Work Paper PGECOPUM103

**Revision 0**

**Pacific Gas & Electric Company**

**Vertical Hollow Shaft Pump Motors**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | MT001 |
| **Measure Description** | NEMA Premium Efficiency Vertical Hollow Shaft Pump Motors, 40-300 HP |
| **Base Case Description** | Standard Efficiency Vertical Hollow Shaft Pump Motors, 40-300 HP |
| **Units** | per HP |
| **Energy Savings** | 39.3 kWh, 0.1638 kW |
| **Full Measure Cost ($/unit)** | N/A |
| **Incremental Measure Cost ($/unit)** | $24.02 |
| **Effective Useful Life** | 15 years (DEER EUL ID: Motors-HiEff) |
| **Measure Installation Type** | Replace on Burnout (ROB) |
| **Net-to-Gross Ratio** | 0.6 (DEER NTGR ID: Agric-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 | 9/22/15 | Jia Huang (PG&E) | Deemed measure for vertical hollow shaft motors 40-300 HP derived from customized projects. |
|  |  |  |  |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
| 0 | CS | 9/22/15 |  |  |  |
|  |  |  |  |  |  |

# 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 Vertical Hollow Shaft Pump Motors, 40-300 HP |
| Existing Condition | Standard Efficiency Vertical Hollow Shaft Pump Motors, 40-300 HP |
| Code/Standard | N/A |
| Industry Standard Practice | Standard Efficiency Vertical Hollow Shaft Pump Motors, 40-300 HP |

Complete the following table of measures and codes:

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
|  |  |  | MT001 | NEMA Premium Efficiency Vertical Hollow Shaft Pump Motors, 40-300 HP |

**Eligibility Requirements**

* Customer must have non-residential electric service from PG&E
* Unit must be sized between 40 and 300 HP
* Unit must be used to pump water or other clear liquid

## 1.2 Technical Description

Vertical hollow shaft motors are used to drive deep well vertical turbine pumps. Vertical motors are mounted above the surface in a vertical position on top of a long shaft which drives the impeller at the bottom of the well. For hollow shaft motors in particular, the pump shaft is extended through the hollow shaft, so adjustments required to lift impellers and give a running clearance with the pump casing, can be made by a nut threaded on the shaft at the accessible top portion of the motor. This allows for easy removal and replacement of motors and alignment is less critical because of the long extension of the pump shaft. Vertical hollow shaft motors are used for irrigation, potable water wells, and waste water pumping processes. The efficiencies of these motors, unlike those of general purpose motors, are not covered by EPAct. Manufacturers offer vertical hollow shaft motors with efficiencies which range from below that of general purpose motors to that of premium efficient motors.

## 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).

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. |

**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. |

This measure is delivered through a down-stream incentive.

## 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 2015, READI v2.2.0 |
| Reason for Deviation from DEER | DEER does not contain this type of measure. |
| 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** |
| Agric-Default>2yrs | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Ag | 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 IR values were obtained using the DEER READI tool. 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 |

**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

There are no applicable efficiency standards governing vertical hollow shaft motors.

Since vertical hollow shaft motors are not covered by the Energy Independence Security Act (EISA), it is appropriate to use an industry standard practice baseline for this measure. PG&E conducted interviews with representatives from Goulds Pumps, Central Valley Pump, and Crown Pumps. The following was noted from the interviews:

* All confirmed that between 66-100% of motors being sold and installed with Vertical Hollow Shaft (VHS) pumps systems are either Standard or Epact efficiency, not premium efficiency.  They confirmed that VHS system motor sizes range from 7.5-300 HP.
* The most popular VHS pump system is made by Goulds and it comes with a US Motor standard efficiency motor.  If they specified a NEMA Premium efficiency motor, the motor price would increase 25% and add significant lead time to ship since Premium VHS motors are not kept in stock by US Motors’ Hayward facility.  Most farmers want the lowest cost that will do the job.
* VHS pump systems tend to be less expensive than solid shaft pump systems and easier to connect.
* The biggest gap in the VHS premium efficiency motor market is that installation contractors don’t want to risk success with customers, so they stay with what they know.  Manufacturers and customers have to each drive contractors to change their standard practice, i.e. upsell premium eff., add a VFD, add automatic controls.
* VHS pump systems also compete with submersible pumps, which are even cheaper, but less efficient and less reliable due to water or electrical cooling problems.
* Pump contractors can increase their margin 25% by becoming OEM partners with pump manufacturers if they assemble the pump system in their shop or customer site.  If they ordered a complete system, it would have to ship from New York (if it’s a Goulds pump), whereas components can come from component warehouses in CA.  The problem is that OEM system components are prescribed to qualify for the discount pricing and requesting a premium efficiency motor kicks them out of this advantageous pricing.

The calculation baseline used in the sample of custom projects was the average full-load efficiency of motors below the NEMA Energy Efficient minimum efficiency standards. We believe this to be a reasonable assumption based on the ISP research above.

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

### 1.5.1 Agricultural Water Energy Efficiency[[1]](#endnote-1)

The Agricultural Water Energy Efficiency (CEC-500-200-049) report, prepared by Irrigation Training and Research Center for the California Energy Commission as part of the Public Interest Energy Research (PIER) Program addresses the industry standard practice for agricultural irrigation pumps. The report included an irrigation district energy survey that surveyed whether premium efficiency motors were installed on agricultural irrigation pumps. Basic pump data was gathered from 30 irrigation districts which included:

* Type of pump
  + Deep well pumps
  + Surface supply pumps (includes lift and booster pumps)
  + Surface drain pumps
* Pump horsepower
* Pump annual electrical energy consumption
* Whether pump efficiencies were checked annually
* Average pumping efficiency
* Whether variable frequency drives were installed on the pumps

A total of 646 deep well pumps were reported in the survey, and of those pumps, only 70 pumps (about 10%) used premium efficiency motors.

# Section 2. Calculation Methodology

Deemed kWh and kW savings estimates for this measure are derived by averaging a total of 112 customized retrofit projects installed from 2011 to 2015. Savings claims for each project were calculated using PG&E’s Pumping System Energy Savings Calculator (PSESC), a tool developed for agricultural pumping system performance analyses. The baseline values for VHS motors (which falls into a category of non-EPACT regulator motors) used by this tool were developed from MotorMaster v4.00.01 software, and are average efficiencies of available motors with efficiencies rated below NEMA “High Efficiency” levels.

|  |  |  |
| --- | --- | --- |
| **Motor Efficiencies Used in Analysis of Paid Projects** | | |
| HP | PSESC Baseline Efficiency | NEMA Premium Efficiency |
| 40 | 90.2 | 94.1 |
| 50 | 91.3 | 94.5 |
| 75 | 91.7 | 95.4 |
| 100 | 92.2 | 95.4 |
| 125 | 92.3 | 95.4 |
| 150 | 93 | 95.8 |
| 200 | 93.5 | 96.2 |
| 250 | 94.2 | 96.2 |
| 300 | 94.4 | 96.2 |

Savings values for each project are normalized by HP and weighted by the percentage of projects that fall into each HP category.

# 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** |
| Agricultural | PGE:AGRICULTURAL:14 = Agricultural | Industrial |

# Section 4. Costs

Costs for Standard and Premium efficiency motors were obtained from the US Motors catalog for 1800 RPM, three phase weather protected Type 1 (WPI) vertical hollow shaft motors. The per-HP costs were weighted by the percentage of projects that fall into each HP category.

## 4.1 Base Case Cost

The base case cost for a Standard Efficiency hollow shaft motor is $124.96.

## 4.2 Measure Case Cost

The measure case cost for a Premium Efficiency hollow shaft motor is $148.98.

## 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 | $24.02 | $24.02 | N/A |

# References

1. Irrigation Training and Research Center (ITRC). (December 2011). CEC-500-2011-049. *Agricultural Water Energy Efficiency*. Retrieved from <http://www.energy.ca.gov/2011publications/CEC-500-2011-049/CEC-500-2011-049.pdf> [↑](#endnote-ref-1)