

PG&E's Energy Management Solutions for

MOTORS



Electric motors consume 23% of all the electricity in the U.S. The average motor easily consumes 50-60 times its initial purchase price in electricity during its 10-year life. Any improvements in motor efficiency can save energy and reduce operating costs. For example, at an electrical rate of \$0.12/kWh, a standard efficiency 20 horsepower motor running continuously will cost more than \$17,000 in electricity to operate annually. Because electricity accounts for nearly 98% of the lifetime costs of most motors, with the purchase price representing only 2%, any improvements in efficiency represent a sound financial investment.

For more information on PG&E's ENERGY MANAGEMENT SOLUTIONS, call the Business Customer Center (800) 468-4743 or visit www.pge.com/business



Pacific Gas and Electric Company®



Studies from the Department of Energy have demonstrated that specifying NEMA Premium efficient motors and following best practice repair procedures has many benefits, including: reducing motor-related energy costs by typically 2 to 6 percent; increasing productivity, increasing reliability, and improving profit-margins. Premium efficiency motors are normally constructed with better manufacturing techniques and materials, which means they usually have higher service factors, higher quality insulation and bearing, less waste heat, and less vibration, all of which increase reliability. In addition, most motor manufacturers offer longer warranties for their most efficient models. Additional benefits cited by the Consortium for Energy Efficiency include: efficient motors, which are more likely to run cooler and are better suited to withstand voltage variation and harmonics; many efficient motors have a slightly higher power factor; and most efficient motors operate more quietly than standard motors.

WHAT IS A PREMIUM EFFICIENCY MOTOR?

Motors are available in a range of efficiencies. Premium efficiency motors are available for most applications and are typically 1 to 5 percentage points more efficient than standard-efficiency motors (based upon full load operation). Smaller motors are at the high end of this range and larger motors at the low end. Even though one or two percentage points of efficiency may not sound like much, it can add up to considerable savings over the life of a motor. Because electricity accounts for nearly 98% of the lifetime costs of most motors, with the purchase price representing only 2%, the payback on the incremental cost of premium efficiency motors is often very attractive.

A voluntary Premium Energy Efficiency Motor Standard was implemented in August of 2001, by the National Electrical Manufacturers Association (NEMA) and is endorsed by the

Consortium for Energy Efficiency (CEE). In order to be marketed as a NEMA Premium motor, a motor must meet or exceed a set of NEMA minimum full-load efficiency levels. These efficiencies are higher than standards for energy-efficient motors established by the Energy Policy Act of 1992 (EPAAct). Many manufacturers have motors that exceed NEMA Premium efficiency levels.

While NEMA Premium motors typically cost 10% to 15% more, depending upon hours of operation and utility costs, the incremental cost can usually be recovered very quickly. See the table below for some examples of cases that can pay for themselves in less than a year.

MEASURES OF EFFICIENCY – When comparing motors, it's important to use a consistent efficiency measure. Nominal efficiency, which is the recommended value to use, is the average

	Example One 50 hp, 1800 rpm, 460 V		Example Two 25 hp, 1800 rpm, 460 V		Example Three 10 hp, 1800 rpm, 460 V		Example Four 5 hp, 1800 rpm, 460 V	
	EPAct Standard	NEMA Premium	EPAct Standard	NEMA Premium	EPAct Standard	NEMA Premium	EPAct Standard	NEMA Premium
Full Load Efficiency	93.1	94.5	92.4	93.6	89.5	91.7	87.5	89.5
Efficiency	93.6	95.1	93.1	94.1	90.8	92.6	88.2	90.3
Demand Reduction		0.47 kW		0.16 kW		0.12 kW		0.07kW
Incremental Motor Cost		\$176		\$96		\$60		\$27
Annual kWh Energy Savings		2,829		958		719		443
Annual Utility Cost Savings		\$ 339.48		\$ 114.96		\$ 86.28		\$ 53.16
Payback Time (Months)		6		10		8		6

NOTE: Assumes 75% Load, 6000 hours annually, \$0.12/kWh electric rate

efficiency obtained through standardized testing of a population of motors. The guaranteed minimum efficiency is less accurate, and is slightly lower to take into account typical variations.

OPEN DRIP PROOF VS. TOTALLY ENCLOSED FAN COOLED

Generally, motors are classified into two groups, based on the method used to cool the motor:

- **OPEN DRIP PROOF (ODP).** An ODP motor is cooled by a fan moving cool air through ventilation holes. The openings are positioned to keep water from falling in from above. Because the interior components of ODP motors are exposed to dirt, the maintenance costs can be higher. Most motors found in commercial buildings are ODP motors.
- **TOTALLY ENCLOSED FAN COOLED (TEFC).** TEFC motors are designed to prevent the exchange of air

between the inside and the outside of the motor. They are cooled by an externally-mounted fan that blows air across the motor casing. TEFC motors are designed to protect the components from damaging contamination, so their purchase costs are typically higher than ODP motors.

VARIABLE FREQUENCY DRIVES – Variable frequency drives (VFDs), electronically control the motor speed and can result in substantial energy savings. For example, reducing the speed of connected equipment (fans or pumps) by 20% can reduce energy use by nearly 50%.

MOTOR SIZING – Variable frequency drives (VFDs), electronically control the motor speed and can result in substantial energy savings. For example, reducing the speed of connected equipment (fans or pumps) by 20% can reduce energy use by nearly 50%. during operation. When the load falls below

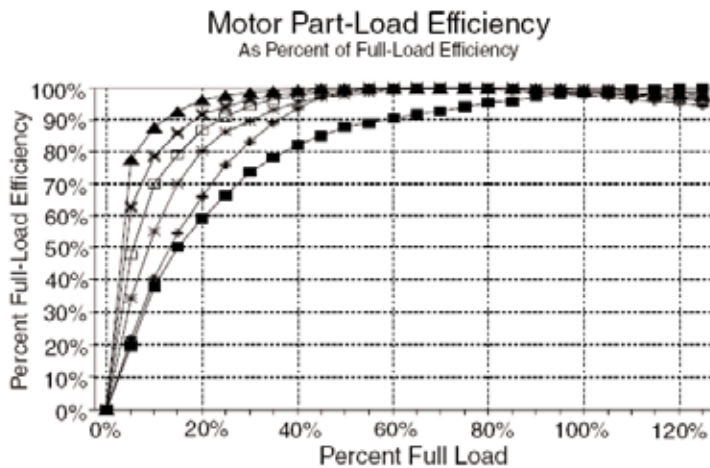
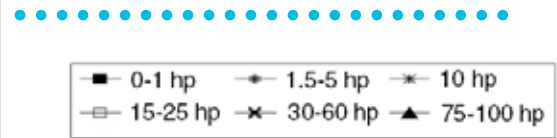


Figure 1.
Part-Load Motor Efficiency Range
(Source: Department of Energy)



50%, motor efficiency and power factor decline, which increases utility power factor charges.

REPAIR – Best practices for motor repair can retain motor efficiency and reliability—most motors can be restored to their original efficiency. However, improper repair of motors can decrease efficiency by up to 5 percent. Improperly repaired motors also operate at higher temperatures, which can reduce the operating life of the motor. Guidance on motor repairs is available at The Electrical Service Apparatus Association and the Department of Energy.

REWINDING OR REPLACING – It is a common practice, especially with larger motors, to rewind or repair a motor when it fails. Although it costs less to rewind a motor than to purchase a new one, in most cases it is cost-effective to replace a standard efficiency motor with a new NEMA Premium

motor. Follow the rewinding protocols adapted by the Electrical Service Apparatus Association and avoid practices known to degrade motor efficiency, such as the use of high temperatures to soften wire. If you are going to calculate operating costs for rewound motors, deduct one efficiency point for motors greater than 40 hp and two points for smaller motors. Only use repair shops that utilize low temperature (under 700°F) bakeout ovens, use high quality materials, and follow quality protocol based on EASA-Q or ISO-9000. Ask them to perform a core loss or loop test as part of their rewind procedures. As a general rule of thumb, purchase a new premium efficiency motor instead of rewinding, if:

- The motor is smaller than 40hp
- The cost of rewinding is greater than 65% of a new motor
- The motor was rewound prior to 1980

hp	Open Drip-Proof					
	1200 RPM (6-pole)		1800 RPM (4-pole)		3600 RPM (2-pole)	
	EPAct*	NEMA Premium	EPAct*	NEMA Premium	EPAct*	NEMA Premium
1	80.0	82.5	82.5	85.5	N/A	77.0
1.5	84.0	86.5	84.0	86.5	82.5	84.0
2	85.5	87.5	84.0	86.5	84.0	85.5
3	86.5	88.5	86.5	89.5	84.0	85.5
5	87.5	89.5	87.5	89.5	85.5	86.5
7.5	88.5	90.2	88.5	91.0	87.5	88.5
10	90.2	91.7	89.5	91.7	88.5	89.5
15	90.2	91.7	91.0	93.0	89.5	90.2
20	91.0	92.4	91.0	93.0	90.2	91.0
25	91.7	93.0	91.7	93.6	91.0	91.7
30	92.4	93.6	92.4	94.1	91.0	91.7
40	93.0	94.1	93.0	94.1	91.7	92.4
50	93.0	94.1	93.0	94.5	92.4	93.0
60	93.6	94.5	93.6	95.0	93.0	93.6
75	93.6	94.5	94.1	95.0	93.0	93.6
100	94.1	95.0	94.1	95.4	93.0	93.6
125	94.1	95.0	94.5	95.4	93.6	94.1
150	94.5	95.4	95.0	95.8	93.6	94.1
200	94.5	95.4	95.0	95.8	94.5	95.0
250		95.4		95.8		95.0
300		95.4		95.8		95.4
350		95.4		95.8		95.4
400		95.8		95.8		95.8
450		96.2		96.2		95.8
500		96.2		96.2		95.8

THE FOLLOWING TABLES COMPARE EPACT AND NEMA PREMIUM MOTOR EFFICIENCIES FOR VARIOUS MOTOR SIZES AND TYPES.

hp	Totally Enclosed Fan-Cooled					
	1200 RPM (6-pole)		1800 RPM (4-pole)		3600 RPM (2-pole)	
	EPAct*	NEMA Premium	EPAct*	NEMA Premium	EPAct*	NEMA Premium
1	80.0	82.5	82.5	85.5	75.5	77.0
1.5	85.5	87.5	84.0	86.5	82.5	84.0
2	86.5	88.5	84.0	86.5	84.0	85.5
3	87.5	89.5	87.5	89.5	85.5	86.5
5	87.5	89.5	87.5	89.5	87.5	88.5
7.5	89.5	91.0	89.5	91.7	88.5	89.5
10	89.5	91.0	89.5	91.7	89.5	90.2
15	90.2	91.7	91.0	92.4	90.2	91.0
20	90.2	91.7	91.0	93.0	90.2	91.0
25	91.7	93.0	92.4	93.6	91.0	91.7
30	91.7	93.0	92.4	93.6	91.0	91.7
40	93.0	94.1	93.0	94.1	91.7	92.4
50	93.0	94.1	93.0	94.5	92.4	93.0
60	93.6	94.5	93.6	95.0	93.0	93.6
75	93.6	94.5	94.1	95.4	93.0	93.6
100	94.1	95.0	94.5	95.4	93.6	94.1
125	94.1	95.0	94.5	95.4	94.5	95.0
150	95.0	95.8	95.0	95.8	94.5	95.0
200	95.0	95.8	95.0	96.2	95.0	95.4
250		95.8		96.2		95.8
300		95.8		96.2		95.8
350		95.8		96.2		95.8
400		95.8		96.2		95.8
450		95.8		96.2		95.8
500		95.8		96.2		95.8

Additional Resources

MOTORMASTER+ is an energy-efficient motor selection and management tool sponsored by the Department of Energy. The software includes a catalog of over 25,000 motors and features motor inventory management tools, maintenance log tracking, efficiency analysis, savings evaluation, energy accounting, and environmental reporting capabilities.

Phone: (800) 862-2086

ELECTRICAL APPARATUS SERVICE ASSOCIATION (EASA) offer guidance on motor repair.

Phone: (314) 993-2220

MOTOR DECISIONS MATTER is co-sponsored by the Department of Energy and industry groups. You can download a quick and easy-to-use spreadsheet for calculating savings associated with premium efficiency motors. "Estimated Annual Savings with NEMA Premium Motors (interactive chart)".

Phone 1-877-337-3463