Work Paper PGECOPUM105

**Revision 0**

**Pacific Gas & Electric Company**

**Motor Upgrade**

**For Work Paper Reviewer Use Only**

**List all major comments that occurred during the review. This table may only be removed during management review.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Major Comment** | **Reviewer Name** | **Date** | **Outcome/Resolution** |
| E.g. Please remove measure LT-12345 (LD123) from this work paper because it is no longer eligible for incentives. | Reviewer 1 | 6/1/15 | E.g. Comment incorporated. LT-12345 was. |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | MT004 : NEMA PREMIUM EFFICIENCY MOTORS, 50 HP  MT005 : NEMA PREMIUM EFFICIENCY MOTORS, 60 HP  MT006 : NEMA PREMIUM EFFICIENCY MOTORS, 75 HP  MT007 : NEMA PREMIUM EFFICIENCY MOTORS, 100 HP  MT008 : NEMA PREMIUM EFFICIENCY MOTORS, 125 HP  MT009 : NEMA PREMIUM EFFICIENCY MOTORS, 150 HP  MT010 : NEMA PREMIUM EFFICIENCY MOTORS, 200 HP  MT011 : NEMA PREMIUM EFFICIENCY MOTORS, 250 HP  MT012 : NEMA PREMIUM EFFICIENCY MOTORS, 300 HP  MT013 : NEMA PREMIUM EFFICIENCY MOTORS, 350 HP  MT014 : NEMA PREMIUM EFFICIENCY MOTORS, 400 HP  MT015 : NEMA PREMIUM EFFICIENCY MOTORS, 450 HP  MT016 : NEMA PREMIUM EFFICIENCY MOTORS, 500 HP |
| **Measure Description** | NEMA Premium Efficiency motors |
| **Base Case Description** | Rewound motor with efficiency equal NEMA Energy Efficient Standard |
| **Units** | Per HP |
| **Energy Savings** | Refer to Excel Calculation Attachment |
| **Full Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Incremental Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Effective Useful Life** | 15 years, Premium-Efficiency Motors (DEER EUL ID: Motors-HiEff) |
| **Measure Installation Type** | Replace on Burnout (ROB) |
| **Net-to-Gross Ratio** | 0.6 (DEER NTGR ID: Com-Default>2yrs) |
| **Important Comments** | This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| 0 | 9/29/2016 | Jia Huang (PG&E) |  |
|  |  |  |  |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
| 0 | CS | 6/2/15 | 6/15/15 | * Comment 1 * Comment 2 | * Response 1 * Response 2 |
| 0 | Cal TF | 6/2/15 | 6/15/15 | * Comment 1 * Comment 2 | * Response 1 * Response 2 |
|  |  |  |  |  |  |

Cal TF website: <http://www.caltf.org/>

The Cal TF approved the version X of this workpaper found under the “Approved Measures” section of the website, <http://www.caltf.org/approved-measures/>

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | NEMA Premium Efficiency Motors, 50 HP to 500 HP |
| Existing Condition | Rewound NEMA Energy Efficient Rated Motors, 50 HP to 500 HP |
| Code/Standard | NEMA Premium Efficiency Motors, 50 HP to 500 HP |
| Industry Standard Practice | Rewound NEMA Energy Efficient Rated Motors, 50 HP to 500 HP |

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
|  |  |  | MT004 | NEMA PREMIUM EFFICIENCY MOTORS, 50 HP |
|  |  |  | MT005 | NEMA PREMIUM EFFICIENCY MOTORS, 60 HP |
|  |  |  | MT006 | NEMA PREMIUM EFFICIENCY MOTORS, 75 HP |
|  |  |  | MT007 | NEMA PREMIUM EFFICIENCY MOTORS, 100 HP |
|  |  |  | MT008 | NEMA PREMIUM EFFICIENCY MOTORS, 125 HP |
|  |  |  | MT009 | NEMA PREMIUM EFFICIENCY MOTORS, 150 HP |
|  |  |  | MT010 | NEMA PREMIUM EFFICIENCY MOTORS, 200 HP |
|  |  |  | MT011 | NEMA PREMIUM EFFICIENCY MOTORS, 250 HP |
|  |  |  | MT012 | NEMA PREMIUM EFFICIENCY MOTORS, 300 HP |
|  |  |  | MT013 | NEMA PREMIUM EFFICIENCY MOTORS, 350 HP |
|  |  |  | MT014 | NEMA PREMIUM EFFICIENCY MOTORS, 400 HP |
|  |  |  | MT015 | NEMA PREMIUM EFFICIENCY MOTORS, 450 HP |
|  |  |  | MT016 | NEMA PREMIUM EFFICIENCY MOTORS, 500 HP |

**Eligibility requirements**

* New motor must meet NEMA Premium Efficient specification and be >= 50 hp and <= 500 hp. Motor must be rated 600 volts or less and have 2, 4, or 6 poles.
* Customer must submit verification (receipt) from recycling of old motor.
* Customer must submit invoice for new motor showing motor efficiency rating, motor horsepower, and model number.

**Implementation and installation requirements:** This measure is applicable to all nonresidential building types.

## 1.2 Technical Description

NEMA design A & B motors are used for most applications including, fans, pumps, some compressors, and many other types of machineries. ODP motors and TEFC motors are the most common enclosure types. Most motors operate at 1800 rpm, with fewer at 1200, 3600 and very few at 900 rpm. Based on paid 2010 PG&E upstream motors applications, 72% of the motors were 1800 RPM, 20% were 1200 RPM and 8% were 3600 RPM. Approximately 78% of motors in the 2010 Upstream Motors Program were TEFC and 22% were ODP.

Not all motors that fail are replaced with new motors. Larger motors are typically rewound, if possible. According to Section 3.1 of the CPUC Energy Division Phase 2 Workpaper Review and Measure Disposition[[1]](#endnote-1) (the Disposition), in industrial applications, motors are rewound 22% to 82% of the time for a range between 25 to 200 hp motors. The percentage of rewound motors in each size range is summarized in Table 3. This workpaper assumes no efficiency loss for a rewound motor as recommended in the Disposition, Attachment A, Section 1.6.

## 1.3 Installation Types and Delivery Mechanisms

**Installation Type Descriptions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Replace on Burnout (ROB) | Above Code or Standard | N/A | EUL | N/A |
| New Construction (NEW/NC) | Above Code or Standard | N/A | EUL | N/A |
| Retrofit or Early Replacement (RET/ER) | Above Customer Existing | Above Code or Standard | RUL | EUL-RUL |
| Retrofit First Baseline Only (REF) | Above Customer Existing | N/A | EUL | N/A |
| Retrofit Add-on (REA) | Above Customer Existing | N/A | EUL | N/A |

The installation type for this measure is Replace on Burnout (ROB). The base case is industry standard practice, where 80% of motors above 50 HP are rewound.

A delivery mechanism is a delivery method paired with an incentive method. Delivery mechanisms are used by programs to obtain program participation and energy savings.

**Delivery Method Descriptions**

|  |  |
| --- | --- |
| **Delivery Method** | **Description** |
| Appliance Turn-in and Recycling | The program motivates customers, through financial incentives, to recycle appliances that are functional but inefficient. This prevents the continued use of those appliances, by both the current owner and potential future owners. |
| Audit/Information/Testing Services | The program performs a free assessment of a customer’s facility and provides the customer with information and guidance on energy efficiency opportunities. |
| Commissioning and Retrocommissioning | The program modifies or repairs existing equipment to ensure that it works as intended. |
| Financial Support | The program motivates customers, through financial incentives such as rebates or low interest loans, to implement energy efficient measures or projects. |
| Innovative Design | The program funds new ideas that meet reasonable scientific scrutiny for potential energy savings. These innovative measures typically have small market penetration (less than 5%) or are targeted toward relatively unreached market segments. |
| New Construction | The program offers financial incentives and/or design assistance to customers involved with new building construction. This is intended is to motivate customer to exceed Title 24 building energy efficiency requirements (residential or nonresidential). |
| Partnership | The program implements projects through a partnership between the utility and an institutional, government, or community-based organization. |
| Performance Based | The program offers financial incentives that vary based on the energy efficiency performance of specific projects. |
| Up-Stream Programs | See Up-Stream Incentive and Up-Stream Buy Down in the Incentive Method table. |

The delivery method is financial support.

**Incentive Method Descriptions**

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| Direct Install | The program implements energy efficiency measures for qualifying customers, at no cost to the customer. |
| Down-Stream Incentive | The customer installs qualifying energy efficient equipment and submits an incentive application to the utility program. Upon application approval, the utility program pays an incentive to the customer. Such an incentive may be deemed or customized. |
| Mid-Stream Incentive | The program gives a financial incentive to a midstream market actor, such as a retailer or contractor, to encourage the promotion of efficient measures. The incentive may or may not be passed on to the end-use customer. |
| Up-Stream Incentive | The program gives a financial incentive to an upstream market actor, such as a manufacturer or distributor, to encourage the manufacture, provision, or distribution of an efficient measure. The incentive may or may not be passed on to the end-use customer. |
| Up-Stream Buy Down | The program gives a financial incentive to an upstream market actor, such as a manufacturer or distributor, with specific requirements to pass down the incentive to the end use customer. Such an incentive buys-down the cost of an efficient measure for the end-use customer by at least the amount of the financial incentive. |
| Giveaway | The program provides customers with energy efficiency equipment or services for free. |
| Exchange/Replacement | The utility program holds events where customers can trade functional equipment for similar but more energy efficient equipment, free of charge. |
| On-bill Finance/Loan | The program offers financing for the cost an efficient measure as part of the utility bill. This can be an add-on option to an existing program or can serve as an organizing principle for its own program. |

The incentive method is a down-stream incentive provided directly to the customer.

## 1.4 Measure Parameters

### 1.4.1 DEER Data

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Workpaper?** |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | No |
| DEER Measure Case | No |
| DEER Building Types | No |
| DEER Operating Hours | No |
| DEER eQUEST Prototypes | No |
| DEER Version | DEER 2016, READI v2.4.7 |
| Reason for Deviation from DEER | DEER does not contain energy impacts for large motors, but a DEER EUL is available. |
| DEER Measure IDs Used | N/A |

**Net-to-Gross Ratio**

The NTG values were obtained using the DEER READI tool. The relevant NTG values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| Com-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Com | Any | Any | 0.6 |

**Spillage Rate**

Spillage rates are not tracked in work papers; they are tracked in an external document which will be supplied to the Commission Staff.

**Installation Rate**

The relevant IR values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| Def-GSIA | Default GSIA values | Any | Any | Any | 1 |

The installation service rate (ISR) is already incorporated into energy savings calculations.

**Effective and Remaining Useful Life**

The EUL and RUL values were obtained using the DEER READI tool. DEER defines the RUL as 1/3 of the EUL value. The RUL value is only applicable to the first baseline period for an RET measure with an applicable code baseline. The relevant EUL and RUL values for the measures in this work paper are in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| Motors-HiEff | Premium-Efficiency Motors | Com | Any | 15 | 5 |

### 1.4.2 Codes and Standards Analysis

**California Code of Regulations, Public Utilities and Energy (Title 20):** This measure falls under section 1605.1, subsection S of the 2015 California Energy Regulations, Public Utilities and Energy (Title 20)[[2]](#endnote-2). Title 20 refers to The Energy Independence and Security Act (EISA) 2007, the federal standard that supersedes it.

**California Code of Regulations, Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24):** This measure does not fall under Part 6, of the 2008 California Code of Regulations, Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24).

***Federal Standards:*** The Energy Independence and Security Act (EISA) 2007, effective December 19, 2010, mandates that motors manufactured or imported into the United States must meet at a minimum NEMA Premium™ Efficiency Levels. These levels are defined by the NEMA Standards Publication MG 1-2009, Revision 1-2010, Part 12, Page 35, Table 12-12 for motors 1 to 200 hp, design A&B. The standard applies to NEMA design A and B, integral horsepower, general purpose, ODP and TEFC motors (1200, 1800, and 3600 RPMs) from 1-200 hp.

NEMA designs C & D, also considered Subtype II, are special-purpose motors and are not addressed in this work paper. EISA 2007 has mandated that NEMA designs C & D special purpose motors have EPACT minimum efficiency levels stated in the NEMA Standards Publication MG 1-2011, Table 12-11[[3]](#endnote-3).

The DOE issues a final rule in May 2014 to establish new and amended energy conservation standards for electric motors with an effective date of June 1st, 2016. This rulemaking would require all currently regulated motors, with the exception of fire pump electric motors, to satisfy the efficiency levels prescribed in Table 12-12 of NEMA MG 1-2011. Covered products include NEMA Design A, NEMA Design B, and IEC Design N motors with a power rating from 1 horsepower to 500 horsepower.

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 20 (2014) | Section 1605.1(s) Electric Motors | July 1, 2015 |
| Code of Federal Regulations | Title 10, Chapter II, Subchapter D, Part 431.25 | June 1, 2016 |

## 1.5 EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information

### 1.5.1 United States Industrial Electric Motor Systems Market Opportunities Assessment (December 2002) [[4]](#endnote-4)

Electric motors account for approximately 52% of the US electricity use. In California, it is estimated that the energy use of electric motors accounts for approximately 57% of electricity used in the industrial sector, 22% of the electricity used in the commercial sector, and 80% of the electricity used in the agricultural sector7. Space cooling, ventilation, and refrigeration dominate commercial-sector motor use. Pumps, fans, compressed air and refrigeration accounts for 61% of industrial motor use.

## 1.6 Data Quality and Future Data Needs

# Section 2. Calculation Methodology

**Hours of Operation**:

*Weighted Sector Hours of Operation*

The operating hours for each customer sector – industrial, agricultural, and commercial - were weighted by sector allocation within PG&E’s service territory to calculate the combined average operating hours by horsepower. The CPUC Energy Division Phase 2 Workpaper Review and Measure Disposition7 presents the percentage of energy used by sector in California, the percentage of energy used by motors within each sector, and finally, the percentage of total motor energy allocated by sector. These values are presented in Table 4 below.

Table 4: Percentage of Motor Speeds by Motor Type

|  |  |  |  |
| --- | --- | --- | --- |
| **Sector** | **%Energy Use By Sector** | **% Energy Used By Motors Per Sector** | **% of Motor Energy Usage By Sector** |
| Commercial | 69% | 22% | 43% |
| Industrial | 21% | 57% | 34% |
| Agriculture | 10% | 80% | 23% |

Based on the percentage of total motor energy allocated by sector, the hours of operation were weighted for each motor size group. Table 5 (below) presents the weighted hours of operation.

Table 5: Annual Hours of Operation for Electric Motors

|  |  |
| --- | --- |
| **Motor Size Category (hp)** | **Annual Hours** |
| 1 through 5 | 1,657 |
| 6 through 15 | 1,877 |
| 16 through 20 | 1,992 |
| 21 through 50 | 2,222 |
| 51 through 100 | 2,651 |
| 101 through 200 | 2,607 |
| 201 through 500 | 2,924 |

The determination of operating hours by horsepower for each of the customer sectors is presented below.

*Industrial Sector*

The most comprehensive, accurate and useful data for motor operating hours in the industrial sector is from the study done for the Department of Energy called *United States Industrial Electric Motor Systems Market Opportunities Assessment*11. 2005 DEER uses this same study for motor operating hours. The hour data for Overall Manufacturing (SIC 20 -39) are shown in Table 6. The hours of operation vary from 2,745 for smaller motors to 6,132 for larger motors.

Table 6: Annual Hours of Operation for Electric Motors in the Industrial Sector

|  |  |
| --- | --- |
| **Motor Size Category (hp)** | **Annual Hours** |
| 1 through 5 | 2,745 |
| 6 through 20 | 3,391 |
| 21 through 50 | 4,067 |
| 51 through 100 | 5,329 |
| 101 through 200 | 5,200 |
| 201 through 500 | 6,132 |

Source: “United States Industrial Electric Motor Systems Market Opportunities Assessment,” Prepared by Xenergy Inc. for U.S. DOE, Burlington, MA, Dec.2002, pg 42; Table 1-1511.

*Commercial Sector*

Commercial applications are particularly difficult to assess because of the potential variable loading on the motors and range of mechanisms used to address unloading (e.g. motor cycling, reduced motor loading without cycling, active load control through variable frequency drives, etc.). As such, reasonable estimates must be made concerning motor runtime under these possible conditions. It is important to note that runtime as used in this context is equivalent full-load operating hours, not motor operating hours (time the motor is operating without regard to how it may be unloaded). Without better data, the approach taken here is to adjust operating hours to full-load operating hours via an assumed loading correction. The assumptions used for this adjustment are as follows:

* The average loading on the motor is 60% of peak. This is mid-way between a minimum load of 20% and full load at 100%. While the load could and would drop below 20%, this is taken as a minimum energy use operating point as long as the motor is running.
* The mechanisms that control the motor produce a range of part-load power values. Most common, as required by current building codes, is the use of a variable frequency drive on the motor. This would include most supply fan, pump, or cooling tower fan motors that would be covered by the definition of commercial electric motors. As a reasonable approximation, one would assume that a mix of control approaches would lead to a motor power input that varies with the square of the loading. Systems using variable frequency drives typically have greater part-load impact on power than the square of the loading assumption. Other control mechanisms would have less part-load impact.

Given the above assumptions, a reasonable average loading impact would be (0.6)2, or 36% of the peak load on the motor. Thus, equivalent full-load motor operating hours would equal to 36% of the run-hours.

Run-hour estimates for commercial motors were obtained from the 06-08 Specialized Commercial EM&V study[[5]](#endnote-5). This study notes 2,076 annual operating hours for motors 15-hp or smaller, and 2,820 annual operating hours for motors over 15-hp. Given this, commercial motor runtimes to be used by the work paper should be as follows:

Table 7: Annual Hours of Operation for Electric Motors in the Commercial Sector

|  |  |
| --- | --- |
| **Motor Size Category (hp)** | **Annual Hours** |
| 15 hp or less | 747 |
| Greater than 15 hp | 1,015 |

*Agricultural Sector*

No direct data have been found on runtime for motors for agricultural application. The best inferred data is that associated with agricultural pump energy measures as presented in the 2005 DEER database[[6]](#endnote-6). Chapter 4.1 of the DEER database reference presents irrigation savings for flow reduction measures in terms of energy and demand savings. Pumping runtime is estimated as the ratio of energy to demand savings. Pump runtimes (as determined by the ratio of energy to demand savings) appear to vary with the pumping system type (portable or solid-set), but not by location. Portable runtimes are 1,000 hours/year; solid set are 2,500 hours/year. An average of 1,750 hours per year is used for all agricultural applications until such time that better information is available.

*∆Watts/unit:*

The *∆Watts/unit* achieved by the measure was calculated using the following formula:



Motor loading was assumed to a constant 65% for the base case and measure case motors. The % rewind is the percentage of motors that are assumed to be rewound in the absence of the program.

The coincident demand savings is the demand reduction multiplied by a coincident diversity factor of 0.64.

*Annual Electric Savings:*

Annual electric savings achieved by the measure is calculated using the following formula:



These calculations were made for TEFC and ODP motors. To obtain a single savings value, a weighted average calculation was made assuming following percentages:

* 78% of motor sales are TEFC and 22% are ODP (used for both existing and above code energy savings analysis) from the 2010 PG&E Upstream Motors Program. Savings are also weighted by the distribution of motor RPMs.

Finally, According to Attachment A, Section 1.6.9 of the CPUC Energy Division Phase 2 Workpaper Review and Measure Disposition7 recommends that the savings estimates should be reduced by 20% to account for an 80% in service rate (ISR). The ISR adjusted energy savings is calculated by multiplying the energy savings (calculated above) by the ISR of 0.8.

# Section 3. Load Shapes

The ideal load shape for net benefits estimates would represent the difference between the base case and measure case. The closest load shapes that are applicable to the measures in this work paper are listed in the table below.

Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **Load Shape** | **E3 Alternate Building Type** |
| Commercial | PGE:6 = Commercial Motors | NON\_RES |

# Section 4. Costs

*Vaughen’s Motor and Pump Repair Price Guide*, 2016 Edition provides rewind costs and new motor costs for motors up to 400 HP (Workpaper costs for the 450 HP and 500 HP categories assume the same cost per HP as a 400 HP motor). The base and measure case costs are weighted by percentage of ODP and TEFC motors as well as motor RPM, and the difference is the IMC for each horsepower category.

## 4.1 Base Case Cost

The base case cost is the price to rewind an existing motor. The stator rewind price for T frame ODP and TEFC motors from 50 HP to 400 HP were taken from Vaughen’s Price Guide.

## 4.2 Measure Case Cost

The measure case cost is the cost to purchase a new NEMA Premium Efficiency motor. In this workpaper, we use the price to the user for a premium efficiency ODP or TEFC motor from 50HP to 400 HP.

## 4.3 Full and Incremental Measure Cost

**Full and Incremental Measure Cost Equations**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| ROB | (MEC + MLC) – (BEC + BLC) | (MEC + MLC) – (BEC + BLC) | N/A |
| NEW/NC |
| RET/ER | (MEC + MLC) – (BEC + BLC) | MEC + MLC | (MEC + MLC) – (BEC + BLC) |
| REF | (MEC + MLC) – (BEC + BLC) | MEC + MLC | N/A |
| REA | MEC + MLC | MEC + MLC | N/A |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

BEC = Base Case Equipment Cost; BLC = Base Case Labor Cost

**Full and Incremental Costs**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| ROB | Varies by HP | Varies by HP | N/A |

# References

1. CPUC Energy Division Phase 2 Workpaper Review and Measure Disposition. [↑](#endnote-ref-1)
2. 2015 California Energy Regulations, Public Utilities and Energy (Title 20) [↑](#endnote-ref-2)
3. NEMA Standards Publication MG 1-2011, Part 12, Page 33, Table 12-11 Full-Load Efficiencies of Energy Efficient Motors. [↑](#endnote-ref-3)
4. “United States Industrial Electric Motor Systems Market Opportunities Assessment,” Prepared by Xenergy Inc. for U.S. DOE, Burlington, MA, Dec.2002, pg 80; Table 3-15. [↑](#endnote-ref-4)
5. Evaluation Measurement and Verification of the California Public Utilities Commission HVAC High Impact Measures and Specialized Commercial Contract Group Programs, KEMA, December 2009. [↑](#endnote-ref-5)
6. 2004-05 Database for Energy Efficient Resources (DEER), Version 2.01, October 26, 2005. <http://eega.cpuc.ca.gov/deer/> [↑](#endnote-ref-6)