DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Product: Motor & Drive Efficiency

Prescriptive rebates will be offered for new motors (Plan A) up to 500 hp and replacement of currently operating motors (Plan B) up to 500 hp, installation of new variable frequency drives (VFD) up to 200 hp, replacement of standard refrigeration evaporator fan motors with electronically commutated motors (ECM) and Constant Speed Motor Controllers up to 500HP.

Algorithms:

Motor Electrical Energy Savings (Customer kWh)	= HP x LF_Motors x Conversion x (1/Standard_Eff - 1/ High_Eff) x Hrs
Motor Electrical Demand Savings (Customer kW)	= HP x LF_Motors x Conversion x (1/Standard_Eff - 1/ High_Eff)
VFD Drive Electrical Energy Savings (Customer kWh)	= HP x LF_Drives x Conversion x (1/Standard_Eff) x Hrs x %_Savings_Drives
VFD Drive Electrical Demand Savings (Customer kW)	= HP x LF_Drives x Conversion x (1/Standard_Eff) x %_Savings_Drives
Constant Speed Motor Controller Electrical Energy Savings (Customer kWh)	= HP x kW_per_HP x Hrs
Constant Speed Motor Controller Electrical Demand Savings (Customer kW)	= HP x kW_per_HP
Electronically Commutated Motor Electrical Demand Savings (Customer kW)	= (ECM_Baseline_Fan_ Watts - ECM_Efficient_Fan_ Watts) x Refrigeration_Factor
Electronically Commutated Motor Electrical Energy Savings (Customer kWh)	= (ECM_Baseline_Fan_ Watts - ECM_Efficient_Fan_ Watts) x Refrigeration_Factor x ECM_Hours
Electrical Energy Savings (Gross Generator kWh)	= Customer kWh / (1-TDLF)
Electrical Demand Savings (Gross Generator kW)	= Customer kW x CF / (1-TDLF)
Electrical Energy Savings (Net Generator kWh)	= Gross Generator kWh x NTG
Electrical Demand Savings (Net Generator kW)	= Gross Generator kW x NTG

Variables:

Hrs	= Annual operational hours per year of the motor. Deemed values are used for hours based on the type and use of the motor as seen in Tables 1, 2, & 3. The customer provides the following information on the rebate form (HP, Industrial/non industrial, building type, and compressor/pump/fan/other)
LF_Motors	= Motor load factor as percentage (0 - 100). The assumed value of 75% will be used for prescriptive motors. (Reference 3)
LF_Drives	= Drive load factor as percentage (0 - 100). The assumed value of 75% will be used for prescriptive pumping drives and 65% will be used for prescriptive fan drives. (Reference 5)
HP	= Rated motor horsepower provided by customer on rebate form.

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

High_Eff	= Efficiency of high efficiency replacement motor as percentage (0-100). Plan A high efficiency is NEMA Premium plus 1%. Plan B high efficiency is NEMA Premium. Plan B Enhanced high efficiency is NEMA Premium plus 1%. Efficiencies shown in the Deemed Motor Tables. The customer will provide the model and serial number of the motor along with actual nameplate efficiency from the new motor. If the actual efficiency is not provided by the customer, it will be determined from specification sheet.
Standard_Eff	= Efficiency of standard replacement motor as percentage (0 - 100). Plan A is NEMA Premium. Plan B is EPACT. Plan B Enhanced is EPACT. Efficiencies shown in Deemed Motor Tables. Based on customer provided motor size, speed, and type.
%_Savings_Drives	= Average savings achieved by installing a variable frequency drive on a fan or pumping motor. 33% will be used for prescriptive drive rebates. (Reference 5)
kW_per_HP	= Demand savings per horsepower for constant speed motor controller applications. We will use 0.10 for escalators (Reference 9) and 0.013 for all other qualifying applications (Reference 10)
ECM_Baseline_Fan_ Watts	= Average input watts for shaded pole or permanent split capacitor motor, Table 4 (Reference 12)
ECM_Efficient_Fan_Watts	= Average input watts for efficient motor, Table 4 (Reference 12)
ECM_Hours	= Hours per year (freezer subtracts defrost time), Table 4 (Reference 12)
Refrigeration_Factor	= Multiplier to include interactive effects of refrigeration energy to remove heat from the motor. Reduction in motor energy results in a reduction in refrigeration energy. = 1+1/COP (See assumptions for values)
COP	= Coefficient of Performance = refrigeration capacity(btu/hr)/energy input(btu/hr)
Conversion	= Standard conversion from horsepower to kW. 1 HP = .746 kW
Coincidence Factor	= Probability that peak demand of the motor will coincide with peak utility system demand. 0.78 will be used for prescriptive rebates, see Reference 2.
Measure Life	= Length of time the motor/drive will be operational = 20 years for new, replacement motors, CS motor controllers & 15 years for VFDs and EC Motors, (Reference 3,11)
Baseline and incremental cost assumptions	= The customer will provide the model and serial number of the motor and from that the size, type and rpm of the motor/drive will determine the deemed baseline cost or incremental cost. (Reference 8-motor replacement, and VFDs , 10-CS Motor Controllers, and 13-EC Motors)
TDLF	A transmission distribution loss factor of 6.5%

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

NTG	Net-to-Gross factors - 65% as the NTG for motor replacement, VFD, and custom products. For EC Motors and CS Motor Controllers 95% is used. (Reference 7)
Incremental operation and maintenance costs or savings	= 0 value assumed for this product
Incremental cost	Motors - see Deemed Motor Table 6. VFDs - see Deemed ASD Table 7. Motor Controllers - see Deemed Motor Controller Table 3. EC Motors - See Table 4

Provided by Customer:	**Verified during M&V:**
For Motors:	
New motor model and serial number (HP, efficiency, type, and speed can then be looked up in a database)	Yes
Application of motor (Industrial/non Industrial)	Yes
Building type where motor is installed for non industrial motors	Yes
Use of motor (pump, fan, other) for non industrial motors	Yes
Equipment is installed	Yes
For Variable Frequency Drives (VFD):	
Size, speed, type and use of motor drive is connected to	Yes
Application of motor (Industrial/non Industrial)	Yes
Building type where motor is installed for non industrial motors	Yes
Use of motor (pump, fan, other) for non industrial motors	Yes
Equipment is installed	Yes
For Constant Speed Motor Controllers:	
Size of motor	
Application of motor (Escalator/Other that qualify)	
For Electronically Commutated Evaporator Fan Motors:	
Size of motor	Yes
Application of motor (Display Case or Walk-in)	Yes
Case or Walk-in temperature (Medium Temp or Low Temp)	Yes
For Walk-in's: Fan diameter (<= 15 inches or >15 inches	Yes

Assumptions:

- Each motor is replaced with the same size on a 1 for 1 basis. Motors replaced with different sizes can participate in the Custom Efficiency product.
- Prescriptive rebates are only given for motors put into service, rebates are not given for backup motors.
- Prescriptive rebates are only given to variable frequency drives installed on centrifugal pump or fan applications.
- Rebates do not apply to rewound or repaired motors.

- Constant speed motor controllers are only eligible if installed on escalators, or industrial/commercial applications that cannot be shut of or slowed down during normal business operation, and operate at a load factor of less than 20% more than 65% of the time.

- COP Deemed at **1.43** ~~**1.6**~~ for Low Temperature Applications and **2.28** ~~**2.3**~~ for Medium Temperature Applications, from our anti-sweat heater projects, EC Motor custom projects and are consistent with custom projects from various custom refrigeration applications.

Table 1: Operating Hours by Motor Size, Industrial Applications (5)

HP	Fans	Pumps	Air Compressor	Other
1	4,550	3,380	1,257	2,435
1.5	4,550	3,380	1,257	2,435
2	4,550	3,380	1,257	2,435
3	4,550	3,380	1,257	2,435
5	4,550	3,380	1,257	2,435
7.5	4,316	4,121	2,131	2,939
10	4,316	4,121	2,131	2,939
15	4,316	4,121	2,131	2,939
20	4,316	4,121	2,131	2,939
25	5,101	4,889	3,528	3,488
30	5,101	4,889	3,528	3,488
40	5,101	4,889	3,528	3,488
50	5,101	4,889	3,528	3,488
60	6,151	5,667	4,520	5,079
75	6,151	5,667	4,520	5,079
100	6,151	5,667	4,520	5,079
125	5,964	5,126	4,685	5,137
150	5,964	5,126	4,685	5,137
200	5,964	5,126	4,685	5,137
250	7,044	5,968	6,148	6,102
300	7,044	5,968	6,148	6,102
350	7,044	5,968	6,148	6,102
400	7,044	5,968	6,148	6,102
450	7,044	5,968	6,148	6,102
500	7,044	5,968	6,148	6,102

Table 2: Operating Hours by Application for all products other than motor controllers, Non-industrial (3)

Building Type	Operating Hours
Office HVAC Pump	2,000
Retail HVAC Pump	2,000
Hospitals HVAC Pump	2,754
Elem/Sec Schools HVAC Pump	2,190
Restaurant HVAC Pump	2,000
Warehouse HVAC Pump	2,241
Hotels/Motels HVAC Pump	4,231
Grocery HVAC Pump	2,080
Health HVAC Pump	2,559
College/Univ HVAC Pump	3,641
Office Ventilation Fan	6,192
Retail Ventilation Fan	3,261
Hospitals Ventilation Fan	8,374
Elem/Sec Schools Ventilation Fan	3,699
Restaurant Ventilation Fan	4,155
Warehouse Ventilation Fan	6,389
Hotels/Motels Ventilation Fan	3,719
Grocery Ventilation Fan	6,389
Health Ventilation Fan	2,000
College/Univ Ventilation Fan	3,631
Office Other Application	4,500
Retail Other Application	4,500
Hospitals Other Application	4,500
Elem/Sec Schools Other Application	4,500
Restaurant Other Application	4,500
Warehouse Other Application	4,500
Hotels/Motels Other Application	4,500
Grocery Other Application	4,500
Health Other Application	4,500
College/Univ Other Application	4,500

Table 3: Operating Hours & Incremental Cost for Motor Controllers by Application, Non-industrial (Reference 4 ,10)

Building Type and motor application	Escalator	Industrial	Incremental Cost
5	4,500	2,435	$918
7.5	4,500	2,939	$918
10	4,500	2,939	$918
15	4,500	2,939	$918
20	4,500	2,939	$933
25	4,500	3,488	$1,012
30	4,500	3,488	$1,091
40	4,500	3,488	$1,300
50	4,500	3,488	$1,497
60	4,500	5,079	$1,796
75	4,500	5,079	$1,943
100	4,500	5,079	$2,389
125	4,500	5,137	$3,087
150	4,500	5,137	$3,784
200	4,500	5,137	$4,555
250	4,500	6,102	$4,655
300	4,500	6,102	$4,755
350	4,500	6,102	$4,855
400	4,500	6,102	$4,955
450	4,500	6,102	$5,055
500	4,500	6,102	$5,155

Table 4: Baseline Watts, Efficient Watts, Operating Hours and Incremental Cost for EC Motors by Application (Reference 12 and 13)

Motor Application	ECM_Baseline_ Fan_ Watts	ECM_Efficient_F an_Watts	ECM_Hours	ECM Incremental Cost
EC Motors - Medium Temp Display Case	71	24	8,672	$ 88.00
EC Motors - Low Temp Display Case	81	27	8,672	$ 88.00
EC Motors - Medium Temp Walk-in, Evap fan <= 15" Diameter	136	44	8,585	$ 180.00
EC Motors - Low Temp Walk-in, Evap fan <= 15" Diameter	154	50	8,585	$ 180.00
EC Motors - Medium Temp Walk-in, Evap fan > 15" Diameter	138	69	8,585	$ 180.00
EC Motors - Low Temp Walk-in, Evap fan > 15" Diameter	156	78	8,585	$ 180.00

Changes from 2011:

Added EC Motors and Constant Speed Motor Controllers products
Changed Plan A Baseline from EPACT to NEMA Premium and the High Eff. from NEMA Premium to NEMA Premium +1% (Enhanced)
Changed Plan B Baseline from Pre-EPACT standard efficiency to EPACT standard efficiency
Changed Plan B Enhanced from Pre-EPACT standard efficiency to EPACT standard efficiency
Incremental Cost update gathered April 2011 for Plan A, B, B enhanced and VFD's
Additional custom projects added for summarizing average savings per project most accurately

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

References:

1. CEE (Consortium for Energy Efficiency) Premium Efficiency Motors Initiative - Source for premium motor efficiencies, EPAct Standard Motor Efficiencies and baseline/incremental costs

2. NYSERDA (New York State Energy Research and Development Authority), Energy $mart Programs Deemed Savings Database - Source for Coincidence Factor

3. Efficiency Vermont's Technical Reference User Manual, 2004 - Source for operating hours for non-industrial motors (p.15) and source for measure life, Source for load factor (75%) and baseline/incremental costs

4. United States Industrial Electric Motor Systems Market Opportunities Assessment, EERE, US DOE, Dec 2002 - Source for operating hours for industrial motors and source for load factor (Table 1-18 and 1-19)

5. Office of Industrial Electric Motor Systems Market Opportunities Assessment : Department of Energy (assessment of 265 Industrial facilities in 1997) - Source for VSD opportunity in the US market along with Load Factors for Fans and Pumps along with average savings.

6. NWPCC (Northwest Power Conservation Council) RTF's (Regional Technical Forum) Archived Measures - Source for full motor cost

7. Net-to-gross factor from Program Evaluation in 2010 by third party and other sources for new products.

8. Average cost for VFD's and Motor Cost information from April 2011 effort local vendors

9. Engineering analysis performed by Xcel energy on installation of 164 controllers, Colorado custom project 404, 2009.

10. Methodology for demand savings from Esource TAS-F-1, March 2007 - Identifying Cost-Effective Applications for Motor Voltage Controllers

11. Comprehensive Process and Impact Evaluation of the (Xcel Energy) Colorado Motor and Drive Efficiency Program, FINAL, March 28, 2011, TetraTech

12. ECM baseline and efficient watts and hours are from monitored data from Custom Efficiency projects

13. ECM incremental costs are from Southern California Edison Work Paper WPSCNRRN0011: Evaporator Fan Motors

14. Rewind Costs from http://www.greenmotors.org/downloads/RTFSubmittalMay_08%20_2_.pdf website