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# Drive Power Initiative – 2018 Long Term Monitoring and Tracking Report

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## Table of Contents

# Introduction

The Northwest Energy Efficiency Alliance's (NEEA) Drive Power Initiative (DPI) (via the Green Motor Initiative [GMI][1] and the Green Motors Practices Group [GMPG])[2] encouraged adoption of green motor rewind practices by Northwest motor service centers between 1999 and 2004. Green rewind practices are rigorous and include motor testing. When motor service centers use these practices in commercial, agricultural, and industrial motor rewinds, the energy efficiency of these motors is maintained or improved; often, this is not the case with standard motor rewinds.

Since the DPI's inception, the GMPG has actively promoted these practices, and GMPG-verified member motor service centers and their customers are eligible to receive utility incentives for green motor rewinds. For motor rewinds that meet GMPG specifications (see Appendix A for a list of these specifications), several utilities across the region provide incentives of $2 per horsepower, per GMPG member service center. Each member service center retains $1 per horsepower rewound and passes the other $1 per horsepower rewound directly to the customer. Nonmember service centers remain ineligible to receive utility incentives.

In 2013, NEEA began ongoing long-term monitoring and tracking (LTMT) of the DPI, including an update of key assumptions used by NEEA in its Alliance Cost Effectiveness (ACE) model. This report, prepared by The Cadmus Group (Cadmus), presents the 2018 LTMT findings.

Cadmus collected a range of data to meet three major objectives:

- Update the size of the motor rewind market in the Northwest
- Establish the market share of green motor rewinds
- Calculate regional savings for green motor rewinds

The report presents an overview of key findings and historical trends, followed by a brief discussion and three appendices that provide further details on the DPI and LTMT, Cadmus' methodology, and a sample data collection form.

[1] The GMI offers electric utility-financed incentives for rewinds meeting the GMI standards. See http://www.greenmotors.org/gmi.htm.

[2] The non-profit GMPG oversees the services and practices of the GMI. See http://greenmotors.org/about_gmpg.htm.

# Key Findings

This section presents key takeaways, a summary of 2018 results, and historical trends in the motor rewind market.

## Key Takeaways

### The Northwest motor rewind market continues to contract

### Fewer motor service centers performed motor rewinds in 2018

Cadmus determined that 70 motor service centers (30 GMPG members and 40 nonmembers) in the Northwest market conducted motor rewinds in 2018, a decrease from 80 (32 GMPG members and 48 nonmembers) in 2017.

80 (2017) > 70 (2018)

### The estimated number of motor rewinds in the Northwest continued to decrease

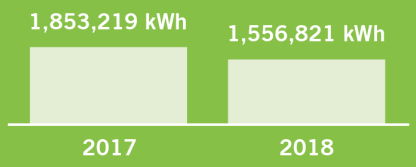
As in prior years, the estimated number of motor rewinds (standard and green) in the Northwest continued to decrease. The estimated number of motor rewinds decreased by 58 motors from 2017 to 2018.

2,622 (2017) > 2,564 (2018)

### Total estimated savings from green motor rewinds continue to decrease

Since 2013, estimated energy savings from green motor rewinds have decreased year-over-year (excepting from 2016 to 2017), from 2,632,305 kWh in 2013 to 1,556,821 kWh in 2018.

### From 2017 to 2018, regional savings decreased 16%




### Two primary factors contributed to the decreased energy savings from 2017 to 2018

#### Fewer green motor rewinds performed in 2018

The estimated number of green motor rewinds decreased by 20 motors from 2017 to 2018.

372 (2017) > 352 (2018)

#### Decrease in total reported horsepower rewound to green motor specifications for industrial motors

Motor service centers reported a 21% decrease in total horsepower rewound to green motor specifications for industrial motors (which operate longer than motors in agricultural settings and therefore achieve higher energy savings) in 2018 compared to 2017.

## Summary of 2018 Results

This section presents Cadmus' key findings for 2018, organized by market size, market share of green motor rewinds, and regional savings.

### *Market Size*

Cadmus determined that 70 motor service centers (30 GMPG members and 40 nonmembers) in the Northwest market conducted motor rewinds in 2018, a decrease from 80 service centers (32 GMPG members and 48 nonmembers) in 2017. The decrease primarily resulted from motor service centers going out of business, merging with another motor service center, confirming they did not perform or are no longer performing motor rewinds, or motor service centers not performing any rewinds in the Northwest during 2018.

The following describes performance by member and nonmember centers:

- **Total Number of Rewinds**. In 2018, motor service centers performed an estimated 2,564 motor rewinds (green and standard) in the Northwest. Of those, GMPG members performed 1,718 (67%) and nonmembers performed 846 (33%).
- **Total Horsepower Rewound**. In 2018, motor service centers rewound motors representing 342,689 horsepower (green and standard) in the Northwest. GMPG members rewound 275,263 horsepower (80%), and nonmembers rewound 67,426 horsepower (20%).
- **Motor Rewind Applications**. Overall, in 2018, industrial motors accounted for 53% of the total horsepower rewound at GMPG member motor service centers and 43% at nonmember motor service centers. Agricultural motors accounted for the remaining 47% and 57% of total horsepower rewound, respectively, for GMPG members and nonmember motor service centers.
- **Undocumented Rewinds.** Cadmus compared the number of green motor rewinds self-reported by motor service centers in the survey to the number of green motor rewinds recorded by GMPG (which tracks green motor rewinds documented by motor service centers for receipt of utility incentives). This comparison revealed that motor service centers did not document (and therefore did not receive incentives for) an estimated 28% of their total self-reported green motor rewinds. These non-documented/non-incented green motor rewinds constituted 21% of the total horsepower rewound using green rewind practices. Table 1 lists the number of rewinds by application that motor services centers reported to GMPG for incentive payments (as reported to Cadmus), along with the percentage undocumented by GMPG.

**Table 1. GMPG Green Motor Rewinds Documented and Undocumented for 2018**

| Sector | Number of Rewinds | | |
|---|---|---|---|
| | GMPG Documented (n = 21) | Reported to Cadmus (n = 21) | Percent not Documented by GMPG |
| Agricultural | 64 | 126 | 49% |
| Industrial | 123 | 133 | 8% |
| **Total** | 187 | 259 | 28% |

## *Market Share of Green Motor Rewinds*

As shown in Table 2, Cadmus found that, out of the total 1,718 motor rewinds performed by GMPG member service centers in 2018, an estimated 351 were green motor rewinds, representing 20% of GMPG member rewinds and 34% of GMPG member horsepower rewound. One nonmember performed one green motor rewind in 2018, representing <1% of nonmember rewinds and 1% of nonmember horsepower.[3]

**Table 2. Green Motor Rewind Market Share by Number of Rewinds and Horsepower Rewound**

| | Number of Rewinds | | | Horsepower Rewound | | |
|---|---|---|---|---|---|---|
| | Total Rewinds | Green Motor Rewinds | Percent Green Motor Rewinds | Total HP | Green Motor Rewind HP | Percent Green Motor Rewind HP |
| **Member (N=30)** | 1,718 | 351 | 20% | 275,263 | 94,544 | 34% |
| **Nonmember (N=40)** | 846 | 1 | 0.1% | 67,426 | 350 | 0.5% |

## *Regional Savings*

Green motor rewinds performed in 2018 by GMPG members resulted in an estimated annual total of 1,556,821 kilowatt hours (kWh) in energy savings. Table 3 provides annual kWh energy savings from green motor rewinds (by state) for GMPG members and nonmembers.

[3] Given that only one nonmember performed a green motor rewind and likely does not represent the nonmember population, Cadmus did not extrapolate the sample green rewind to the population of nonmember service centers.

**Table 3. 2018 Annual kWh Savings from Green Motor Rewinds**

| State | Green Motor Rewind Savings (Annual kWh) | | |
|---|---|---|---|
| | Member | Nonmember | Total |
| Washington | 665,207 | 0 | 665,207 |
| Oregon | 316,938 | 0 | 316,938 |
| Idaho | 567,756 | 0 | 567,756 |
| Montana | 0 | 6,919 | 6,919 |
| **Total** [1] | 1,549,902 | 6,919 | 1,556,821 |

[1] Total does not equal sum of column due to rounding.

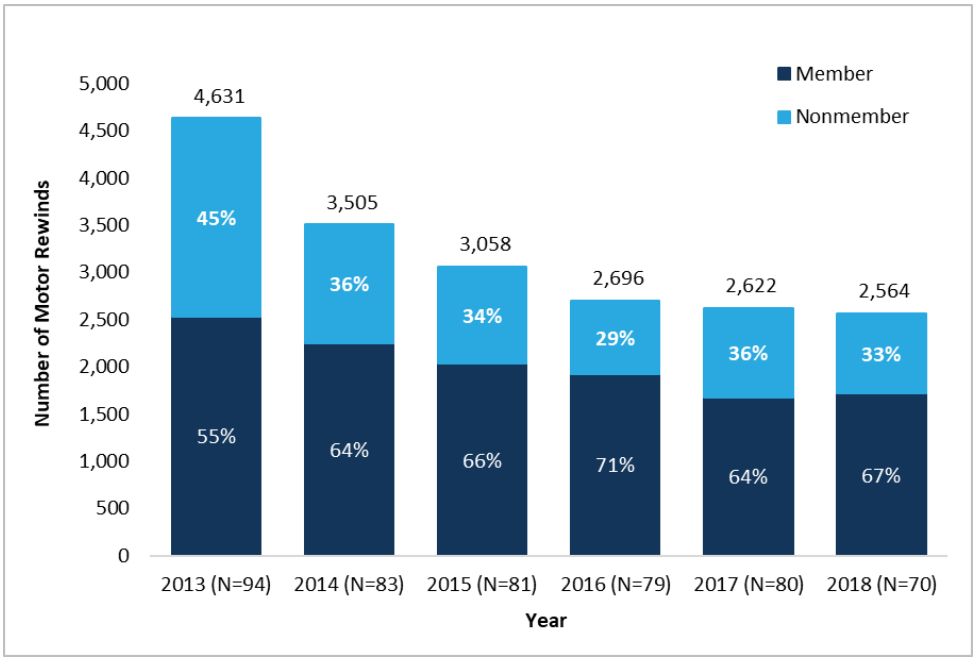
## Historical Trends

This section presents historical trends for the number of motor rewinds, the market share of green motor rewinds, and regional savings.

### Number of Rewinds

As illustrated in Figure 1, Cadmus found that the estimated number of motor rewinds in the Northwest decreased substantially from 4,631 in 2013 to 2,696 in 2016, a decrease of 1,935, and then remained steady, decreasing slightly by 132 motors from 2016 to 2018. The overall decrease in estimated motor rewinds since 2013 most likely resulted, in part, from a general decline in the motor rewind industry (e.g. due to less expensive motors and to a decline in the number of U.S.-based industrial manufacturing facilities). This decrease probably is also attributable to an increasingly accurate profile of the motor service market as motor service center participation in sharing sales data with NEEA grew, and as Cadmus adjusted the nonmember population size estimates over time to account for ineligible businesses (i.e. those that do not perform motor rewinds).

**Figure 1. Historical Extrapolated Number of Motor Rewinds**




## Green Rewind Market Share

Table 4 shows the penetration of green motor rewinds practices among GMPG members by study year. Between 2013 and 2018, the percentage of GMPG member green motor rewinds fluctuated between 20% and 33%. In 2018, both the number and percentage of GMPG member green motor rewinds decreased slightly from the prior year—from 372 green motor rewinds, representing 22% of total motors rewound by GMPG members in 2017, to 351 green motor rewinds, representing 20% of total motors rewound by GMPG members in 2018. The percentage of horsepower rewound to green motor rewind specifications also decreased, from 38% of GMPG member horsepower in 2017 to 34% 2018.

**Table 4. Market Share of Green Motor Rewinds Among GMPG Members by Study Year**

| | Market Share | | | | | |
|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| **Number of Motor Rewinds** | 29% | 22% | 23% | 33% | 22% | 20% |
| **Horsepower Rewound** | 34% | 34% | 32% | 37% | 38% | 34% |

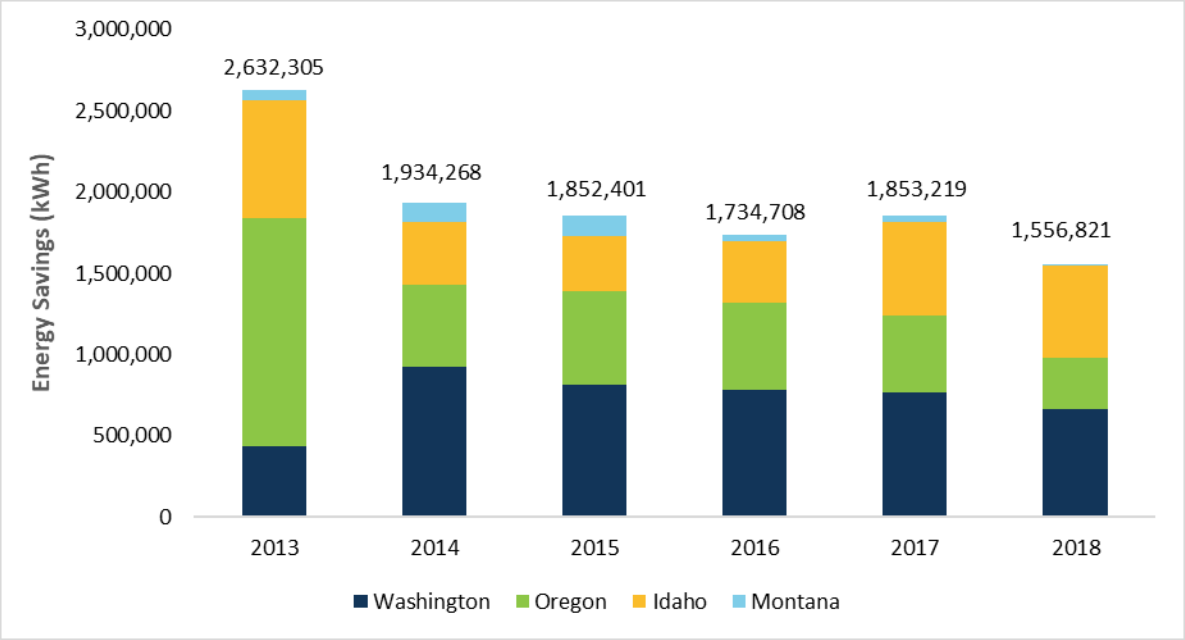
## Regional Savings

Figure 2 shows extrapolated regional savings over time. Since 2013, total savings have decreased year-over-year, except for 2017, when Cadmus found that, despite decreases in the estimated number and percentage of green motor rewinds performed, estimated savings

increased in 2017 due to an increased number of large horsepower industrial motors reported to Cadmus.

The savings decrease from 1,853,219 kWh in 2017 to 1,556,821 in 2018 primarily resulted from a decrease in the estimated number of green motor rewinds performed—352 green motor rewinds (351 GMPG-member green rewinds and one nonmember green rewind), compared to 372 green motor rewinds performed in 2017. Additionally, the total horsepower of industrial motors rewound to green motor specifications reported to Cadmus decreased by 21% from 42,835 horsepower in 2017 to 33,895 horsepower in 2018. Because motors in industrial applications typically operate for more hours within a year than motors in agricultural settings, energy savings are higher for industrial green motor rewinds than rewinds in agricultural applications.

**Figure 2. Historical Extrapolated Regional Savings**



# Discussion

- The Northwest motor rewind market continues to contract. The estimated number of motor rewinds (standard and green rewinds) in the Northwest has decreased year-over-year, from 4,631 in 2013 to 2,564 in 2018. This decrease probably is in part attributable to an increasingly accurate profile of the motor service market as motor service center participation in sharing sales data with NEEA grew, and as Cadmus adjusted the nonmember population size estimates over time to account for ineligible businesses (i.e. those that do not perform motor rewinds). The current and prior studies, however, have provided evidence of a general decline in the motor rewind industry. Fewer motor service centers operate in the Northwest. Cadmus determined that 70 motor service centers performed motor rewinds in 2018, compared to 80 in 2017. This decrease in the population size estimate in 2018 primarily results from motor service centers indicating they had gone out of business or merged with another motor service center, no longer performed motor rewinds, or had not performed any rewinds in the Northwest in 2018. Cadmus' and NEEA's prior market intelligence research suggest a contracting Northwest motor rewind market due to less expensive new motors, encouraging motor replacements rather than repair, and a declining number of U.S.-based industrial manufacturing facilities.[4]
- Since 2013, the number of green motor rewinds performed has decreased year-over-year, as has the estimated number of green motor rewind savings (excepting 2017). Between 2013 and 2018, the percentage of GMPG member green motor rewinds fluctuated between 20% and 33%. Green motor rewinds have not become standard practice in the Northwest. Further increases in green motor rewinds appear unlikely without additional market intervention.

[4] *Cadmus*. *Evaluation of Key Ace Model Assumptions for Motor Rewinds.* Prepared for NEEA. February 14, 2014

# Appendix A. Drive Power Initiative and LTMT Background

NEEA funded the Drive Power Initiative (DPI) between 1999 and 2004 to increase motor efficiency and to transform the electric motor market. The Electric League of the Pacific Northwest provided initial funding.

Through the DPI, NEEA sought to achieve the following objectives:

- Increase the region's overall motor fleet efficiency
- Influence end users' decision-making processes to repair or replace motors, and encourage consideration of lifecycle costing in investment decisions
- Help motor service centers improve their repair practices and expand their motor management services

In 2007, NEEA began tracking activities and trends in the drive power and motor rewinds markets through its LTMT efforts.

Also in 2007, the Green Motors Practices Group (GMPG) submitted a request to the Regional Technical Forum (RTF) for approval of deemed savings for motors rewound by participating GMPG member service centers. GMPG further requested that the RTF recognize and include green motor rewinds on its list of eligible energy efficiency measures. Later that year, the RTF approved green motor rewinds as an eligible energy efficiency measure.

Shortly thereafter, a group of northwest utilities convened to discuss an approach for supporting certified green motor rewinds at GMPG member service centers. The utilities decided to pursue a regional approach, focusing on helping the GMPG, utilities, and motor service centers achieve increased numbers of certified green motor rewinds. Though the group of utilities recognized that success depended on agreeing to a simple, market-based approach (e.g., providing incentives for green motor rewinds), it understood that complete uniformity in executing the approach might not be possible due to utility-specific preferences.

With assistance from NEEA and the region's utilities, the Bonneville Power Administration (BPA) formed the Green Motor Initiative (GMI) in 2008. GMI sought to educate, train, and certify service centers to follow effective shop procedures and to offer service centers and end users incentives for efficient motor rewinds.

Specific GMI objectives included the following:

- By 2010, grow the GMPG to self-sustain through membership and utility programs
- By 2010, ensure Northwest motor service centers train personnel and adopt GMPG rewind practices

- Continue to promote customer motor management practices that result in all industrial customers demanding GMPG-certified rewinds

Via the GMI and the GMPG, the DPI encourages the Northwest's motor service center market to adopt green motor rewind practices. These practices reduce energy use for motors utilized in the agricultural and industrial sectors. Green motor rewinds require rigorous testing and offer greater energy savings compared to standard motor rewinds.

Service centers offering these services must, at a minimum, meet the following GMPG specifications for green motor rewinds:

- There must be no visible damage to the motor's core
- The burn-off temperature must not exceed 385 degrees Celsius (720 degrees Fahrenheit) using verified water-mist controls
- The motor must undergo two (or more) core loss tests before and after stripping. The final core's test watts loss per pound must be no more than 20% greater than the results from the first test
- No hot spots may occur that are greater than 10 degrees Celsius
- Final core tests must be less than or equal to 4 watts loss per pound
- The new winding must achieve an equivalent to the manufacturer's original length and (may exceed) circular mils (voltage changes must be calculated to circular mil equivalents)

For green motor rewinds, BPA, Energy Trust, and other regional investor-owned utilities provide incentives of $2 per horsepower, per GMPG member service center. Each member service center retains $1 per horsepower rewound and passes the other $1 per horsepower rewound directly to the customer as part of GMPG's member agreement. Nonmember service centers remain ineligible to receive utility incentives.

GMPG serves as the program administrator for each of the region's utilities and provides the documentation necessary for each utility to claim savings and pay incentives. Monthly, GMPG collects this documentation from each member service center.

Although NEEA no longer provides funding, GMI's formation would not have been possible without NEEA's initial funding of the DPI and its subsequent funding to support development of the GMPG and GMI. Due to its crucial role as a regional collaborator, NEEA seeks to understand the current Northwest motor rewind marketplace and to identify underlying data and assumptions that will allow NEEA to claim savings from this market transformation initiative.

## *Overview of LTMT Research Objectives and Methodology*

Cadmus designed this study to meet three key research objectives necessary to update NEEA's ACE model assumptions for motor rewinds: (1) determine the size of the motor rewind market in the Northwest; (2) establish the market share of green motor rewind practices; and (3) calculate regional savings for green motor rewinds.

### Market Size

To determine the motor rewind market size, Cadmus conducted the following secondary and primary research:

- **Secondary Research:** This research determined the number of Northwest motor service centers, and, among these, identified the number of GMPG members and nonmembers.
- **Data Collection Forms:** Cadmus sent data collection forms (see Appendix C for sample form) to Northwest motor service centers to fill out. The form collected the number of motor rewinds conducted at each service center to determine the total number of rewinds performed annually in the Northwest and the distribution among GMPG members and nonmember groups by horsepower. The research also collected the number of green motor rewinds documented by GMPG motor service centers that received utility incentives, and the number of undocumented green motor rewinds that did not receive utility incentives.

### Market Share

Using feedback from the data collection forms described in the Market Size section, Cadmus measured the market share of green motor rewind practices among Northwest motor service centers. Specifically, Cadmus determined the following:

- The number of rewinds in compliance with green motor rewind specifications.
- The penetration of green motors practices among GMPG member and nonmember centers.

### Savings Rate

Cadmus used several sources to estimate regional savings from green motor rewinds:

- The data collection form described in the Market Size section (above).

- The RTF industrial and agricultural workbooks (version 2.3), which recorded details and assumptions pertaining to green motor rewinds.[5,6]

The RTF maintains one workbook each for industrial and agricultural green motor rewinds. Motors in industrial applications typically operate for more hours within a year than motors in agricultural settings, meaning they adopt different assumptions per application in terms of hours of operation, savings values, and measure lifetimes.

The RTF workbooks also contain annual energy-savings estimates for agricultural and industrial motors for a range of discrete horsepower values, from 15 horsepower to 5,000 horsepower. Cadmus multiplied these savings estimates by the number of green rewinds for each horsepower level within each market sector; this determined total annual energy savings for green motor rewinds.

[5] Regional Technical Forum. *UES Measure: Green Motor Rewind.* Available online: https://rtf.nwcouncil.org/measure/green-motor-rewind?id=115.

[6] Though the RTF released version 3.1 of the green motor rewind workbooks in December 2017, Cadmus used version 2.3 (published in December 2016), as these values reflected NEEA's practice of using the initiative's start year for current practice baseline measures.

# Appendix B. Detailed Methodology

Cadmus conducted secondary and primary research to meet the study's major objectives. Table 5 lists these objectives, their associated research activities, and respondents to the primary research (data collection forms).

**Table 5. Key Study Objectives and Activities**

| Study Objectives | Study Activities | Respondents (to primary research) |
|---|---|---|
| Market Size | Review GMPG membership list; data collection form | GMPG members and nonmembers |
| Market Share | Data collection form | GMPG members and nonmembers |
| Savings Rate | Data collection form | GMPG members and nonmembers |

## *Secondary Research*

For 2018, Cadmus identified 70 motor service centers in the Northwest (30 GMPG members and 40 nonmembers) compared to 80 motor service centers in 2017. To determine the number and membership status of Northwest motor service centers in 2018, Cadmus asked the GMPG administrator to review 2017's list of motor service centers (32 GMPG members, 48 nonmembers). Following the review, the GMPG administrator identified an additional nonmember, which Cadmus added to 2018's motor service center list.

Through data collection phone calls and emails (detailed in the next section), Cadmus determined the following:

- Three motor service centers (two nonmembers and one member) no longer remained in business.
- Five nonmembers do not perform motor rewinds or no longer perform motor rewinds.
- Two motor service centers (one member and one nonmember) did not perform motor rewinds in the Northwest during 2018 (and therefore were removed from the 2018 population).
- A member motor service center purchased and merged with one nonmember.

This reduced the population from 81 (the original 80 motor service centers identified in 2017, plus the nonmember service center added by the GMPG) to 70 service centers (30 member service centers and 40 nonmember service centers).

# *Primary Research*

## Preliminary Solicitation Outreach

Given the issues inherent in working with this hard-to-reach market segment, the 2018 data collection effort continued to focus on service center outreach and solicitation. Based on lessons learned from previously collecting motor rewind sales data, provided by motor service centers in the Northwest, Cadmus employed several tactics to increase response rates. Prior to data collection, the GMPG administrator and Cadmus twice contacted motor service centers to inform them about the 2018 study and to encourage their participation. Cadmus and NEEA also offered nonmember service centers a $150 incentive to complete the form.

**Contact 1:** In August 2018, Cadmus and the GMPG administrator provided advance notification to motor service centers, with the GMPG administrator e-mailing all member service centers and Cadmus e-mailing all nonmember service centers. These e-mails provided notification of the study and a copy of the data collection form.

**Contact 2:** During the last week of November 2018, the GMPG administrator and Cadmus again e-mailed the data collection form to member and nonmember motor service centers, reminded them about the study, and asked them to the complete the form.

During the first week of December, Cadmus began following up with all motor service centers via telephone, requesting their participation in the study and beginning to gather data collection forms.

## Data Collection Forms

NEEA annually updates key ACE model assumptions for estimating energy savings from motor rewinds. Cadmus used a data collection form to acquire the data necessary for these calculations (e.g., the number of motor rewinds performed annually in the Northwest, the distribution of rewinds between GMPG members and nonmembers, by horsepower).

To ensure uniform data collection across the study years, Cadmus has used the same data collection form implemented in NEEA's updates of ACE model assumptions for motor rewinds since 2013. This form asked service centers to provide the following sales data from their businesses:

- The number of motor rewinds conducted in the Northwest during 2018, by horsepower and by state.
- The number of green motor rewinds conducted in the Northwest during 2018, by horsepower and by state.

- To accommodate motor service centers' preferences and needs and to encourage high response rates, Cadmus provided service centers with three options for completing the forms:
  - **Electronic:** The GMPG administrator and/or Cadmus e-mailed the data collection form (in Excel format) to the motor service centers, which completed and returned the forms by email.
  - **Manual:** Cadmus faxed the data collection form to motor service centers. Motor service center staff completed the form by hand and returned it to Cadmus by fax or e-mail.
  - **Verbal:** For motor service center staff that found it more convenient to complete the data collection form verbally, Cadmus provided an option for service centers to complete the form by phone.

To increase response rates, Cadmus and NEEA offered nonmember service centers a $150 incentive to complete the form. Cadmus also conducted all service center outreach and solicitation using in-house staff familiar with green motor rewinds' technical aspects. Cadmus contacted the 80 motor service centers five times by phone. For those indicating willingness to complete the form, Cadmus conducted up to five follow-up phone calls to encourage participants to provide sales data.

Thirty-five motor service centers (21 members and 14 nonmembers) completed the data collection forms, the same number that completed the form in 2017. Table 6 shows the number of data collection forms completed by members, by state and study year. Table 7 shows the same information for non-members.

**Table 6. Completed Member Data Collection Forms by State and Study Year**

| State | Member | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2018 Population (N) | 2013 Sample (n) | 2014 Sample (n) | 2015 Sample (n) | 2016 Sample (n) | 2017 Sample (n) | 2018 Sample (n) |
| Washington | 8 | 7 | 3 | 4 | 5 | 5 | 4 |
| Oregon | 10 | 4 | 4 | 6 | 6 | 6 | 7 |
| Idaho | 8 | 5 | 7 | 8 | 7 | 8 | 7 |
| Montana | 4 | 2 | 2 | 3 | 3 | 3 | 3 |
| **NEEA Region Total** | **30** | **18** | **16** | **21** | **21** | **22** | **21** |

**Table 7. Completed Nonmember Data Collection Forms by State and Study Year**

| State | Nonmember | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2018 Population (N) | 2013 Sample (n) | 2014 Sample (n) | 2015 Sample (n) | 2016 Sample (n) | 2017 Sample (n) | 2018 Sample (n) |
| Washington | 7 | 1 | 5 | 4 | 3 | 2 | 3 |
| Oregon | 16 | 6 | 5 | 4 | 4 | 4 | 4 |
| Idaho | 11 | 2 | 6 | 7 | 4 | 5 | 5 |
| Montana | 6 | 0 | 3 | 2 | 2 | 2 | 2 |
| **NEEA Region Total** | **40** | **9** | **19** | **17** | **13** | **13** | **14** |

## *Savings Rate Analysis*

To calculate savings, Cadmus used the following equation:

$$Energy\ Savings = \sum_{ij} Savings\ Rate_{ij} \times Reported\ Units_{ij}$$

Where:

| | | |
|---|---|---|
| *i* | = | sector (agricultural or industrial) |
| *j* | = | motor rewind horsepower |
| Savings rate$_i$ | = | incremental per-unit savings (kWh per year) over baseline unit energy consumption |
| Reported units$_i$ | = | green motor compliant rewinds |

On the data collection forms, the motor service centers recorded the number of rewinds (green or standard) by horsepower within the agricultural or industrial sectors. Cadmus built a table using these quantities and descriptions.

The RTF unit's energy-savings Excel workbooks provided savings rates for each horsepower value indicated on the data collection forms. Cadmus calculated regional savings for green motor rewinds by building a simple lookup function, which multiplied the number of rewinds by respective annual kWh savings for a given horsepower, both for agricultural and industrial sector motors.

### Savings Extrapolations

To estimate total energy savings attributable to green motor-compliant rewinds, Cadmus extrapolated savings from the reported sample to the population. This section provides the statistical basis for the savings extrapolations.

For each motor service center, Cadmus calculated the energy savings resulting from green motor rewinds, as shown in the Savings Rate Analysis section. The primary objective for

determining regional savings included calculating savings attributable to agricultural and industrial applications for members and nonmembers. The prior evaluation studies used the same methods for determining regional savings.

Cadmus calculated the total savings estimate for the population and its precision level using a standard, stratified mean estimation:

$$Total\ Savings_{\mathrm{i,h}} = Savings_{i,h} \times N_h / n_h$$

Where:

| | | |
|---|---|---|
| i | = | motor service center |
| h | = | stratum |
| N | = | population |
| n | = | sample |

Cadmus used the same method for calculating total energy savings for industrial and agricultural applications. Cadmus calculated the total number of rewinds, the total horsepower rewound, and the precision estimates using a standard, stratified ratio estimation.

## Savings Confidence Interval

Extrapolating from a sample to a population introduces uncertainty into the population estimate. Therefore, it is necessary to build a confidence interval around an estimate to describe its uncertainty level. The confidence interval contains two parts: the confidence level and precision level.

This report presents the extrapolation results of motor rewinds, horsepower rewound, and savings at a confidence level of 90%. Precision is the radius of the confidence interval, as a percentage of the estimate itself, and can be called the “relative precision” or “relative error.”

# Appendix C. Data Collection Form

| Motor Rewind Data Sheet Directions |
|---|
| **On the next tab, labeled "Motor Rewind Data Sheet", you will find the motor rewind form**. Please use the directions below to complete the form. |
| |
| **Section A** |
| Record a count of all 15 to 5,000 HP motor rewinds (green motor rewinds **and** standard motor rewinds) in 2018. |
| In the data sheet, record the number of motor rewinds for each sector (agriculture or industrial), state, and HP. |
| |
| **Section B** |
| Record a count of Green Motor rewinds for 15 to 5,000 HP motors in 2018. |
| (NOTE: If your company is a member of the Green Motors Practices Group, this includes both green motor rewinds you have reported and received an incentive for, as well as those you have not reported or received an incentive for.) |

| Important Definitions |
|---|
| **Green Motor Rewinds**, in contrast to standard motor rewinds, refer to motors that are rewound to their original nominal efficiency. The Green Motors Initiative rewind specifications require several criteria for a motor rewind to be considered a green rewind. The minimum criteria are as follows: |
| |
| a. There must be no visible damage to the core |
| b. The burn-off temperature should not exceed 725 degrees F using verified water mist control |
| c. Service center must conduct two (or more) core-loss tests before and after stripping with the final core test watts loss per pound no more than 20% greater than the first test |
| d. There must be no hot spots greater than 10 degree C |
| e. The final core test must be less than or equal to 4 watts loss per pound |
| f. The new winding must be equivalent to the manufacturer's original length and (may exceed) circular mils ( voltage changes must be calculated circular mil equivalent) |

| Contact Information and Form Submittal |
|---|
| For questions about this form or project, please contact Hanna Lee at the Cadmus Group, at hanna.lee@cadmusgroup.com or (503) 467-7110. |
| Please also email completed forms to Hanna Lee at the email address above, or fax to: (503)-296-2771 by **December 14, 2018.** |
| |
| Name: |
| Company: |
| Address: |
| |
| |
| |

| Rewind Type | Section A: Count of all Motor Rewinds | | | | | | | | Section B: Count of Green Motor Rewinds | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| End Use | Agriculture | | | | Industrial | | | | Agriculture | | | | Industrial | | | |
| State | ID | MT | OR | WA | ID | MT | OR | WA | ID | MT | OR | WA | ID | MT | OR | WA |
| 15 HP | | | | | | | | | | | | | | | | |
| 20 HP | | | | | | | | | | | | | | | | |
| 25 HP | | | | | | | | | | | | | | | | |
| 30 HP | | | | | | | | | | | | | | | | |
| 40 HP | | | | | | | | | | | | | | | | |
| 50 HP | | | | | | | | | | | | | | | | |
| 60 HP | | | | | | | | | | | | | | | | |
| 75 HP | | | | | | | | | | | | | | | | |
| 100 HP | | | | | | | | | | | | | | | | |
| 125 HP | | | | | | | | | | | | | | | | |
| 150 HP | | | | | | | | | | | | | | | | |
| 200 HP | | | | | | | | | | | | | | | | |
| 250 HP | | | | | | | | | | | | | | | | |
| 300 HP | | | | | | | | | | | | | | | | |
| 350 HP | | | | | | | | | | | | | | | | |
| 400 HP | | | | | | | | | | | | | | | | |
| 450 HP | | | | | | | | | | | | | | | | |
| 500 HP | | | | | | | | | | | | | | | | |
| 600 HP | | | | | | | | | | | | | | | | |
| 700 HP | | | | | | | | | | | | | | | | |
| 800 HP | | | | | | | | | | | | | | | | |
| 900 HP | | | | | | | | | | | | | | | | |
| 1000 HP | | | | | | | | | | | | | | | | |
| 1250 HP | | | | | | | | | | | | | | | | |
| 1500 HP | | | | | | | | | | | | | | | | |
| 2000 HP | | | | | | | | | | | | | | | | |
| 2250 HP | | | | | | | | | | | | | | | | |
| 2500 HP | | | | | | | | | | | | | | | | |
| 3000 HP | | | | | | | | | | | | | | | | |
| 3500 HP | | | | | | | | | | | | | | | | |
| 4000 HP | | | | | | | | | | | | | | | | |
| 4500 HP | | | | | | | | | | | | | | | | |
| 5000 HP | | | | | | | | | | | | | | | | |