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Drive Power Initiative: 2019 Long-Term Monitoring and Tracking Report

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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 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 green motor rewind practices. GMPG-verified member motor service centers and their customers are eligible to receive utility incentives for green motor rewinds that meet GMPG specifications (as listed in Appendix A). Utilities across the region provide GMPG motor service centers an incentive of $2 per horsepower rewound to spec. The service center retains $1 per horsepower and passes the other $1 directly to customers. Nonmember service centers are ineligible to receive utility incentives.

In 2013, NEEA began ongoing long-term monitoring and tracking (LTMT) of the DPI including an update of assumptions for NEEA's cost-effectiveness analysis. In preparing this report of the 2019 findings, The Cadmus Group (Cadmus) collected data to meet three major objectives:

- Update the size of the Northwest motor rewind market
- Establish the market share[3] of green motor rewinds
- Calculate regional savings for green motor rewinds

This report presents an overview of 2019 findings and historical trends, followed by a brief discussion of the findings. Three appendices provide further detail on the DPI and LTMT, Cadmus' methodology, and a sample data collection form.

Key Findings

This section presents key 2019 takeaways, a summary of results, and historical trends in the motor rewind market.

[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 GMI's services and practices. See http://greenmotors.org/about_gmpg.htm.

[3] Market share is defined as the percent of total motor rewinds (GMPG member and nonmember motor service center rewinds combined) that are green motor rewinds.

Key Takeaways

From 2018 to 2019 regional savings from green motor rewinds increased. However, overall since 2013, savings have decreased, and the Northwest motor rewind market continues to contract.

From 2018 to 2019 regional savings from green motor rewinds increased 11%.

The 2019 savings increase was due to a greater number of green motor rewinds performed. An estimated 134 more green motor rewinds were performed in 2019 than in 2018. Despite the decrease in total motor rewinds, savings increased due to the increased number of green motor rewinds.

372 (2017) › 352 (2018) › 486 (2019)

Estimated energy savings from green motor rewinds have decreased 34% when comparing savings in 2013 to 2019.

However, unlike most years, between 2018 and 2019 estimated energy savings from green motors increased. Savings increased only once before, between 2016 and 2017.

Fewer motor service centers performed motor rewinds in 2019 than in 2018.

Cadmus determined that 65 motor service centers (29 GMPG members and 36 nonmembers) in the Northwest market performed motor rewinds in 2019, a decrease from 70 motor service centers in 2018 and 80 motor service centers in 2017.

80 (2017) › 70 (2018) › 65 (2019)

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 482 motors from 2018 to 2019. Last year the estimated number of motor rewinds decreased by 58 motors.

2,622 (2017) › 2,564 (2018) › 2,082 (2019)

Summary of 2019 Results

This section presents Cadmus' key findings for 2019, organized by market size, market share of green motor rewinds, and regional savings.

Market Size

Cadmus determined that 65 motor service centers in the Northwest market (29 GMPG members and 36 nonmembers) conducted motor rewinds in 2019, a decrease from 70 service centers (30 GMPG members and 40 nonmembers) in 2018. The decrease resulted from a number of factors: motor service centers going out of business, merging with other motor service centers, reporting that they did not perform any rewinds in 2019, or reporting that rewinds are no longer a service they offer.

The following describes performance by member and nonmember centers:

- **Total Number of Rewinds**. In 2019, motor service centers performed an estimated 2,082 motor rewinds (green and standard combined) in the Northwest. Of that total, GMPG members performed 1,388 (67%) and nonmembers performed 694 (33%).
- **Total Horsepower Rewound**. In 2019, motors rewound by motor service centers represented 298,893 horsepower (green and standard combined) in the Northwest. GMPG members rewound 244,081 horsepower (82%), and nonmembers rewound 54,813 horsepower (18%).
- **Motor Rewind Applications**. In 2019, overall, industrial motors accounted for 44% of the total horsepower rewound at GMPG member motor service centers and 33% rewound at nonmember motor service centers. Agricultural motors accounted for the remaining 56% and 67% of total horsepower rewound, respectively, for GMPG members and nonmember motor service centers.
- **Undocumented Rewinds.** Cadmus compared the number of green motor rewinds reported by motor service centers in the study survey with the number of green motor rewinds the motor service centers documented and reported to GMPG for purposes of obtaining utility incentives. This comparison revealed that motor service centers did not document (and therefore did not receive incentives for) an estimated 47% of the green motor rewinds they reported in the study survey. These non-documented/non-incented green motor rewinds constituted 31% of the total horsepower rewound using green rewind practices. Table 1 lists the number of green motor rewinds by application that motor services centers reported to GMPG for incentive payments (as reported to Cadmus), along with the percent of green motor rewinds the motor service centers did not document.

Table 1. Green Motor Rewinds Documented and Undocumented by Motor Service Centers (MSCs) in 2019

Sector	Number of Green Motor Rewinds		
	Documented by MSCs for GMPG (n = 18)	Reported by MSCs in Study Survey (n = 18)	Percent not Documented by MSCs for GMPG
Agricultural	64	177	64%
Industrial	112	153	27%
Total	176	330	47%

Market Share of Green Motor Rewinds

As shown in Table 2, Cadmus found that, of 1,388 motor rewinds performed by GMPG member service centers in 2019, approximately 484 were green motor rewinds, representing 35% of GMPG member rewinds and 43% of GMPG member horsepower. Among nonmembers, one performed two green motor rewinds in 2019, representing <1% of nonmember rewinds and 1% of nonmember horsepower.[4] For the market as a whole (being total rewinds performed by both GMPG members and nonmembers) the market share of green motor rewinds was 23%, representing 35% of the total horsepower rewound.

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=29)	1,388	484	34.9%	244,081	105,369	43.2%
Nonmember (N=36)	694	2	0.3%	54,813	700	1.3%
Total (N=65)	**2,802**	**486**	**23.3%**	**298,893**	**106,068**	**35.5%**

Regional Savings

In 2019, green motor rewinds performed by GMPG members resulted in an estimated annual total of 1,725,744 kilowatt hours (kWh) in energy savings. Table 3 provides annual kWh energy savings from green motor rewinds (by state) for GMPG members and nonmembers.

[4] 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. 2019 Annual kWh Savings from Green Motor Rewinds

State	Green Motor Rewind Savings (Annual kWh)		
	Member	Nonmember	Total
Washington	580,195	0	580,195
Oregon	515,370	0	515,370
Idaho	616,341	0	616,341
Montana	0	13,838	13,838
Total [1]	1,711,906	13,838	1,725,744

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

Historical Trends

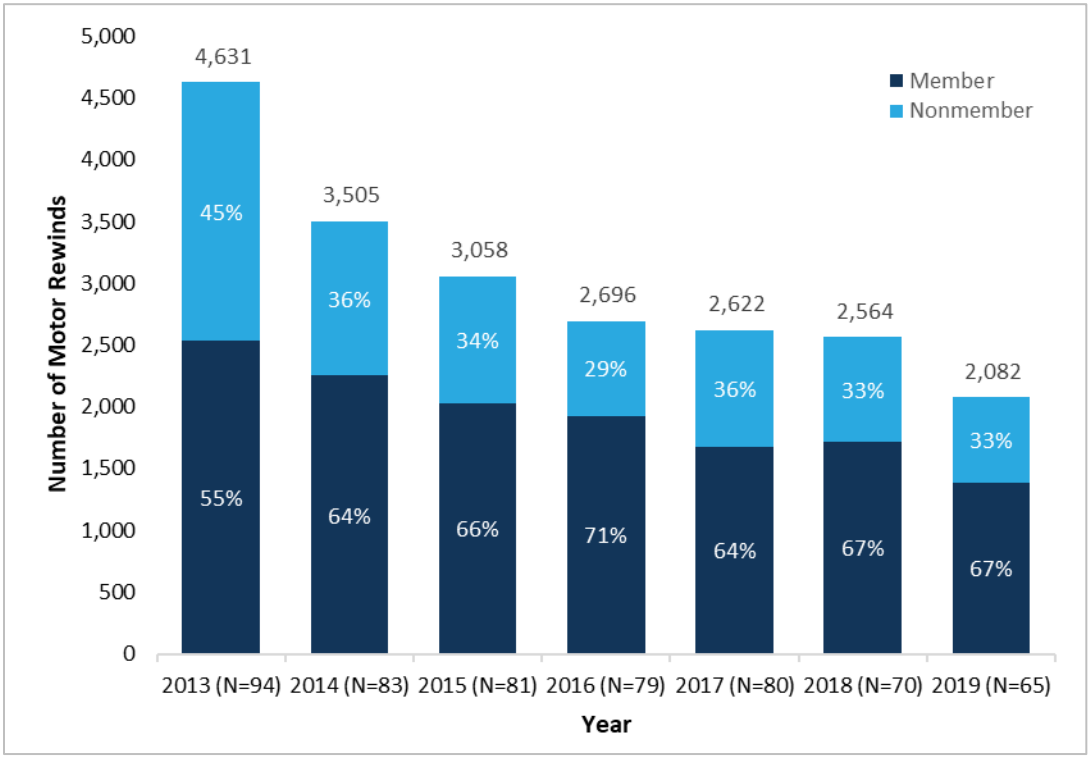
This section presents historical trends for the number of motor rewinds, the market share of green motor rewinds, and regional savings.

Number of Rewinds

As shown in Figure 1 below, the Northwest's estimated number of motor rewinds has decreased substantially over time, from 4,631 motor rewinds in 2013 to 2,696 motor rewinds in 2016—a decrease of 1,935.

Between 2016 and 2018, the number of motor rewinds decreased slightly by 132 motors. In 2019, the motor rewinds rate decreased again, with the number of motor rewinds in the Northwest falling by 482 rewinds from the 2018 level, resulting in an annual total of 2,082. The overall decrease in estimated motor rewinds since 2013 likely resulted from a combination of Cadmus adjusting nonmember population size estimates over time as they identified ineligible business (those not performing motor rewinds) and a general decline in the motor rewind industry. There has been a decline in the number of U.S.-based industrial manufacturing facilities, and falling prices for new motors have resulted in a move away from motor rewinds towards replacements.

Figure 1. Historical Number of Motor Rewinds



Green Rewind Share Among GMPG Members

Table 4 shows the share of all GMPG member rewinds that were green motor rewinds each year. Between 2013 and 2019, the share fluctuated between 21% and 36%. But in 2019, both the number and share of GMPG member green motor rewinds increased significantly from the prior year—from 351 green motor rewinds (representing 21% of total motors rewound by GMPG members) in 2018 to 484 green motor rewinds (representing 36% of total motors rewound by GMPG members) in 2019. Additionally, the share of all horsepower rewound by GMPG members to green motor rewind specifications increased, from 34% of horsepower in 2018 to 43% in 2019.

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

	Share of Green Motor Rewinds						
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Number of Green Motor Rewinds	29%	22%	23%	33%	22%	21%	36%
Horsepower Rewound	34%	34%	32%	37%	38%	34%	43%

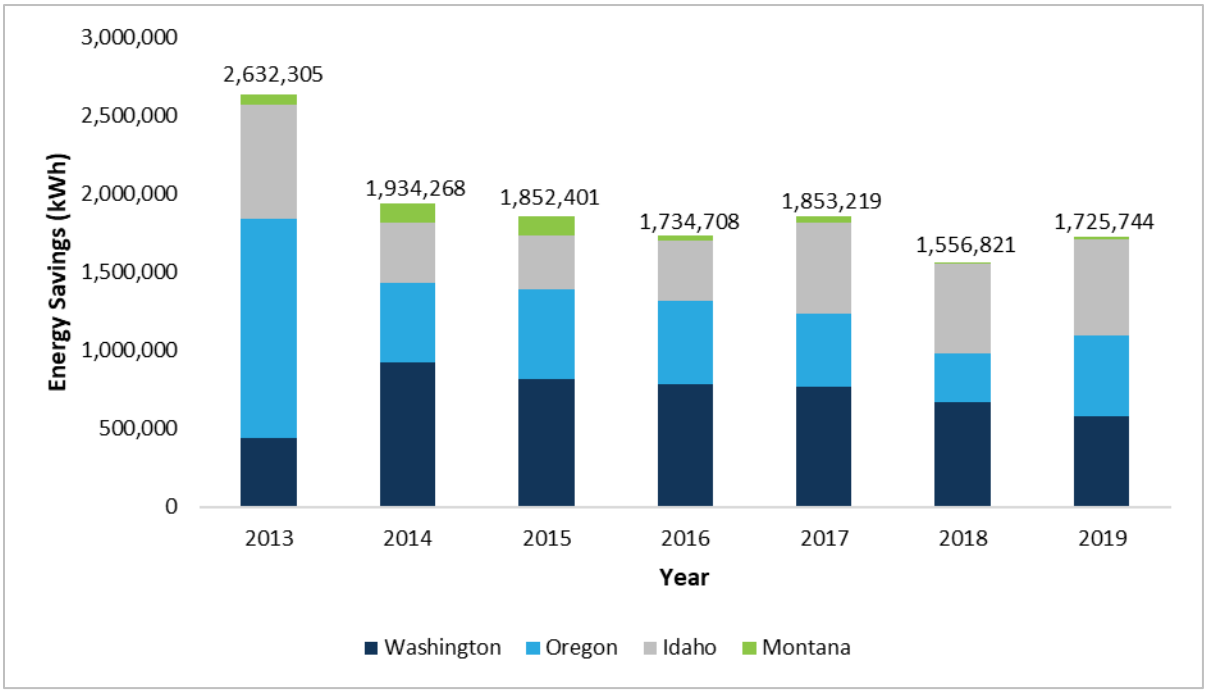
Regional Savings

Figure 2 shows regional savings over time. Total savings have decreased year-over-year since 2013, except from 2016 to 2017 and from 2018 to 2019. The reasons for these increases in energy savings are as follows:

- Between 2016 and 2017, Cadmus found that, despite decreases in the estimated number and market share of green motor rewinds, the calculated savings increased due to an increased number of large-horsepower industrial motors reported to Cadmus. In short, larger motors yield greater annual savings, and industrial motors generate greater savings than agricultural motors due to their longer operating hours. Consequently, even though the number of green rewinds decreased substantially between 2016 and 2017, the shift towards choosing larger motors for green rewinds and the substantial increase in industrial motors rewound helped balance out this change.
- Between 2018 and 2019, Cadmus found that, despite the overall decrease in total motor rewinds, the estimated number of green motor rewinds increased 38% (from 352 to 486), driving an 11% increase in savings. The reason the savings observed only increased 11% is that, on average, the motors rewound to green specifications in 2019 were smaller than in 2018 – the average size of a green motor rewound in 2019 was 211 horsepower in comparison to 249 horsepower in 2018. Additionally, there was a decrease in 2019 in industrial motors rewound to green specifications and an increase in agricultural motors rewound to green specifications. As explained above, larger motors

yield greater annual savings, and industrial motors generate greater savings than agricultural motors.

Figure 2. Historical Regional Savings



Discussion

From 2018 to 2019, regional savings from green motor rewinds increased. However, overall since 2013, savings have decreased, and the Northwest motor rewind market continues to contract.

- **In 2019 compared to 2018, total estimated savings from green motor rewinds increased 11%.** Savings increased due to the increased number of green motor rewinds (134 more in 2019 compared to 2018).
- **However, historically since 2013, energy savings from green motor rewinds have been decreasing.** Estimated energy savings from green motor rewinds have decreased 34% from 2,632,305 kWh in 2013 to 1,725,744 in 2019.
- **Fewer motor service centers performed motor rewinds in 2019 than in 2018.** Cadmus determined that 65 motor service centers (65 GMPG members and 36 nonmembers) in the Northwest market performed motor rewinds in 2019, a decrease from 70 motor service centers in 2018 and 80 in 2017.
- **The estimated number of motor rewinds (standard and green combined) in the Northwest is continuing to decrease.** As in prior years, the estimated number of motor rewinds in the Northwest continued to decrease, falling by 482 between 2018 and 2019.

Between 2017 and 2018, the estimated number of motor rewinds decreased by 58 motors.

- **The 2019 decline in rewinds continues a trend.** The estimated number of motor rewinds (standard and green combined) in the Northwest has decreased from 4,631 in 2013 to 2,082 in 2019. This decrease likely has resulted from a combination of factors, one being that Cadmus has adjusted the nonmember population size estimates over time as they have identified ineligible businesses (those not performing motor rewinds).

  Another factor is a general decline in the motor rewind industry as evidenced in this and prior LTMT studies. In 2019, 65 motor service centers performed motor rewinds compared to 70 in 2018. Cadmus found that motor service centers had gone out of business, merged with other motor service centers, reported that they did not perform any rewinds in 2019, or reported that rewinds are no longer a service they offer.

  Cadmus' and NEEA's prior market research also suggests the Northwest motor rewind market is contracting due to less expensive new motors encouraging motor replacements rather than rewinds, and a declining number of industrial manufacturing facilities based in the United States.[5]

[5] *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 rewind or replace motors and encourage consideration of lifecycle costing in investment decisions.
- Help motor service centers improve their rewind practices and expand their motor management services.

In 2007, NEEA began tracking activities and trends in the motor rewind market 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 to a particular specification 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 program approach (for example, providing uniform incentives across the region for green motor rewinds), the group 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 Motors Initiative (GMI) in 2008, which sought to educate, train, and certify service centers that followed effective shop procedures, and also offered incentives to service centers and end users for efficient motor rewinds.

Specific GMI objectives included the following:

- By 2010, grow the GMPG to sustain itself without NEEA funding, 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.

In partnership with the GMI and the GMPG, the DPI encouraged the Northwest's motor service center market to adopt green motor rewind practices, intended to reduce energy use for motors utilized in the agricultural and industrial sectors. Though green motor rewinds require rigorous testing, they greater energy savings than 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 greater than 10 degrees Celsius may occur.
- Final core tests must be less than or equal to a 4-watt loss per pound.
- New winding must achieve an equivalent to the manufacturer's original length, and may exceed circular mils (that is, voltage changes must be calculated to circular mil equivalents).

For green motor rewinds, the BPA, Energy Trust, and regional investor-owned utilities provide incentives of $2 per horsepower, for each GMPG member service center. These centers each retain $1 per horsepower rewound, passing 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, providing 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 for the project, 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 NEEA's crucial role as a regional collaborator, it 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.

Appendix B. Overview of LTMT Research Objectives and Methodology

Cadmus designed this study to meet three key research objectives necessary to update the assumptions for NEEA's cost-effectiveness.: update the size of the Northwest motor rewind market; establish the market share of green motor rewind practices; and calculate regional savings for green motor rewinds.

Market Size

To determine the motor rewind market's 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 (Appendix D provides a sample form) to Northwest motor service centers for completion. The form collects the number of motor rewinds conducted by each service center to determine the total number of rewinds performed annually in the Northwest, along with the distribution among GMPG members and nonmember groups by horsepower. The research also collects 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 above-described data collection forms, Cadmus measured the market share for 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 market share of green motor rewinds among all rewinds (standard and green rewinds combined) conducted by 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).

- The RTF industrial and agricultural workbooks (version 2.3), which recorded details and assumptions pertaining to green motor rewinds.[6,7]

The RTF maintains separate workbooks for industrial and agricultural green motor rewinds. Motors in industrial applications typically operate for more hours in a year than do motors in agricultural settings, so the RTF adopts different assumptions per application in terms of operating hours, 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.

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

[7] Though the RTF released the green motor rewind workbooks, version 3.1, 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 C. 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 2019, Cadmus identified 65 Northwest motor service centers (29 GMPG members and 36 nonmembers), compared to 70 motor service centers for 2018. To determine the number and membership status of Northwest motor service centers in 2019, Cadmus asked the GMPG administrator to review the 2018 list of motor service centers (30 GMPG members, 40 nonmembers). Following the review, the GMPG administrator identified an additional nonmember, which Cadmus added to the 2019 motor service center list.

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

- Four motor service centers (three nonmembers and one member) no longer remained in business.
- Two motor service centers (one member and one nonmember) did not perform motor rewinds in the Northwest during 2019 (therefore, these were removed from the 2019 population).
- A member motor service center, which did not perform motor rewinds in 2018 but did so in 2019, was considered part of the population in 2019.

This reduced the population from 70 to 65 service centers (29 member service centers and 36 nonmember service centers).

Primary Research

Preliminary Solicitation Outreach

Given the issues inherent in working with this hard-to-reach market segment, the 2019 data collection effort continued to focus on service center outreach and solicitation. Based on

lessons learned from previously collecting motor rewind data from motor service centers in the Northwest, Cadmus employed multiple tactics to increase response rates.

Prior to data collection, the GMPG administrator and Cadmus twice contacted motor service centers to inform them of the 2019 study and to encourage their participation, and NEEA offered nonmember service centers a $150 incentive to complete the form.

Contact 1: In August 2019, Cadmus and the GMPG administrator provided advance notification to motor service centers, with the GMPG administrator emailing all member service centers and Cadmus emailing all nonmember service centers. These emails notified centers about the study and included a copy of the data collection form.

Contact 2: During the first week of December 2019, the GMPG administrator and Cadmus again emailed 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 assumptions for their cost-effectiveness analysis. Cadmus used a data collection form to acquire the data necessary for this analysis (for example, the number of motor rewinds performed annually in the Northwest, and the distribution of rewinds between GMPG members and nonmembers, by horsepower).

To ensure uniform data collection across the study years, Cadmus has employed the same data collection form since 2013. This form asked service centers to provide the following data from their businesses:

- The number of motor rewinds conducted in the Northwest during 2019, by horsepower and by state.
- The number of green motor rewinds conducted in the Northwest during 2019, by horsepower and by state.

To accommodate motor service centers' preferences and needs and to encourage high response rates, Cadmus provides service centers with three options for completing the forms:

1. **Electronic:** The GMPG administrator and/or Cadmus emails the data collection form (in Excel format) to the motor service centers, which complete and return the forms by email

2. **Manual:** Cadmus faxes the data collection form to motor service centers, and motor service center staff complete the form by hand, returning it to Cadmus by fax or email
3. **Verbal:** For motor service center staff who find it more convenient to complete the data collection form verbally, Cadmus provides an option for service centers to complete the form by telephone.

To increase response rates, Cadmus and NEEA offered nonmember service centers a $150 incentive to complete the form. Additionally, Cadmus conducted all service center outreach and solicitation using in-house staff familiar with green motor rewinds' technical aspects. This resulted in Cadmus contacting the 65 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 data.

The effort resulted in 33 motor service centers (18 members and 15 nonmembers) completing the data collection forms. Table 6 shows the number of data collection forms completed by members, by state and study year. Table 7 shows the same information for nonmembers.

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

State	Member							
	2019 Population (N)	2013 Sample (n)	2014 Sample (n)	2015 Sample (n)	2016 Sample (n)	2017 Sample (n)	2018 Sample (n)	2019 Sample (n)
Washington	8	7	3	4	5	5	4	4
Oregon	9	4	4	6	6	6	7	6
Idaho	9	5	7	8	7	8	7	7
Montana	3	2	2	3	3	3	3	1
NEEA Region Total	**29**	**18**	**16**	**21**	**21**	**22**	**21**	**18**

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

State	Nonmember							
	2019 Population (N)	2013 Sample (n)	2014 Sample (n)	2015 Sample (n)	2016 Sample (n)	2017 Sample (n)	2018 Sample (n)	2019 Sample (n)
Washington	7	1	5	4	3	2	3	3
Oregon	14	6	5	4	4	4	4	4
Idaho	10	2	6	7	4	5	5	5
Montana	5	0	3	2	2	2	2	3
NEEA Region Total	**36**	**9**	**19**	**17**	**13**	**13**	**14**	**15**

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 and 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 the respective annual kWh savings for a given horsepower, applicable to 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:

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

Where:

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

Cadmus used the same total energy savings calculation method for industrial and agricultural applications. This included calculating 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, a confidence interval should be built around an estimate to describe its uncertainty level. The confidence interval contains two parts: the confidence level and the precision level.

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

Appendix D. 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 2019.
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 2019.
(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 Trent Hardman at the Cadmus Group, at greenmotors@cadmusgroup.com or (503) 467-7179.
Please also email completed forms to Trent Hardman at the email address above, or fax to: (503)-296-2771 by **December 13, 2019.**
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																