2005 and 2006; and one major manufacturer no longer reported shipments after 2004.

Source: CEE and Summit Blue projections

Regional Sales

Regional shipment data 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 2004, 2005 and 2006 to the Northwest was reported to be 10,621, 12,404 and 19,318 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 in Figure 4-1. For example, the adjustment factor for 2004 was 1.33 (357,345 divided by 267,220) and resulted in an estimate of more than 14,200 NEMA Premium™ motors shipped in that year.[10]

The adjustment factor in 2005 and 2006 was larger (1.8), owing to the fact that Baldor Electric Company dropped out of the survey in that year11. The result is an estimate of more than 22,443 NEMA Premium™ motors shipped in 2005 and 34,952 in 2006. This relatively large increase is supported by the raw data comparing national and Northwest shipments of premium motors. Whereas national shipments of NEMA Premium™ motors, as reported by CEE, dropped by 19% between 2004 and 2005 (owing to the factors discussed previously), reported shipments of premium motors in the Northwest actually increased by 17%. This trend is more pronounced in 2006, where the sale of premium motors in the nation increased by 9% as compared to an increase of 55% in the Northwest. 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 2006, the only years for which regional shipment data is available. In order to estimate sales for prior and subsequent years, the initiative team considered the fact that previous research (from MPERs and the 2007 M&T report) indicated that NEEA's influence on the sale of NEMA Premium™ motors was minimal in 2001, the first year for which data is available.[12] 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 was based on data from 2005 and 2006, the only two years for which shipment data on all motors is available, and was found to be 4.8%. This translates into an estimate of more than 9,000 NEMA Premium TM motors shipped in the Northwest in 2001.

Using this value for 2001 and the previously estimated values for 2005 a compound annual growth rate of 26% was calculated and used to estimate unit sales values for 2002 and 2003. (Sales in 2004, 2005, and 2006 were estimated above.) Similarly, the values for 2007 and 2008 were estimated using the compound growth rate as applied to the 2006 estimate.13 With the annual growth rate of 26%, projected sales of

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[10] 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.

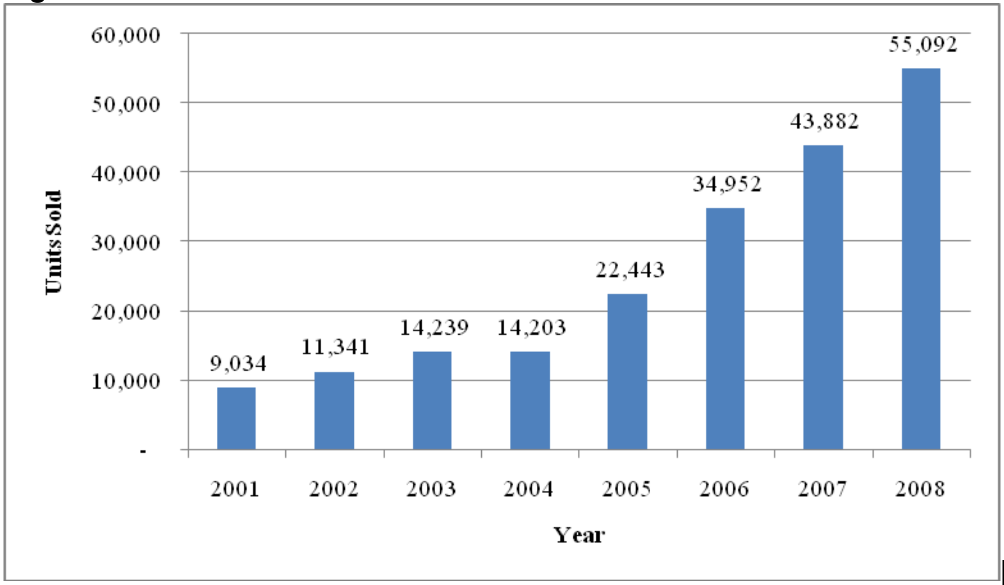
[11] The 2005 adjustment factor value of 1.8 is less than the 2.0 that was predicted in the last M&T report. This is due to the fact that 2006 data, which shows a decline in growth, is now available to update the growth trend estimates.

12 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.

[13] As presented above, national sales of NEMA Premium™ motors appear to be increasing roughly linearly. However, regional sales show an exponential growth trend between 2001 and 2006, which is assumed to continue through 2008. The increase in sales of premium motors in the Northwest from 2005 to 2006 (the most recent year for which data is available) was much higher than the increase of sales in any of the previous years. Thus, using the 2006 value to calculate an annual growth rate would produce a high growth trajectory that would overshoot the 2005

NEMA Premium™ motors in the Northwest in 2008 were more than 55,000 units (Figure 4-2). Total sales since 2001 are estimated to be more than 200,000 units. The current economic downturn may be dampening demand for new motors, a 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 4-2. Estimated NEMA Premium™ Motor Sales in the Northwest, 2001-2008*



** Values are projected based on reported regional shipment data from 2005 and 2006 and national data from 2001 through 2006. Values are extrapolated for 2007 and 2008 based on M&T research.*

Source: CEE; and Summit Blue projections

In 2005 and 2006 CEE obtained sufficient data from motor manufacturers to publish a national and state motor shipment report for both NEMA Premium™ and non-NEMA Premium™ motors.[14] The market share of NEMA Premium™ motors in 2006 was 52% in the Northwest, with larger motor sizes tending to have a greater market penetration (Table 4-2).

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projection. Consequently, a more conservative approach was taken that uses the 2005 value to estimate the growth trajectory for years beyond 2006.

[14] Source: Interview with Monica Nevius (CEE).

Table 4-2. NEMA Premium™ Shipments in the Northwest by Size, 2006

	1-5 HP	6-20 HP	21-50 HP	51 – 100 HP	101 – 200 HP	201-500 HP	Total
NEMA Premium™ Motors	10,153	5,555	2,175	839	466	128	19,316*
Non NEMA Premium™ Motors	9,834	5,217	1,875	539	267	320	18,052
Total Motor Shipments	19,987	10,772	4,050	1,378	733	448	37,368
NEMA Premium™ Share of All Motors	51%	52%	54%	61%	64%	29%	52%

* The figure of 19,316 for total NEMA Premium™ motors shipped in 2006 is taken directly from the CEE data. As discussed above, the M&T analysis has estimated the total to be 34,952, which accounts for missing data for non-OEM motors and those from Baldor Electric Co.

Source: CEE

4.3.2 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, a CEE standard for efficient motors existed prior to NEMA. However, the CEE 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 standard. 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 initiatives 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 (see Section 4.3.1). Therefore, the 2001 baseline is the same as the estimated market activity of 9,034 units. The values for baseline activity through 2006 were estimated using the same year-to-year growth trend that characterizes national market activity. For 2007 and 2008 the baseline was calculated using the growth rate for 2006, the last year for which data is available. This resulted in a 2008 baseline sales estimate of more than 25,000 motors and a cumulative baseline through 2008 of more than 140,000 units (Table 4-3).[15]

Table 4-3. Estimated Baseline Sales of NEMA Premium™ Motors in the Northwest, 2001-2008

Year	2001	2002	2003	2004	2005	2006	2007	2008	Total
Baseline Motor Sales	9,034	12,885	15,016	17,247	18,937	20,792	22,829	25,066	141,805

Source: CEE and Summit Blue analysis

4.3.3 Per Unit Energy Savings

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.[16] Annual energy consumption for a motor can be calculated as the product of the following factors:

1) motor horsepower times the kW conversion factor of 0.746 kW/hp
2) annual run-time hours,[17]
3) motor loading factor[18]
4) the number 1 divided by motor efficiency.[19]

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, and a single per-unit savings value of 629

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[15] The annual growth rates for national NEMA Premium™ motor sales have declined steadily since 2002. If this trend has continued, then the M&T analysis' use of the 2006 growth rate in estimating sales in 2007 and 2008 may result overestimate the baseline, which would yield conservative savings values as reported in the Conclusions to this report.

[16] Data was obtained from CEE. Document title: "CEE Premium Efficiency Motors Initiative – Efficiency Specifications." Undated.

[17] 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.

[18] 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.

[19] 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 16.

kWh per motor is estimated. This value can be applied to NEMA Premium™ motor sales in the Northwest each year to estimate regional savings.

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

Size Category (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	2,745	84.2%	86.2%	118	5,690	673
6 to 20	3,391	89.8%	91.2%	404	3,896	1,574
21 to 50	4,067	91.9%	93.0%	991	1,733	1,718
51 to 100	5,329	93.4%	94.4%	2,177	583	1,269
101 to 200	5,200	94.4%	95.2%	3,424	361	1,236
201 to 500	6,132	94.4%	95.2%	9,435	141	1,330
Total	**N/A**	**N/A**	**N/A**	**629**	**12,404**	7,800

* 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 CEE shipment reports for 2005. See Table 4-2.

Source: CEE; Summit Blue analysis

4.4 Conclusions and Recommendations

NEEA initiatives focusing on motors have led to a significant market transformation in the Northwest. The sale of NEMA premium motors has increased nearly six-fold since 2001, and *regional growth in sales of premium efficiency motors has been at approximately 26% per year, versus 20% nationally*. Furthermore, while national sales of NEMA Premium™ motors appear to be growing linearly, sales in the Northwest are growing exponentially.

Table 4-5 summarizes recommendations for the values of key indicators, which are characterized for motor sales only. Through 2008, estimated cumulative sales of NEMA Premium™ motors in the Northwest had reached more than 200,000 units. Baseline sales are estimated at approximately 142,000, or nearly 70% of the total market activity. With an annual per-unit savings of 629 kWh (unchanged from the 2007 M&T analysis), the cumulative energy savings implied by these figures is 4.6 aMW in 2008—more than double the 2.2 aMW estimated through 2007. The large increase over the 2007 M&T analysis is due to the significant growth in Northwest NEMA Premium™ sales from the new data released in 2008 relative to nationwide sales. This lowered the baseline trend and allowed the M&T team to relax the highly conservative baseline assumption used in the 2007 analysis.

Table 4-5. M&T Recommendations for Key Indicators

Key Indicators Reviewed	2007 NEEA Cumulative Value*	2008 Recommended Cumulative Values	Incremental Values	Source
Current Market Activity				
NEMA Premium™ motor sales in the Northwest	147,268	205,185	57,917	CEE motor shipment data and interviews with motor industry professionals. See Section 1.3.1.
Current Baseline Activity				
NEMA Premium™ motor sales in the Northwest	116,840	141,805	24,965	CEE motor shipment data and interviews with motor industry professionals. See Section 1.3.2.
Per-Unit Energy Savings				
Replacing existing motors with NEMA Premium™ motors (kWh/motor per year)	629	629	0	CEE and Green Motors Practices Group. See Section 1.3.3.
Implied Energy Savings (aMW)**				
Replacing standard efficiency motors with NEMA premium™ motors	2.2	4.6	2.4	aMW = MWh/8760

* Values taken from the 2007 M&T report.

** Implied Energy Savings represent estimated savings from market activity less estimated savings from baseline activity. Implied Energy Savings are presented for comparison purposes only between NEEA's 2007 values and the 2008 M&T findings. 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: CEE and Summit Blue analysis

It is important to note that the estimated 4.6 aMW of energy savings are only due to *replacement* of standard efficiency motors by NEMA Premium™ motors. With available data it is only possible to quantify with a high level of certainty the savings attributable to new NEMA Premium™ motors entering the market. Savings from efficient rewinds may be significant, but they are more uncertain. A discussion of rewind savings has been included in Appendix A at the end of this chapter.

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, it is recommended that an M&T effort be held for 2009 to address the following specific recommendations:

- **Develop a more robust projection of NEMA Premium™ motor sales in the Northwest.** CEE has only released regional motor shipment data for 2005 and 2006. The 2007 data is expected later this year, which would provide data for three full years and would allow better trend estimation. An additional year of data will also allow for a more extensive comparison of regional versus national sales, which can be used to refine the baseline estimate. The recent economic downturn may be influencing motor sales, but this will not be reflected in the two-year old data. The influence should be studied as part of the interview process with service centers and other market players.

- **Conduct a larger survey of motor service centers in the Northwest** to better understand and obtain more detailed information on what percentage of their services are energy efficient and better understand when customers choose energy efficient rewinds versus buying new motors. More detailed questions should be posed regarding the process for conducting an efficient rewind (e.g., whether a core loss tester is used and how service centers operationalize the EASA guidelines), and an independent assessment should be made by the M&T team regarding which centers are, in fact, conducting qualified efficient rewinds.

- **Develop a more accurate estimate of efficient rewind baseline.** A survey with a larger sample set and more thorough questions will provide a better estimate and quantify the baseline for energy efficient rewinds.

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Interview with Dennis Bowns, December 2008, and January 2009 (Bowns & Co. and the Green Motors Practices Group)

Interview with John Malinowski, March 2008 (Baldor Electric Company)

Interview with Jim Williams, March 2008 (JC Williams Consulting, LLC)

Correspondence with Monica Nevius, December 2008 (CEE)

Interview with Robert Russell, December 2007

Interview with Ted Jones, December 2008, January 2008 (CEE)

Appendix A – Energy Efficient Rewinds

This appendix addresses the M&T research and findings for energy efficient rewinds. Interviews were conducted with motor service centers with the objectives of estimating the number of efficient rewinds being performed, assessing trends the rewinds market, and determining the likely prevalence of energy efficient rewinds without NEEA's influence. The uncertainty of the data on rewind activity is sufficiently high that this discussion has been provided as a supplement to the core analysis of sales of NEMA Premium™ motors. The organization of this appendix mirrors that of the main report.

Methodology

Specific research tasks regarding energy efficient rewinds included the following:

1. **Re-contacted and interviewed professionals active in efforts to promote efficiency in the motors industry.** In particular, several discussions and email exchanges were held with Dennis Bowns of the GMPG, and Ted Jones of CEE.

2. **Interviewed and surveyed motor service centers in the Northwest.** Summit Blue contacted 10 motor service centers, with the specific objectives of the following

    a. Estimating the number of rewinds done per state and the share that qualify as efficient rewinds
    b. Assessing trends the rewinds market
    c. Determining the likely prevalence of energy efficient rewinds without NEEA's influence.

For the 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 GPMG, 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 GPMG, and for each service center the size was given in terms of number of employees. A target sample set of ten service centers was created according to the following criteria:

- The ten 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 the CEE data). This resulted in a target distribution as follows: Washington (4), Oregon (3), Idaho (2), Montana (1).

- Half of the 10 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." The final sample consists of six large and four small centers.

- Half of the 10 service centers were designated to be GPMG participants, and half non-participants.

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 4-6.

Table 4-6. Sample Distribution for Motor Service Center Survey

State	GMP Participant		GMP Non Participant		Total
	Large	Small	Large	Small	
Idaho		✓	✓		2
Montana	✓				1
Washington	✓	✓	✓	✓	4
Oregon	✓		✓	✓	3

Findings

Market Activity

From the 2007 M&T report, it is estimated that in 2001 less than 10% of motor service centers provided energy efficient rewinds. This situation has evolved over the past seven years, as an informal alliance, the Green Motor Practices Group (GMPG), was formed to encourage 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. The organization claimed that it had helped change the practices of these service centers by educating the service centers on the advantages of efficient rewinds.

One interviewee in 2007 offered a different view of the rewind market, suggesting that most service centers are familiar with efficient rewinds. Furthermore, he suggested that since customers are increasingly demanding this service, it should be a natural process for the majority of the industry to change over to efficient rewinding practices.

To better understand service center practices, a survey was conducted of ten service centers in the Northwest as part of the 2008 M&T effort. The primary objectives of this survey were as follows:

1. Estimate the number of rewinds done per state and the share that qualify as efficient rewinds.[20]
2. Assess trends the rewinds market.
3. Determine the likely prevalence of energy efficient rewinds without NEEA's influence.

[20] The estimates of rewind activity are uncertain due in part to the fact that the definition of "efficient rewind," based on EASA Tech Note 17, was not clearly established with all interviewees.

The first two objectives are addressed below, and the final objective is covered in the discussion of baseline activity in the following section.

Number of Efficient Rewinds

Regional data on efficient rewinds is not readily available, although in September 2008 the GPMG began tracking data on some of the efficient rewinds from its members (*i.e.*, those rewinds that receive a utility rebate). The GMPG is addressing this information gap and may be able to provide more comprehensive data in the future.

For the 2008 M&T analysis, each motor service center interviewed was asked to estimate (1) the approximate number of rewinds that they perform each year, (2) their share of the motor repair market in their state, and (3) the share of rewinds performed that are "energy efficient" as defined by EASA. The results are shown below in Table 4-7.

All of the correspondents interviewed *claimed* that they perform energy efficient rewinds. However, these claims cannot be verified with certainty via telephone, and specific probing questions that might have exposed a lack of familiarity with EASA guidelines were not asked. There are indications that at least some respondents, in fact, do not perform rewinds that would qualify as "energy efficient." Two service centers stated that they did not have all the equipment to test whether their rewinds were really efficient or not, although they claimed to follow best practices and believed that their rewinds maintain efficiency. Without the necessary equipment, these service centers cannot be considered to provide "efficient" rewinds as defined by EASA.

Table 4-7. Summary of Motor Service Center Interview Responses

Respondent	State	Annual Rewinds Performed	Share of State's Rewind Market	Share of Rewinds that are Energy Efficient
1	Oregon	90	Don't know	Claims that all his rewinds follow best practices
2	Idaho	500	15% to 20 %	30% to 35 %
3	Montana	500*	35% to 40%	99%
4	Washington	150 to 200	A fair share.	10%
5	Oregon	500 to 750	No idea. In the top 5	80%
6	Idaho	Don't know	30 % in South Idaho	65%
7	Oregon	200 to 300	Niche market; does not know percentage	100%
8	Washington	40 to 50	Small/ Don't know	100%
9	Washington	Don't know	1% - wild guess	75%
10	Washington	Don't know	Don't know	Majority

* The respondent from Montana claimed to perform 3,000 rewinds per year. This figure is significantly higher than the figures from other service centers, even in the more populous states. A significantly lower value of 500, equivalent to that reported by the service center in Idaho, was used in the M&T analysis.

The number of efficient rewinds performed in the Northwest cannot be estimated with a high degree of certainty. Self-reporting of data, as was done for rewinds, does not provide the level of accuracy and reliability that the motor shipment data provides. Also, given the uncertainty of some of the individual responses, a value for the number of rewinds—and efficient rewinds in particular—cannot be calculated without making assumptions about the quality of the responses themselves. The data do suggest, however, that a large share of rewinds are, in fact, "efficient" suggesting that there may be significant, region-wide energy savings from the rewind market. (Per-unit savings for efficient rewinds are estimated at slightly over half of the savings from replacement with premium efficient motors; see Section 4.3.3.)

According to the service center interviews, the majority of rewinds performed may, in fact, be "efficient." All respondents *claim* to perform efficient rewinds, and seven out of 10 estimated that 50% or more of their rewinds qualify as energy efficient. These self-reported figures may be biased high by the fact that some service centers (both GMPG participants and non participants) appear reluctant to admit that majority of their rewinds are not energy efficient. This finding is supported by the GPMG, which has anecdotal evidence that most motor service centers think they use best practices. It appears that while the amount of efficient rewinds is highly uncertain, service centers in general are aware of energy efficient rewinds and do offer them to customers upon request. However, savings from efficient rewinds are not included in the conclusions to this M&T analysis given that the interviews were not able to verify which rewinds actually meet the EASA guidelines. Findings from the interviews may be used to guide future M&T methods in order to better quantify efficient rewind activity.

Respondents were even less certain about their share of the statewide market for rewinds. Only four service center representatives were willing to provide a percentage estimate of their market share, and all of these estimates were either ranges or had additional caveats. In general, responses indicated that respondents represent 20% or less of the market.

For purposes of calculating energy savings from rewinds, the M&T analysis began with a conservative scenario in which just the respondents' self-reported data was tabulated (and data was not extrapolated to the state or regional level). Responses were used directly, and the lower values were used where a range was provided. This approach yielded a first-cut, lower-end estimate of 1,390 efficient rewinds per year performed in the Northwest.

Extrapolation to a regional rewind total is particularly difficult to perform due to the uncertainty in respondents' estimates of their statewide market share. However, using a rough figure (based loosely on the self-reported data) that respondents represent approximately 20% of the market, the total number of efficient rewinds performed in the Northwest was calculated to be 6,950 (1,390 from the self-reported data divided by the 20% market share). This estimate of regional rewinds represents approximately 13% of projected NEMA Premium™ motor sales in the Northwest in 2008, suggesting that rewinds may be a tangible, if smaller, source of energy savings.[21] (See Section 4.3.3 and the Conclusions discussion for additional information on energy savings from efficient rewinds.)

GPMG has begun collecting data on efficient rewind activity, but *only* from its members and *only* for rewinds receiving utility rebates. In the roughly seven months between September 2008 and March 2009, GPMG reported efficient rewinds totaling 13,250 horsepower.

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[21] The interview with the GMPG indicated that most motor rewinds are for motors larger than 75 HP, whereas motors below 75 HP are usually replaced by new motors. GMPG also indicated that the ratio of new motor sales to replacements may be in the range 15:1, but significantly lower for larger motors. Ted Jones of the CEE added that the repair-or-replace decision is dependent on the customer and that a the ratio of new vs. rewound motors cannot be reliably estimated without additional research. The CEE did not know of any such research conducted, but agreed that it would be of value to better understand this aspect of the motors market.

Trends in Motor Rewind Activity

Market activity regarding energy efficient rewinds has increased in the Northwest in the past three years. Six of 10 respondents said that market activity regarding efficient rewinds has increased in the state; this included four GMPG members, but also two service centers that are not part of the GMPG. This is significant, as non-members of GMPG are more likely to say that they have seen an increase in efficient rewind activity and that NEEA's efforts have made a difference. The service center that saw no increase in activity was a small service center in Washington. He said that his customers don't ask for efficient rewinds, they try to educate their customers and use best practices in at least 40% of their rewinds.

Most service centers (participants and non-participants) said that they had seen an increase in customer awareness regarding energy efficient rewinds. They also stated that most customers do not ask for rewinds; rather the service centers educate their customers and encourage them to choose efficient rewinds over purchasing new motors. GMPG participants are seeing a greater increase in activity than non-participants. Six service centers stated that the work that GMPG group and NEEA did is positively changing the rewinds market in the Northwest.

It was found that energy efficient rewind activity is also dependant on the type of customers. For example, one motor rewind shop in Idaho (a non-participant) stated that their customers that are in the mining industry and some old companies do not care about efficiency of the motor. They just want the cheapest and quickest repair. This was corroborated by another shop in Oregon that stated that OEM's are another set of companies that do not ask for efficient rewinds. The details of this survey are attached in the Appendix to this chapter of the M&T report.

Baseline Activity

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 costs significantly less than buying a new motor, customers tend to prefer rewinding. 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 was one of DPI's most notable achievements.[22]

At the time, the U.S. Department of Energy (DOE) stated on its website and in its Motor Master Plus software[23] that motor rewinds lead to a loss of at least 3% to 5 % in efficiency. This discouraged the end users from asking for rewinds, and it was widely believed that rewinding could not be performed without significant loss of efficiency. With the backing of NEEA, the GMPG and prominent motor service centers in the region effectively proved that energy efficient rewinds leading to less than a 1% loss in efficiency were possible. The success of this campaign was highlighted by the fact that DOE changed the default decrease in efficiency from motor rewinds to the values recommended by the GPMG. To get a better idea of where the repairs market would be without the interference of NEEA, the survey stated above was referred to.

NEEA has had a positive influence on the state of the market for efficient rewinds in the Northwest, From the 2008 M&T survey, six out of ten service centers said that the prevalence of efficient rewinds would

[22] Jim Williams of JC Williams Consulting.

[23] Motor Master Plus is a free software package provided by the DOE, which aims to help users better manage their motors. It is a direct competitor of the EM2 software.

have been significantly less without NEEA's influence. This included all the GMPG participants interviewed and one non participant. It was expected that most GMPG participants will agree to the fact that NEEA and GMPG are responsible for some of the change that has taken place in the market. NEEA and GMPG's efforts in educating service centers and customers were stated as the main factor in changing the state of the market in the Northwest. Service centers stated that the teachings of NEEA and the GMPG trickle down to the customers via service centers.

Most non participants had either not heard of the initiative, or responded that it did not affect them in any way. It is important to note here that smaller service centers with niche markets do not believe they are affected as much by these programs. 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 including additional technical assistance would not have grown as prevalent as they are today. Interpretation of the interviews and survey responses suggest that perhaps half or more of the efficient rewinds performed in 2008 would not have been performed had NEEA not intervened in the market.

Per Unit 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 Green Motors Practices Group, per-unit savings from efficient rewinds of motors of various sizes are calculated and presented in Table 4-8.

Table 4-8. 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

An average "per unit" savings value can be calculated by assuming a distribution of motor sizes across all efficient rewinds. This data is not available, but the distribution of NEMA Premium™ motor *sales* can be used as a proxy. Based on this assumption and on an average savings across motors in each size category, a weighted average savings of approximately 385 kWh per year is estimated for an efficient rewind (Table 4-9).

The interview 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. This suggests that the per-unit savings value of 385 kWh per year calculated above may be a low estimate due to the conservative assumption that the distribution of motor sizes for rewinds is the same as that for NEMA Premium™ motor sales. In practice, a greater share of rewinds may be larger motors which provide greater savings, on average, than the value calculated here.

Table 4-9. Average Per-Unit Savings from Efficient Rewinds

Size Category (*hp*)	Average Per Unit Savings (kWh/yr) (A)	Annual NEMA Premium™ Sales in the Northwest (B)	Distribution of Motor Sales (C) = (B) / Sum (B)	Implied Annual Energy Efficient Rewinds* D= (C * 6,950)	Annual Savings in the Northwest *MWh/yr* E = (A * D) / 1000
1 to 5	40	5,690	46%	3,197*	128
6 to 20	255	3,896	31%	2,155*	549
21 to 50	681	1,733	14%	973	663
51 to 100	1,200	583	5%	348	417
101 to 200	2,232	361	3%	209	465
201 to 500	6,146	141	1%	70	427
Total	**385****	**12,404**	**100%**	**6,950**	**2,649**

* Annual Energy Efficient Rewinds across all size categories were estimated to be 6,950 (see Section 4.3.1). In this table, the distribution of NEMA Premium™ motor sales by size category has been used as a proxy for the distribution of energy efficient rewinds, which may result in a skewing of the distribution in this analysis toward smaller motors, which produces a more conservative estimate of per-unit savings.

** Total (weighted) Average Per-Unit Savings was calculated from Total Annual Savings and Total Annual Sales: (Column E / Column D) * 1000. Values in the table have been rounded. This per-unit savings value is considered to be a low estimate due to the conservative assumption that the distribution of motor sizes for rewinds is the same as that for NEMA Premium™ motor sales. In practice, a greater share of rewinds may be larger motors which provide greater savings, on average, than is presented in this analysis.

Source: Based on GMPG data

Conclusions and Recommendations

- There has been a definite increase in awareness of energy efficient rewinds amongst service centers. All service centers interviewed stated that they do provide energy efficient rewinds to customers, and NEEA's efforts were identified as one of the key factors for this increase in awareness.

- Consumer awareness regarding efficient repair practices also has been increasing. Consumers are taking into account the operating costs of motors and are making more informed decisions. NEEA has been instrumental in bringing about this change in both the service centers and the consumers.

Furthermore, on a per-unit basis, savings due to energy efficient rewinds are estimated to be about 60% of the savings from premium efficiency motors—with the figure likely being even higher based on the fact that most rewinds are for larger motors. Based on the conservative estimates for the number of efficient rewinds performed and their associated savings, it is estimated that energy savings from rewinds is at least 0.3 aMW[24] and possibly more, with perhaps half of these savings exceeding baseline activity.

As noted in the main report, **future M&T efforts** should attempt to better quantify the rewind market and associated savings. Specifically, Summit Blue recommends the following steps for future M&T efforts regarding efficient rewinds:

- **Conduct a larger survey of motor service centers in the Northwest** to better understand and obtain more detailed information on what percentage of their services are energy efficient and better understand when customers choose energy efficient rewinds versus buying new motors. More detailed questions should be posed regarding the process for conducting an efficient rewind (*e.g.*, whether a core loss tester is used and how service centers operationalize the EASA guidelines), and an independent assessment should be made by the M&T team regarding which centers are, in fact, conducting qualified efficient rewinds.

- **Develop a more accurate estimate of efficient rewind baseline.** A survey with a larger sample set and more thorough questions will provide a better estimate and quantify the baseline for energy efficient rewinds.

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[24] For purposes of comparison to the 0.3 aMW calculated above from efficient rewinds, GMPG records show that 228,000 kWh, or less than 0.1 aMW, have been claimed in annual savings. This figure is for only seven months of data and is limited to rewinds from GMPG participants who claimed utility rebates.

Appendix B

Motor Service Center Survey Instrument

INTRODUCTION

Hi, my name is __________, and I'm from 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 get a feel for how the market for motor rewinds is changing. 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]

The information that you provide is completely confidential, and the results of our report will be aggregated so that no individual company's data will be shown.

Respondent Information

Name:

Title:

Company:

Phone:

Email:

Member of Green Motors?

QUESTIONS

For this study, we are interested only in MOTOR REWINDS IN THE NORTHWEST, which includes **Washington, Oregon, Idaho, and Montana**.

1. I am going to read of a list of four states. Would you say "yes" or "no" as to whether you rewind motors from customers in that state? [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 PNW as a whole, we would like to get a sense of your relative market share in the region. ***Please remember that all information you provide is completely confidential, and your company's information will in no way be reflected in our report.***

2. Can you tell me ***approximately*** how many total rewinds you performed each year for motors in service in the PNW between 2006 and 2008? [FILL IN TABLE 1 BELOW]

3. In your opinion, what percentage of the total rewinds in your state are you responsible for? ______%

4. Can you also estimate the percentage of motors you rewind in the Pacific Northwest that qualify as energy efficient rewinds between 2006 and 2008 as per Electrical Apparatus Service Association suggestions? Energy efficient rewinds are rewinds for motors that use best repair and practice methods as defined by EASA.[FILL IN TABLE 1 BELOW]

Table 1. Market Share of Energy Efficient Rewinds in the PNW

	2006	**2007**	**2008**
Q2. Total rewinds in PNW			
Q4. % efficient rewinds			

5. How has the activity regarding energy efficient rewinds changed over the past three years? What factors have led to these changes?

6. Has the general awareness of Energy Efficient rewinds among the customers and motor service centers changed over the years? If so, what are the changes you have observed (Open Ended)? If not, skip to 8?

7. What in your opinion are the reasons for this change in attitude towards energy efficient rewinds?

8. A. Would the number of efficient rewinds being performed today be different without the Electric Motor Management Initiative? What impact do you think the Initiative has had?

   B. What other market factors may be increasing the number of efficient rewinds in the PNW? In what way?

9. In your opinion, does an energy efficient rewind actually maintain the efficiency of a motor? (Prompt: Compared to prior to the rewind? Compared to a "normal" rewind?) If so to what degree?

10. Do you have any other comments regarding the use of efficient rewinds?

Thank you very much for participating in our survey. This information will help NEEA determine the ongoing impacts of their Drive Power Initiative.

5 BacGen

In 1997, BacGen Technologies, Inc (BacGen) approached NEEA with a proposal to reduce the energy consumption of small- to medium-sized wastewater treatment facilities with a proprietary mix of micronutrients and process control technologies.[25] BacGen's proposal differed from previous energy efficiency efforts in the wastewater market in that it focused exclusively on optimizing the wastewater treatment process instead of improving building performance (lighting, HVAC, etc). BacGen and NEEA signed an initial 3-year initiative contract to develop and demonstrate the technologies' capabilities beginning in January 1999, and the contract was extended in 2001 with a renewed focus on aeration process control for the small- to medium-sized facilities, defined in this report as facilities with design capacity between 0.1 and 20 million gallons per day. The goal of the initiative was for BacGen to succeed as a business serving this market segment of the wastewater treatment industry and for potential competitors to show interest in BacGen's technical approach.

The 2008 M&T assessment for BacGen builds upon the data collection activities undertaken in the 2005 and 2006 M&T reports and focuses on wastewater optimization for BacGen's target market of small- to medium-sized facilities.

5.1 Indicators and Assumptions for Review

Consistent with the approach used to update the ACE model in the 2006 M&T report, the gross energy savings impact of the BacGen initiative is based on the product of:

1. total design capacity of BacGen's *wastewater process optimization projects* in the Northwest (MGD), and
2. estimated annual average energy savings per unit capacity (kWh/MGD/yr).[26]

Other indicators of BacGen's market activity discussed in this report include wastewater and freshwater design consultation projects, freshwater process optimization projects, and projects completed outside of the Northwest.

5.2 Methodology

The primary difference in methodology from the 2006 M&T report is that interviews were conducted with industry-related organizations, rather than individual facilities, for an external perspective on BacGen's role in the market. The following activities were conducted:

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[25] The single BacGen measure, referred to by NEEA as "Process Controls", consists of continuous monitoring to optimize the aeration process, thereby allowing motor use to be reduced while maintaining or improving effluent quality. This measure is referred to as "wastewater optimization" in this report.

[26] MGD is the wastewater treatment capacity at design conditions, quantified in millions of gallons treated per day. To find the annual energy savings per unit capacity of all BacGen's projects, the savings estimate (kWh/yr) provided for each optimization project was adjusted by the total design capacity of the project (MGD) and the project-specific per-unit savings (kWh/yr/MGD) were aggregated on an annual basis.

- **Reviewed previous project documentation,** including a review with the NEEA planning analyst (Christine Jerko) of the ACE model inputs for the 2008 update.
- **Assigned design capacities to BacGen's 2007 and 2008 projects from the most recently available EPA wastewater capacity database.**
- **Contacted the NEEA BacGen project manager (Andy Ekman)**.
- **Contacted the initiative contractor (Martin Shain of BacGen)**
- **Performed web searches and interviews to identify potential competitors.**

5.3 Findings

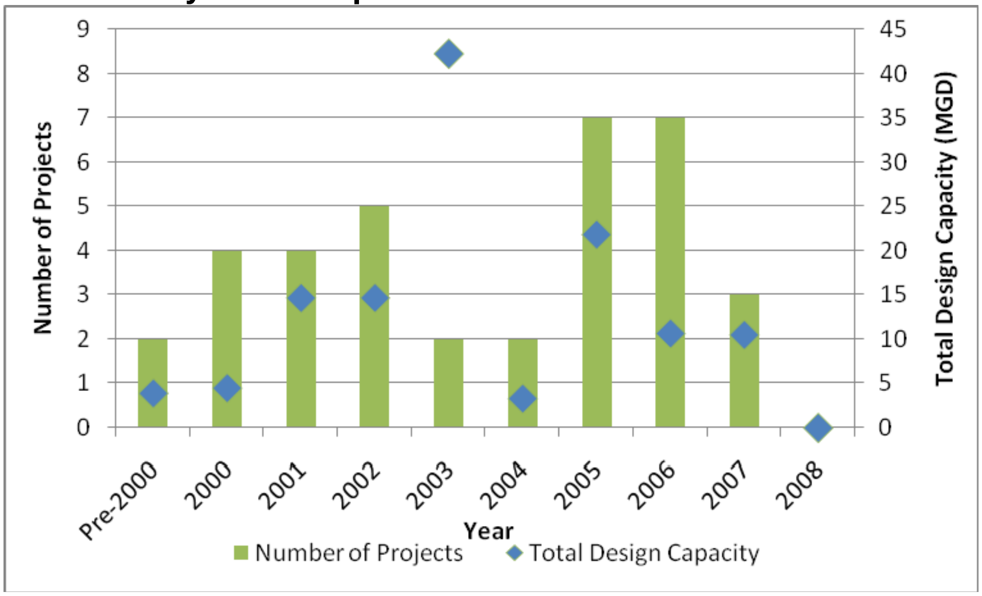
5.3.1 Market Activity

BacGen Wastewater Process Optimization Activity in the Northwest

The past two years represent a marked decline in regional optimization project activity for BacGen (Figure 5-1). BacGen implemented three wastewater process optimization projects in the Northwest in 2007 (representing 10.5 MGD of additional market activity)[27] and none in 2008; BacGen's market activity for wastewater optimization in the Northwest now totals 126 MGD. The reduced availability of incentives from the Bonneville Power Administration and Energy Trust of Oregon, combined with tight capital budgets among municipal wastewater agencies, are the primary drivers for this decline, as illustrated in Figure 5-1.

[27] The characteristics of the three optimization projects were consistent with previous projects in terms of size, type, and energy savings.

Figure 5-1. BacGen Wastewater Optimization Projects and Capacities in the Northwest by Year Completed



Source: 2008 BacGen database.

Presence of Competitors

BacGen appears to be the only company in the Northwest aggressively promoting process optimizations for the sake of energy efficiency. While most other civil engineering companies involved in the wastewater market (i.e. "other wastewater companies") are technically capable of providing the same process optimization services as BacGen, they traditionally emphasize meeting compliance regulations as their primary product and offer process optimizations as a secondary service. BacGen also continues to differentiate itself by focusing on the smaller facilities with fewer available resources that are typically passed over by other wastewater companies in favor of more profitable larger facilities. Thus, the project team concludes that *no other company in the Northwest actively provides process optimizations to facilities in the 0.1-5 MGD size range* and few companies provide process optimization services to 5-20 MGD facilities.[28]

Other BacGen Market Activity

BacGen also offers process optimization and design consulting services for both wastewater and freshwater facilities. Freshwater optimization projects account for the majority of BacGen's non-wastewater optimization projects and energy savings (Figure 5-2), and are equivalent to 45% of BacGen's wastewater optimization savings in the region. These savings are considerable and the findings of MPER-3 suggest that NEEA funding may have significantly influenced BacGen's entrance into this market.

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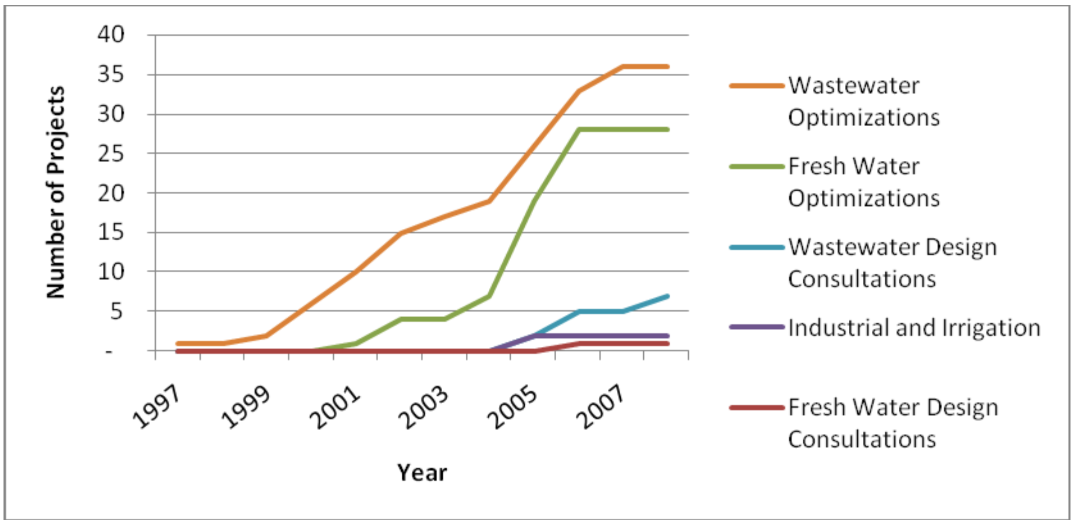
[28] Since other companies in the Northwestern market typically only provide process optimizations to 5-20 MGD facilities as part of more significant upgrades, they are not considered direct competitors.

However, no freshwater projects have been completed in the Northwest since 2006 and inclusion of these project savings would require additional investigation.[29]

Recently, BacGen has shifted its focus towards process design consulting, which involves looking at new facility designs and making recommendations on how to achieve energy efficiency through designs and upgrades. To date, BacGen has performed design consulting services for seven wastewater treatment facilities in the Northwest—two of these projects were completed in 2007-2008. NEEA may consider including some level of savings from these projects in future initiative accounting, since BacGen acknowledged that NEEA had originally directed the company to focus on this consulting business from the beginning, in addition to its process optimization implementation business.[30]

Figure 5-2. Cumulative Number of BacGen Projects in the Northwest by Type



Source: 2008 BacGen database.

5.3.2 Baseline Activity

The energy savings attributable to baseline activity are those due to wastewater treatment efficiency measures that would have occurred in the absence of the BacGen initiative. The 2006 M&T report estimated a 5-10% baseline for projects less than 20 MGD and a case-by-case baseline for facilities larger than 20 MGD. The 2008 project team believes that the growing emphasis on energy efficiency may increase the number of projects undertaken by the facility operators themselves or by other wastewater companies in conjunction with their primary services, depending on the facility's size:

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[29] To include freshwater optimization savings in NEEA reported savings, the following would be needed: third-party verification of BacGen savings data, a separate baseline, and a source for freshwater facility design capacity since the EPA database only covers wastewater facilities.

[30] To include design consultation savings in NEEA reported savings, the savings data from BacGen would need third-party verification, potentially through interviews with facilities that received a design consultation to determine which measures they implemented from BacGen's recommendations and what level of savings they actually achieved.

- *0.1-5 MGD:* Based on research findings, another wastewater company would not have implemented the process optimization at these smaller facilities due to the low potential for profit. However, the 2006 M&T report found 5-10% of baseline activity occurring in this size range from facility operators independently implementing one or more optimization measures without assistance from an external company. To reflect the market trend towards energy efficiency, *the project team recommends a 10% baseline for projects under 5 MGD.*

- *5-20 MGD:* Other wastewater companies are increasingly likely to implement energy efficiency measures in these facilities as part of required facility upgrades, but they are unlikely to offer a process optimization otherwise, due to a lack of potential profit for the company. Relative to smaller facilities, however, the greater energy consumption, budget, staff, and exposure to available information make it more probable that operators at medium-sized facilities would independently install portions of a process control system in the absence of BacGen. As such, *a 20% baseline is recommended for 5-20 MGD projects.*

- *Greater than 20 MGD:* Larger facilities often have greater energy consumption, more customer revenue, and more sophisticated resources, including the ability to internally implement and operate a process control system. Furthermore, most other wastewater companies willingly offer energy efficiency measures to large facilities. Thus, it is reasonable to assume that most large facilities would have still pursued an efficiency project in the absence of BacGen.[31] Accordingly, *95% of savings from large facilities are recommended for treatment as baseline activity going forward*.

When these baseline assumptions are applied to all completed projects, a baseline market activity of 7.0 MGD is calculated.

5.3.3 Per-Unit Energy Savings

Table 5-1 presents energy savings data for BacGen projects in the Northwest in the past two years, both in aggregate and normalized for design capacity. The average energy savings per unit design capacity increased slightly from the 203,550 kWh/MGD/yr reported in 2006 to 209,860 kWh/MGD/yr through 2008.

[31] The 2006 report found that the only project over 20 MGD completed by BacGen thus far would not have occurred in the absence of BacGen. However, this project was described as “an anomaly” in the 2006 M&T report because of the unusual facility characteristics.

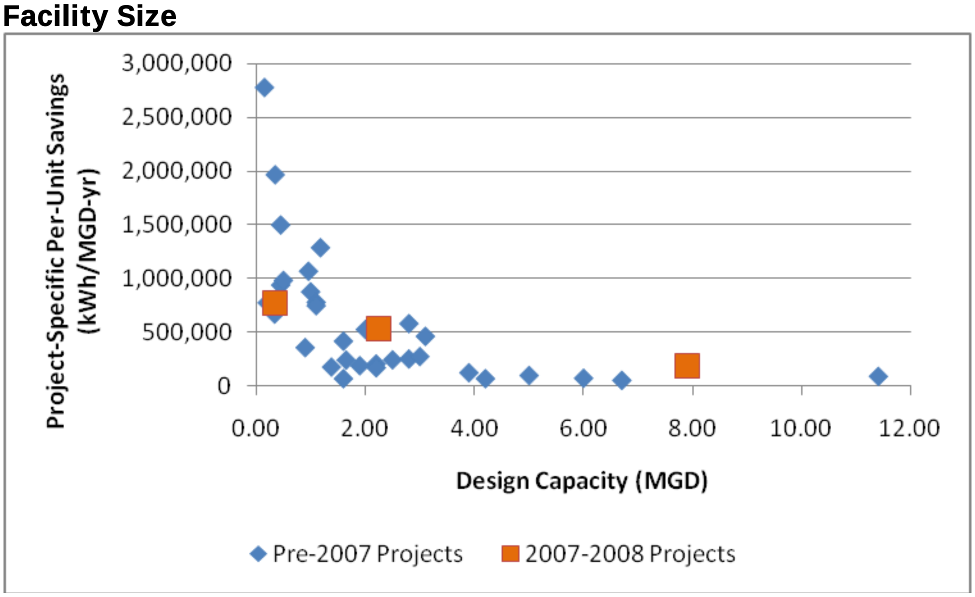
Table 5-1. BacGen Savings from Wastewater Optimization Projects in the Northwest by Year

Year	Number of Projects	Total Design Capacity (MGD)	Annual Energy Savings (kWh/yr)	Per-Unit Savings (kWh/MGD/yr)
Pre-2000	2	3.90	2,497,660	640,430
2000	4	4.49	2,515,260	560,190
2001	4	14.65	2,201,470	150,270
2002	5	14.65	1,920,250	131,080
2003	2	42.18	4,261,830	101,040
2004	2	3.30	1,211,740	367,190
2005	7	21.80	4,143,430	190,070
2006	7	10.64	4,781,460	449,390
2007	3	10.49	2,932,700	279,570
2008	0	0	0	0
Total	***36***	***126.1***	***26,465,790***	***209,860***

Source: 2008 BacGen database.

As recommended in the 2006 M&T report, the BacGen-reported numbers are likely the most accurate source of savings data. Figure 5-3 shows that the 2007 savings reported by BacGen fall within the range of per-unit savings reported for past projects. Thus, the 2007 and 2008 annual energy savings were not subject to additional independent verification.

Figure 5-3. BacGen Per-Unit Savings for Wastewater Optimization Projects by Facility Size



Source: 2008 BacGen database and EPA CWNS 2004 Wastewater Treatment Flow Data.

5.4 Conclusions and Recommendations

BacGen continues to perform wastewater optimization projects in the Northwest, although at a slower pace than in previous years. The market is slowly maturing but shows little indication of a major transformation. The following are some of the major M&T conclusions regarding market activity for BacGen and the broader wastewater industry in the Northwest:

- **BacGen's wastewater optimization project activity has declined in the Northwest.** Because of the region's economic conditions, this trend is likely to continue unless external project funding increases.

- **BacGen is the only company in the Northwest that is actively promoting wastewater process optimizations to smaller facilities (0.1 - 5 MDG) or to medium-sized facilities (5 – 20 MGD) expressly for purposes of energy efficiency** (as opposed to being part of a facility upgrade).

- **BacGen is shifting its business away from wastewater process optimization projects in the Northwest.** The company is focusing more on design consultation than on process optimization in the Northwest and actively pursuing all project types in other regions.

- **The baseline assumed for market activity beginning in 2007 and going forward should be increased to reflect the growing focus on energy efficiency within the wastewater industry.** This growing focus increases the likelihood that the facilities themselves or other companies in the wastewater industry will implement wastewater optimizations, which are traditionally outside of their primary service offerings. Since the extent of the facility's focus on energy efficiency and ability to implement measures was found to be size-dependent the recommended baseline for projects completed after 2006 is 10% of market activity for facilities with 0.1-5 MGD of design capacity, 20% for 5-20 MGD facilities, and 95% for facilities over 20 MGD.

Table 5-2 presents the incremental changes in market activity, baseline activity, per-unit energy savings, and implied energy savings between the values recommended for 2008 and NEEA's 2007 values for *wastewater process optimization projects only*. The three wastewater optimizations completed in the Northwest in 2007-2008 represented a gross design capacity of 10.5 MGD and a 0.2 aMW increase in the implied energy savings for 2008.

Table 5-2. M&T Recommendations for Key Indicators

Key Indicators Reviewed*		NEEA 2007 Cumulative Values**	2008 Recommended Cumulative Values	2008 Incremental Values (2008 minus 2007)	Source
Current Market Activity					
Wastewater Optimization Total Design Capacity (MGD)	Pre-2007	115.6	115.6	0.0	Section 1.3.3; EPA CWNS 2004
	2007-2008	0.0	10.5	10.5	
	Total	**115.6**	**126.1**	**10.5**	
Baseline Activity					
Wastewater Optimization Total Design Capacity (MGD)	Pre-2007	0.0	5.2	5.2	Section 1.3.2; Interviews
		*Apply the baseline recommended in the 2006 M&T report: 5-10% for projects 0.1-20 MGD and 0% for projects over 20 MGD (to be assessed on a case-by-case basis).****			
	2007-2008	0.0	1.8	1.8	
		Adjust the baseline to reflect recommendations from the 2008 M&T report: 10% for projects 0.1-5 MGD, 20% for projects 5-20 MGD, and 95% for projects over 20 MGD.			
	Total	**0.0**	**7.0**	**7.0**	
Per-Unit Energy Savings					
Wastewater Optimization (kWh/MGD/yr)		203,556	209,863	6,307	Section 1.3.3; ACE Model.
Implied Energy Savings****					
Wastewater Optimization Implied Energy Savings (aMW)	Pre-2007	2.7	2.6	(0.0) *[rounded]*	aMW = MWh divided by 8760 hours
	2007-2008	0.0	0.2	0.2	
	Total	**2.7**	**2.9** *[rounded]*	**0.2**	

* Design consultation and freshwater optimization projects not included due to lack of verified savings data. See discussion in Market Activity section about future reporting of these savings.

** Values taken from Excel file "BacGen APR 2007.xls". These values did not include the baseline activity recommended in the 2006 M&T report.

*** For projects completed prior to 2007, it is recommended that NEEA apply a 5% baseline to projects 0.1-5 MGD, a 10% baseline for projects 5-20 MGD, and a 0% baseline for BacGen's 2003 project over 20 MGD, as recommended in the 2006 report.

**** Implied Energy Savings represent estimated savings from market activity less estimated savings from baseline activity. Implied Energy Savings are presented for comparison purposes only between NEEA's 2007 values and the 2008 M&T findings. 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: BacGen and Summit Blue analysis

Without a significant change in Northwestern energy prices, utility incentive levels, federal stimulus, or some other external funding source, it is unlikely that future M&T research focused solely on wastewater process optimization projects in the Northwest would be warranted. However, if the project economics of process optimizations were to change for BacGen in the Northwest, future M&T research might find a considerable amount of energy savings attributable to NEEA's initial project support.

The 2008 project team recommends that biennial M&T research continue only if NEEA staff believes that, over the course of the next two years, BacGen maintains an active presence in the Northwest through completion of optimization and design consultation projects. In this case, the M&T assessment should proceed according to the following guidelines:

- **Continue using the project savings reported by BacGen.** As long as the BacGen-reported savings of future projects continue to be reasonable and consistent with previously reported values, they should be aggregated as annual savings for input into the ACE model.

- **Increase the baseline for projects completed after 2006.** For small facilities, defined as having 0.1-5 MGD of design capacity, 10% of market activity can be reasonably treated as baseline activity. Similarly, 20% is the suggested baseline for medium-sized facilities with 5-20 MGD of capacity and 95% is recommended for large facilities over 20 MGD. Since these baseline estimations are based on the evolution of the market, they should be reevaluated in subsequent M&T reports and potentially increased if energy efficiency becomes more ingrained in standard industry practice.

- **Consider including and verifying savings from design consultation projects and from freshwater process optimization projects.**

    - If BacGen continues to pursue *design consultation* work in the Northwest, NEEA may consider including some level of savings from these projects in its initiative accounting, since NEEA can reasonably claim that its funding allowed BacGen to build the fundamental skills it requires for design consulting projects. BacGen has provided savings data for all design consultation projects to date, but these numbers would need to have third-party verification. One potential method of verification includes interviewing facilities that received a design consultation to determine which measures they implemented from BacGen's recommendations and what level of savings they actually achieved.

    - The reported savings from *freshwater process optimization* projects are currently unverified but potentially significant. If this market continues to grow in the Northwest, NEEA may consider verifying the reported savings, determining an appropriate baseline, and locating the design capacity of each facility in order to include these savings.

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