DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Product: Motor & Drive Efficiency

Description:
Prescriptive rebates will be offered for new motors and replacement of currently operating motors up to 200 HP, installation of new variable frequency drives (VFD) up to 20(HP, installation of new VFD's on previously throttled water well pumps up to 200 HP, installation of constant speed motor controllers (CSMC) on select applications from 5 HP up to 500 HP, and new clean water pumps with motors up to 200 HP.

Algorithms:

Motor Electrical Energy Savings (Customer kWh)	= HP x LF_Motors x Conversion x (1 / Standard_Eff - 1 / High_Eff) x Hrs x Refrigeration_Factor
Motor Electrical Demand Savings (Customer kW)	= HP x LF_Motors x Conversion x (1 / Standard_Eff - 1 / High_Eff) x Refrigeration_Factor
VFD Electrical Energy Savings (Customer kWh)	= HP x LF_Drives x Conversion x (1 / Standard_Eff) x Hrs x %_Savings_Drives x Refrigeration_Factor
VFD Electrical Demand Savings (Customer kW)	= HP x LF_Drives x Conversion x (1 / Standard_Eff) x %_Savings_Drives x Refrigeration_Factor
CSMC Electrical Energy Savings (Customer kWh)	= HP x kW_per_HP x Hrs
CSMC Electrical Demand Savings (Customer kW)	= HP x kW_per_HP
Water Well Pump VFD Algorithms:	
Well Pump VFD Electrical Energy Savings (Customer kWh)	= (Base_kW - VFD_kW) x Well Hours
Well Pump VFD Electrical Demand Savings (Customer kW)	= Base_kW - VFD_kW
VFD_kW	= VFD_BHP / Standard_Eff / VFD_Eff x Conversion
Base_ kW	= Base_BHP / Standard_Eff x Conversion
VFD_BHP	= (Flow x VFD_Head) / (3960 x Design_Pump_Eff)
Base_BHP	= (Flow x Base_Head) / (3960 x Base_Pump_Eff)
Base_Pump_Eff	= -0.40205 x (%_Flow)^2 + 1.00876 x %_Flow + 0.20113
VFD_Head	= Static_Head + Flow_Coeff x (Flow)^2
Base_Head	= %_Design_Head x Design_Head
Static_Head	= %_Flow x (Max_Well_Depth - Average_Well_Depth) + Average_Well_Depth
Flow_Coeff	= Peak_Dynamic_Head / (Design_Flow)^2
%_Design_Head	= -0.11656 x (%_Flow)^2 - 0.34465 x %_Flow + 1.46170
%_Flow	= Flow / Design_Flow
Peak_Dynamic_Head	= Design_Head - Max_Well_Depth

Clean Water Pump Algorithms:

Energy Savings (kWh)	= Baseline_Pump_Energy_Use - Efficient_Pump_Energy_Use
Baseline_Pump_Energy_Use (kWh)	= HP x 0.746 x Hours x Baseline_PEI x Baseline_Adj_Factor
Efficient_Pump_Energy_Use (kWh)	= HP x 0.746 x Hours x Efficient_PEI x Efficient_Adj_Factor
Demand_Savings (kW)	= (Horsepower x 0.746 x Baseline_Adj_Factor x Baseline_PEI - Horsepower x 0.746 x
CS_to_CS_Incremental_Cost	= CS_to_CS_Cost_Factor x (Baseline_PEI - Efficient_PEI) x 100 x Horsepower
VS_to_VS_Incremental_Cost	= VS_to_VS_Cost_Factor x (Baseline_PEI - Efficient_PEI) x 100 x Horsepower
CS_to_VS_Incremental_Cost	= CS_to_VS_Cost_Factor x (Baseline_PEI - Efficient_PEI) x 100 x Horsepower

Variables:

Variable ID	Value	Description
Hrs	See Tables 1, 2, & 3 below	Annual operational hours per year of the motor. Deemed values are used for hours based on the type and use of the motor. The customer provides the following information on the rebate form: HP, industrial/non-industrial, building type, and compressor/pump/fan/other.
LF_Motors	75%	Motor load factor as a percentage.[3]
LF_PumpDrives	75%	Pump drive load factor as a percentage.[5] Excludes water well pump VFD's.
LF_FanDrives	65%	Fan drive load factor as a percentage.[5]
HP	Customer Input	Rated motor horsepower. Can refer to baseline motor or to proposed new motor.
High_Eff	See Table ~~6~~14 - Deemed Motors Table	Efficiency of high efficiency replacement motor expressed as a percentage. New Enhanced and Upgrade Enhanced use NEMA Premium plus 1%. 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	See Table ~~6~~14 - Deemed Motors Table	Efficiency of standard replacement motor expressed as a percentage. New Enhanced measure uses NEMA Premium as its standard efficiency baseline. Upgrade Enhanced uses EPACT as its standard efficiency baseline. Customer provided motor size in HP, nominal speed in RPM, and enclosure type wil select motor efficiencies from deemed table data.
%_Savings_Drives	33%	Average savings achieved by installing a VFD on a fan or pumping motor.[5]
kW_per_HP_Escalator	0.066	Demand savings per HP for CSMC's on escalators.[9, 18]
kW_per_HP_Other	0.012	Demand savings per HP for CSMC's for all other qualifying applications.[7, 8, 9, 10]
Refrigeration_Factor	See Table 4	Multiplier to include interactive effects of refrigeration or cooling energy to remove heat from the motors located in the refrigeration load. Reduction in motor energy results in a reduction in refrigeration/cooling energy. Equation Factor = 1 +1/COP
COP	See Table 4	Coefficient of Performance = Refrigeration/Cooling Capacity (BTU/hr) / Energy Input (BTU/hr)

Well Pump VFD Variables:		
Well Hours	See Table 5	Number of hours per year the well pump will operate. Deemed values are used for hours based on the well pump application that will be provided by the customer.
VFD_Eff	97%	Drive efficiency of a VFD, deemed to be 97% using a table of drive efficiency versus percent of rated power using the motor rated power.[13]
3960	3,960	Pump power equation constant used to convert units of feet of water and gallons per minute to HP. The calculation is 33,000 foot lbs per horsepower / 8.333 lbs per gallon.
Base_Pump_Eff	Calculated Value	Percent efficiency of the water well pump at a given percent of design flow rate. The algorithm is defined above and comes from a linear regression of a second-order polynomial on pump curve data (normalized to design head and flow) from Xcel well pump custom rebate projects.[14] Formula is Base Pump Efficiency = -0.40205 x (%_Flow)^2 + 1.00876 x %_Flow + 0.20113 and is a function of the Average Flow from customer information.
Design_Pump_Eff	80.8%	Pumping efficiency at given conditions (%_Flow). This algorithm comes from a second-order polynomial curve fit of acheivable pump efficiency versus flow rate from custom rebates and their associated pump curves. The design pump efficiency is a constant value used at all flow rates for VFD driven pumps.[14]
Design_Flow	Customer Input	Flow rate (in GPM) of well pump at design conditions.
Design_Head	Customer Input	Total head (in feet of water) of well pump at design conditions
Flow	Customer Input	Flow rate (in GPM) of well pump at proposed operating conditions. If there are multiple flow rates at which the pump will operate, this is the time-weighted average of those flow rates.
Average_Well_Depth	Customer Input	Average water level in well, i.e. vertical distance (in feet), between the pump discharge and the water level.
Max_Well_Depth	Customer Input	Minimum level in well at design flow rate, i.e. how far below the pump discharge the water level is (in feet), when the pump is operating at design flow.
%_Design_Head	Calculated Value	Percent of design total pump head occuring at a given percent of design flow rate. The algorithm is defined above and comes from a linear regression of a second-order polynomial on pump curve data (normalized to design head and flow) from seven Xcel well pump custom rebate projects.[14]

Clean Water Pump Variables:		
Baseline_PEI	See Table 6	Pumps manufactured after 2020 must meet the minimum performance standard for the style and size pump (Ref 1) This varies for variable pumps, but is a deemed value of 1 for constant speed pumps.
Baseline_Adj_Factor	See Table 7	Adjustment Factors are derived from a sample of simulated pump installations, and varies with the minimum head associated with the pumping application.
Efficient_Adj_Factor	See Table 7	Adjustment Factors are derived from a sample of simulated pump installations, and varies with the minimum head associated with the pumping application.
Hours	See Table 8	Hours of Operation per year or (hr/yr.) Hours are associated with customer provided market segments
CS_to_CS_Cost_Factor	See Table 10 & 11	For constant speed to variable speed applications, use average incremental cost found by NEEA per pump based on hp and PEI.
VS_to_VS_Cost_Factor	See Table 10 & 11	For variable speed to variable speed applications, use average incremental cost found by NEEA per pump based on hp and PEI.. This is the same as the CS_to_CS_Incremental_ Cost as the only change is the pump body.
CS_to_VS_Cost_Factor	See Table 9	For constant speed to variable speed applications, assumed VFD cost per horsepower as a proxy for cost of pump with integrated VFD. Broken down by HP bin.
Efficient_PEI	Customer Input	Pump efficiency level (PEI), which must be meet the minimum requirements in table below****must be at least .02 PEI below baseline****.
Existing Pump Speed Control	Customer Input	Identify if the existing pump is constant speed or variable speed.
Proposed Pump Speed Control	Customer Input	Identify if the proposed pump speed is constant speed or variable speed
Horsepower	Customer Input	Nominal Pump Horsepower as identified on pump motor
Pumping Application	Customer Input	Check Pumping Application for Commercial HVAC and DHW, Agricultural or Industrial or Municipal
Pump Class	Customer Input	Identify type of pump and class
Other Variables:		
Conversion	0.746	Standard constant used to convert from HP to kW.
Coincidence Factor	78%	Probability that peak demand of the motor will coincide with peak utility system demand. Excludes water well pump VFD's.[2]
Coincidence Factor VFD on Well Pump	53%	Probability that peak demand of well pump motor will coincide with peak utility system demand.[14]
Measure Life_New Motor	20	Length of time the motor will be operational.[2, 3, 11]
Measure Life_Upgrade Motor	20	Length of time the motor will be operational.[2, 3, 11]
Measure Life_VFD	15	Length of time the VFD will be operational.[3, 11] Includes water well pump VFD's.
Measure Life_CSMC	20	Length of time the controller will be operational.[2, 11]
Incremental O&M Costs or Savings	$0.00	Non energy costs or savings associated with the measure
Incremental Cost_Motors	See Table ~~6~~14 - Deemed Motors Table	Deemed Cost Table for Incremental cost
Incremental Cost_VFD	See Table ~~7~~13	All VFDs except clean water pumps pumps.
Incremental Cost_CSMC	See Table 3	Deemed Cost Table for Constant Speed Motor Controllers
NTG_CSMC	95%	Net-to-Gross factor for CSMC's.[6]
NTG_Other	65%	Net-to-Gross factor for motor replacement, VFD's, and custom products.[6]

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Inputs 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 VFD's:	
Size, speed, type and use of motor drive is connected to (if speed & enclosure information is not available we will deem 1800 RPM, and the average between TEFC and ODP for the given motor HP)	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	Yes
Application of motor (Escalator/Other that qualify)	Yes
For Water Well Pump VFD's:	
Pump Rated HP	Yes
Design Flow (GPM)	Yes
Design Head (ft)	Yes
Well Depth (ft)	No
Max Well Depth at design flow (ft)	No
Average Flow Rate (GPM)	No
Application of well pump (agriculture, golf course, municipal, etc.)	Yes
For Clean Water Pumps:	
Measure Identifiers	
Pump Speed Control	Yes
Pump Efficiency Level (PEI)	Yes
Horsepower	Yes
Pumping Application	Yes
Pump Class	Yes
Savings Baseline	
Measure identifiers "CL/VL->VL" shall only be allowed in existing applications where code does not require a variable speed pump system and where the pre-existing pump system type was constant speed, and shall only be allowed in new applications where code does not require a variable speed pump system.	Yes
Application of motor	
Design Flow (GPM)	Yes
Design Head (ft)	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 produc
- Prescriptive rebates are only given for motors put into service, rebates are not given for backup motors
- Prescriptive rebates are only given to VFD's 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 off or slowed down during norma business operation, and operate at a load factor of less than 20% more than 65% of the time.
- COP for Low Temperature Applications and Medium Temperature Applications are from our anti-sweat heater projects, EC Motor custom projects, and are consistent with custom projects from various custom refrigeration applications.
- COP for Data Center Applications based on custom projects from various custom data center applications

Water Well Pump VFD Assumptions:

- Existing system is controlled by a throttling valve.
- Pump efficiency for the proposed VFD case is constant at all flows and equal to the design pump efficiency. The baseline pump efficiency depends on the flow rate.
- Static head varies linearly with flow rate and ranges from static water level to max well depth
- Backup well pumps do not qualify, only primary pumps.
- On-Peak operation (pump will operate below 100% speed during 9a-9p, M-F in summer).

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
Data Center Pump	8,760
Data Center Fan	8,760
Low Temperature Case Fan	8,629
Medium Temperature Case Fan	8,629

Table 3: Operating Hours & Incremental Cost for Motor Controllers by Application, Non-Industrial[10]

Building Type & 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: Coefficient of Performance

Application	kW / Ton Refrig.	COP	kW Factor
Low Temperature	2.459	1.43	1.70
Medium Temperature	1.543	2.28	1.44
Data Center	0.879	4.00	1.25

Table 5: Operating Hours by Application for Well Pumps[14, 15, 16, 17]

Application	Operating Hours
Agricultural Irrigation	1,954
Golf & Landscape Irrigation	1,941
Municipal Water Supply	3,177
Other Water Well Pump	3,630

Table 6: Baseline Pump PEI Values

DOE Product Category/Nominal Speed of Rotation	1-5 HP	7.5+ HP
All Constant Speed Pumps	1.00	1.00
Non-VT Variable Speed Pumps	0.54	0.50
VT Variable Speed Pumps	0.63	0.60

Table 7: Adjustment Factors for Pumps - See Reference 30

Pump Type	Variable Speed Pumps			Constant Flow Pumps (All
	Agricultural Irrigation	Industrial and	Commercial HVAC	
Non-Vertical Turbine Pump	1.13	1.13	1.22	0.85
Vertical Turbine Pump	1.50	1.50	1.60	1.15

Note: Commercial HVAC is assumed to have pumps with 40% BEP minimum. Agricultural and Industrial/Municipal are assumed to have 20% BEP minimum.
Source CIP_FR_LCC_2015-09-21_VL_VL_LoadFactor_v2.xlsm, taken and simplified from "lookups" tab and is calculated in excel file "ComIndAgPumps_1_1" on tab "Adj Factors"

Table 8: Pumping Application Data

Application	Agricultural Irrigation	Industrial and Municipal	Commercial HVAC and DHW
Operating Hours (hrs/yr)	2,400	4,000	5,000

Source for hours
DOE, pump subcommittee
Northwest motor database pumping applications, pump subcommittee
Green Motor Rewind UES measure workbook

Table 9: New VFD Costs

HP Bin	$/HP
1-5 HP	$412.65
7.5-30 HP	$138.77
40-75 HP	$98.54
100-200 HP	$86.35

Source: These were calculated using the forcast incr. cost tab. Each pump PEI level was individually set at 100% with the other levels at 0%. The resutling values were pasted below.

Table 10: Tier 1 Constant Speed Pump Costs

	Incremental costs, $/Pump								
	PEI Level (TIER 1)								
HP	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.90
1	$52.93	$65.14	$70.63	$97.28	$103.58	$130.47	$157.66	$184.84	$212.03
1.5	$60.98	$74.52	$80.88	$111.48	$118.67	$149.50	$180.65	$211.80	$242.95
2	$67.42	$81.99	$89.05	$122.80	$130.69	$164.66	$198.97	$233.28	$267.60
3	$77.67	$93.80	$101.97	$140.73	$149.72	$188.68	$228.00	$267.31	$306.63
5	$92.83	$111.12	$120.96	$167.09	$177.69	$223.99	$270.66	$317.33	$364.00
7.5	$106.94	$127.13	$138.51	$191.49	$203.56	$256.67	$310.14	$363.61	$417.10
10	$118.24	$139.86	$152.49	$210.93	$224.17	$282.70	$341.60	$400.49	$459.40
15	$136.21	$160.01	$174.63	$241.73	$256.82	$323.93	$391.42	$458.91	$526.41
20	$150.60	$176.04	$192.25	$266.27	$282.82	$356.79	$431.12	$505.46	$579.80
25	$162.80	$189.57	$207.14	$287.01	$304.80	$384.55	$464.67	$544.79	$624.91
30	$173.49	$201.39	$220.16	$305.15	$324.01	$408.83	$494.01	$579.18	$664.37
40	$191.82	$221.57	$242.38	$336.13	$356.82	$450.30	$544.11	$637.93	$731.75
50	$207.35	$238.60	$261.15	$362.31	$384.54	$485.34	$586.45	$687.57	$788.69
60	$220.98	$253.48	$277.56	$385.20	$408.78	$515.98	$623.48	$730.98	$838.48
75	$238.88	$272.97	$299.05	$415.20	$440.54	$556.13	$671.99	$787.86	$903.72
100	$264.11	$300.31	$329.24	$457.36	$485.15	$612.54	$740.15	$867.77	$995.38
125	$285.50	$323.40	$354.74	$492.98	$522.84	$660.21	$797.74	$935.29	$1,072.83
150	$304.26	$343.57	$377.03	$524.13	$555.79	$701.89	$848.11	$994.34	$1,140.57
175	$321.08	$361.60	$396.96	$552.01	$585.28	$739.18	$893.17	$1,047.17	$1,201.16
200	$336.39	$377.98	$415.08	$577.35	$612.07	$773.08	$934.13	$1,095.20	$1,256.25

Table 11: Tier 2 Constant Speed Pump Costs

	Incremental costs, $/Pump						
	PEI Level (TIER 2)						
HP	0.89	0.88	0.87	0.86	0.85	0.84	0.83
1	$240.38	$261.02	$292.67	$318.69	$300.48	$327.79	$355.11
1.5	$275.09	$298.71	$334.93	$364.70	$343.86	$375.12	$406.38
2	$302.71	$328.70	$368.56	$401.32	$378.39	$412.78	$447.19
3	$346.42	$376.16	$421.78	$459.27	$433.02	$472.38	$511.75
5	$410.57	$445.82	$499.89	$544.32	$513.22	$559.87	$606.53
7.5	$469.85	$510.19	$572.06	$622.91	$587.32	$640.70	$694.10
10	$517.03	$561.42	$629.51	$685.46	$646.30	$705.04	$763.80
15	$591.68	$642.48	$720.40	$784.43	$739.61	$806.84	$874.08
20	$651.10	$707.00	$792.74	$863.20	$813.88	$887.86	$961.85
25	$701.26	$761.47	$853.81	$929.71	$876.58	$956.27	$1,035.96
30	$745.11	$809.08	$907.19	$987.83	$931.39	$1,016.05	$1,100.72
40	$819.93	$890.32	$998.29	$1,087.03	$1,024.91	$1,118.08	$1,211.25
50	$883.10	$958.92	$1,075.20	$1,170.78	$1,103.88	$1,204.23	$1,304.58
60	$938.31	$1,018.87	$1,142.43	$1,243.97	$1,172.89	$1,279.52	$1,386.14
75	$1,010.60	$1,097.37	$1,230.44	$1,339.81	$1,263.26	$1,378.10	$1,492.93
100	$1,112.08	$1,207.56	$1,354.00	$1,474.35	$1,390.11	$1,516.48	$1,642.85
125	$1,197.76	$1,300.60	$1,458.32	$1,587.94	$1,497.21	$1,633.32	$1,769.42
150	$1,272.65	$1,381.91	$1,549.49	$1,687.22	$1,590.81	$1,735.44	$1,880.05
175	$1,339.60	$1,454.61	$1,631.01	$1,775.99	$1,674.50	$1,826.74	$1,978.96
200	$1,400.44	$1,520.67	$1,705.09	$1,856.65	$1,750.55	$1,909.71	$2,068.83

Table 12: Pump Types Considered

Type	HP Range
End Suction Frame Mount (ESFM)	1-200 HP
End Suction Close Coupled (ESCC)	1-200 HP
In-Line (IL)	1-200 HP
Radially Split multi-stage vertical in-line	1-200 HP
Vertical Turbine Submersible (ST)	1-200 HP

Table ~~7~~13: VFD Deemed Inremental Cost~~21, 22, 23, 24~~ 33

HP	~~Avg. Motor MSRP~~	~~Motor less discount plus mark-up and inflation~~	~~Installed Loaded~~	Installed Loaded
1	~~$782~~	~~$702~~	~~$1,053~~	$2,182.10
1.5	~~$1,234~~	~~$741~~	~~$1,111~~	$2,493.50
2	~~$1,299~~	~~$779~~	~~$1,169~~	$2,741.03
3	~~$1,433~~	~~$1,578~~	~~$2,367~~	$3,132.19
5	~~$1,689~~	~~$1,762~~	~~$2,642~~	$3,705.41
7.5	~~$2,075~~	~~$1,891~~	~~$2,837~~	$4,234.18
10	~~$2,352~~	~~$2,039~~	~~$3,058~~	$4,654.52
15	~~$2,969~~	~~$2,702~~	~~$4,053~~	$5,318.74
20	~~$3,804~~	~~$3,477~~	~~$5,216~~	$5,846.74
25	~~$4,664~~	~~$4,337~~	~~$6,506~~	$6,292.12
30	~~$5,504~~	~~$4,635~~	~~$6,952~~	$6,681.09
40	~~$6,770~~	~~$5,262~~	~~$7,893~~	$7,344.33
50	~~$8,386~~	~~$7,609~~	~~$11,414~~	$7,903.80
60	~~$10,094~~	~~$9,310~~	~~$13,965~~	$8,392.40
75	~~$11,814~~	~~$10,509~~	~~$15,764~~	$9,031.71
100	~~$15,433~~	~~$11,856~~	~~$17,785~~	$9,928.29
125	~~$19,836~~	~~$12,789~~	~~$19,184~~	$10,684.59
150	~~$25,897~~	~~$15,101~~	~~$22,651~~	$11,345.11
200	~~$35,992~~	~~$19,652~~	~~$29,478~~	$12,471.35

Table ~~6~~14: Motor Efficiency and Incremental Costs1, 19, 20, 25

HP	Speed	Type	EPACT Motor Efficiency	NEMA Premium Motor Efficiency	NEMA Premium +1% Motor Efficiency	EPACT Motor Installed cost	NEMA Premium Installed Cost	NEMA Premium +1% Installed Cost
1	900	ODP	74.0%	75.5%	76.5%	$890	$637	$769
1.5	900	ODP	75.5%	77.0%	78.0%	$1,012	$682	$832
2	900	ODP	85.5%	86.5%	87.5%	$1,175	$680	$829
3	900	ODP	86.5%	87.5%	88.5%	$1,305	$706	$866
5	900	ODP	87.5%	88.5%	89.5%	$1,697	$740	$914
7.5	900	ODP	88.5%	89.5%	90.5%	$2,043	$936	$1,191
10	900	ODP	89.5%	90.2%	91.2%	$1,460	$1,067	$1,376
15	900	ODP	89.5%	90.2%	91.2%	$2,458	$1,973	$2,393
20	900	ODP	90.2%	91.0%	92.0%	$2,733	$2,179	$2,684
25	900	ODP	90.2%	91.0%	92.0%	$3,060	$2,442	$3,057
30	900	ODP	91.0%	91.7%	92.7%	$3,321	$2,639	$3,335
40	900	ODP	91.0%	91.7%	92.7%	$3,843	$3,003	$3,850
50	900	ODP	91.7%	92.4%	93.4%	$4,394	$3,269	$4,227
60	900	ODP	92.4%	93.0%	94.0%	$4,942	$3,981	$5,233

75	900	ODP	93.6%	94.1%	95.1%	$5,750	$4,612	$6,127
100	900	ODP	93.6%	94.1%	95.1%	$8,355	$5,896	$7,677
125	900	ODP	93.6%	94.1%	95.1%	$8,614	$7,057	$9,319
150	900	ODP	93.6%	94.1%	95.1%	$9,514	$8,134	$10,842
200	900	ODP	93.6%	94.1%	95.1%	$16,463	$9,764	$13,148
250	900	ODP	94.5%	95.0%	96.0%	$26,970	$10,815	$14,636
300	900	ODP	94.5%	95.0%	96.0%	$31,881	$13,293	$18,140
350	900	ODP	94.5%	95.0%	96.0%	$41,294	$24,766	$34,370
400	900	ODP	94.9%	95.1%	96.1%	$43,707	$28,224	$39,260
450	900	ODP	95.3%	95.5%	96.5%	$53,685	$31,975	$44,566
500	900	ODP	95.3%	95.5%	96.5%	$56,251	$33,093	$46,149
1	1200	ODP	80.0%	82.5%	83.5%	$663	$637	$769
1.5	1200	ODP	84.0%	86.5%	87.5%	$709	$682	$832
2	1200	ODP	85.5%	87.5%	88.5%	$655	$680	$829
3	1200	ODP	86.5%	88.5%	89.5%	$747	$706	$866
5	1200	ODP	87.5%	89.5%	90.5%	$879	$740	$914
7.5	1200	ODP	88.5%	90.2%	91.2%	$1,007	$936	$1,191
10	1200	ODP	90.2%	91.7%	92.7%	$1,214	$1,067	$1,376
15	1200	ODP	90.2%	91.7%	92.7%	$2,137	$1,973	$2,393
20	1200	ODP	91.0%	92.4%	93.4%	$2,393	$2,179	$2,684
25	1200	ODP	91.7%	93.0%	94.0%	$2,623	$2,442	$3,057
30	1200	ODP	92.4%	93.6%	94.6%	$2,766	$2,639	$3,335
40	1200	ODP	93.0%	94.1%	95.1%	$3,593	$3,003	$3,850
50	1200	ODP	93.0%	94.1%	95.1%	$4,035	$3,269	$4,227
60	1200	ODP	93.6%	94.5%	95.5%	$4,682	$3,981	$5,233
75	1200	ODP	93.6%	94.5%	95.5%	$5,325	$4,612	$6,127
100	1200	ODP	94.1%	95.0%	96.0%	$6,562	$5,896	$7,677
125	1200	ODP	94.1%	95.0%	96.0%	$6,959	$7,057	$9,319
150	1200	ODP	94.5%	95.4%	96.4%	$8,320	$8,134	$10,842
200	1200	ODP	94.5%	95.4%	96.4%	$10,433	$9,764	$13,148
250	1200	ODP	95.4%	95.8%	96.8%	$14,381	$10,815	$14,636
300	1200	ODP	95.4%	95.8%	96.8%	$14,954	$13,293	$18,140
350	1200	ODP	95.4%	95.8%	96.8%	$27,707	$24,766	$34,370
400	1200	ODP	95.8%	95.9%	96.9%	$29,766	$28,224	$39,260
450	1200	ODP	96.2%	96.3%	97.3%	$31,232	$31,975	$44,566
500	1200	ODP	96.2%	96.3%	97.3%	$32,620	$33,093	$46,149
1	1800	ODP	82.5%	85.5%	86.5%	$544	$637	$769
1.5	1800	ODP	84.0%	86.5%	87.5%	$561	$682	$832
2	1800	ODP	84.0%	86.5%	87.5%	$576	$680	$829
3	1800	ODP	86.5%	89.5%	90.5%	$625	$706	$866
5	1800	ODP	87.5%	89.5%	90.5%	$652	$740	$914
7.5	1800	ODP	88.5%	91.0%	92.0%	$807	$936	$1,191
10	1800	ODP	89.5%	91.7%	92.7%	$910	$1,067	$1,376
15	1800	ODP	91.0%	93.0%	94.0%	$1,760	$1,973	$2,393
20	1800	ODP	91.0%	93.0%	94.0%	$1,922	$2,179	$2,684

25	1800	ODP	91.7%	93.6%	94.6%	$2,130	$2,442	$3,057
30	1800	ODP	92.4%	94.1%	95.1%	$2,284	$2,639	$3,335
40	1800	ODP	93.0%	94.1%	95.1%	$2,570	$3,003	$3,850
50	1800	ODP	93.0%	94.5%	95.5%	$2,779	$3,269	$4,227
60	1800	ODP	93.6%	95.0%	96.0%	$3,336	$3,981	$5,233
75	1800	ODP	94.1%	95.0%	96.0%	$3,833	$4,612	$6,127
100	1800	ODP	94.1%	95.4%	96.4%	$4,976	$5,896	$7,677
125	1800	ODP	94.5%	95.4%	96.4%	$5,890	$7,057	$9,319
150	1800	ODP	95.0%	95.8%	96.8%	$6,739	$8,134	$10,842
200	1800	ODP	95.0%	95.8%	96.8%	$8,022	$9,764	$13,148
250	1800	ODP	95.4%	95.8%	96.8%	$9,636	$10,815	$14,636
300	1800	ODP	95.4%	95.8%	96.8%	$12,133	$13,293	$18,140
350	1800	ODP	95.4%	95.8%	96.8%	$17,340	$24,766	$34,370
400	1800	ODP	95.4%	95.8%	96.8%	$17,595	$28,224	$39,260
450	1800	ODP	95.8%	96.2%	97.2%	$19,690	$31,975	$44,566
500	1800	ODP	95.8%	96.2%	97.2%	$27,051	$33,093	$46,149
1	3600	ODP	76.3%	77.0%	78.0%	$554	$637	$769
1.5	3600	ODP	82.5%	84.0%	85.0%	$581	$682	$832
2	3600	ODP	84.0%	85.5%	86.5%	$608	$680	$829
3	3600	ODP	84.0%	85.5%	86.5%	$635	$706	$866
5	3600	ODP	85.5%	86.5%	87.5%	$615	$740	$914
7.5	3600	ODP	87.5%	88.5%	89.5%	$785	$936	$1,191
10	3600	ODP	88.5%	89.5%	90.5%	$857	$1,067	$1,376
15	3600	ODP	89.5%	90.2%	91.2%	$1,712	$1,973	$2,393
20	3600	ODP	90.2%	91.0%	92.0%	$1,854	$2,179	$2,684
25	3600	ODP	91.0%	91.7%	92.7%	$2,073	$2,442	$3,057
30	3600	ODP	91.0%	91.7%	92.7%	$2,273	$2,639	$3,335
40	3600	ODP	91.7%	92.4%	93.4%	$2,540	$3,003	$3,850
50	3600	ODP	92.4%	93.0%	94.0%	$2,703	$3,269	$4,227
60	3600	ODP	93.0%	93.6%	94.6%	$3,245	$3,981	$5,233
75	3600	ODP	93.0%	93.6%	94.6%	$3,963	$4,612	$6,127
100	3600	ODP	93.0%	93.6%	94.6%	$4,855	$5,896	$7,677
125	3600	ODP	93.6%	94.1%	95.1%	$5,804	$7,057	$9,319
150	3600	ODP	93.6%	94.1%	95.1%	$6,787	$8,134	$10,842
200	3600	ODP	94.5%	95.0%	96.0%	$7,857	$9,764	$13,148
250	3600	ODP	94.5%	95.0%	96.0%	$9,939	$10,815	$14,636
300	3600	ODP	95.0%	95.4%	96.4%	$14,634	$13,293	$18,140
350	3600	ODP	95.0%	95.4%	96.4%	$16,517	$24,766	$34,370
400	3600	ODP	95.4%	95.8%	96.8%	$19,100	$28,224	$39,260
450	3600	ODP	95.8%	96.2%	97.2%	$20,871	$31,975	$44,566
500	3600	ODP	95.8%	96.2%	97.2%	$30,520	$33,093	$46,149
1	900	TEFC	74.0%	75.5%	76.5%	$942	$637	$769
1.5	900	TEFC	77.0%	78.5%	79.5%	$1,034	$682	$832
2	900	TEFC	82.5%	84.0%	85.0%	$1,176	$680	$829
3	900	TEFC	84.0%	85.5%	86.5%	$1,308	$706	$866

5	900	TEFC	85.5%	86.5%	87.5%	$1,821	$740	$914
7.5	900	TEFC	85.5%	86.5%	87.5%	$2,121	$936	$1,191
10	900	TEFC	88.5%	89.5%	90.5%	$2,448	$1,067	$1,376
15	900	TEFC	88.5%	89.5%	90.5%	$3,865	$1,973	$2,393
20	900	TEFC	89.5%	90.2%	91.2%	$4,326	$2,179	$2,684
25	900	TEFC	89.5%	90.2%	91.2%	$5,036	$2,442	$3,057
30	900	TEFC	91.0%	91.7%	92.7%	$5,567	$2,639	$3,335
40	900	TEFC	91.0%	91.7%	92.7%	$6,671	$3,003	$3,850
50	900	TEFC	91.7%	92.4%	93.4%	$8,318	$3,269	$4,227
60	900	TEFC	91.7%	92.4%	93.4%	$9,458	$3,981	$5,233
75	900	TEFC	93.0%	93.6%	94.6%	$10,950	$4,612	$6,127
100	900	TEFC	93.0%	93.6%	94.6%	$14,223	$5,896	$7,677
125	900	TEFC	93.6%	94.1%	95.1%	$15,380	$7,057	$9,319
150	900	TEFC	93.6%	94.1%	95.1%	$16,998	$8,134	$10,842
200	900	TEFC	94.1%	94.5%	95.5%	$21,144	$9,764	$13,148
250	900	TEFC	94.5%	95.0%	96.0%	$25,265	$10,815	$14,636
300	900	TEFC	94.5%	95.0%	96.0%	$30,091	$13,293	$18,140
350	900	TEFC	94.5%	95.0%	96.0%	$39,340	$24,766	$34,370
400	900	TEFC	94.5%	95.0%	96.0%	$41,712	$28,224	$39,260
450	900	TEFC	94.5%	95.0%	96.0%	$51,516	$31,975	$44,566
500	900	TEFC	94.5%	95.0%	96.0%	$54,038	$33,093	$46,149
1	1200	TEFC	80.0%	82.5%	83.5%	$544	$637	$769
1.5	1200	TEFC	85.5%	87.5%	88.5%	$589	$682	$832
2	1200	TEFC	86.5%	88.5%	89.5%	$722	$680	$829
3	1200	TEFC	87.5%	89.5%	90.5%	$835	$706	$866
5	1200	TEFC	87.5%	89.5%	90.5%	$958	$740	$914
7.5	1200	TEFC	89.5%	91.0%	92.0%	$1,304	$936	$1,191
10	1200	TEFC	89.5%	91.0%	92.0%	$1,472	$1,067	$1,376
15	1200	TEFC	90.2%	91.7%	92.7%	$2,528	$1,973	$2,393
20	1200	TEFC	90.2%	91.7%	92.7%	$2,960	$2,179	$2,684
25	1200	TEFC	91.7%	93.0%	94.0%	$3,274	$2,442	$3,057
30	1200	TEFC	91.7%	93.0%	94.0%	$3,660	$2,639	$3,335
40	1200	TEFC	93.0%	94.1%	95.1%	$4,448	$3,003	$3,850
50	1200	TEFC	93.0%	94.1%	95.1%	$5,081	$3,269	$4,227
60	1200	TEFC	93.6%	94.5%	95.5%	$5,894	$3,981	$5,233
75	1200	TEFC	93.6%	94.5%	95.5%	$6,739	$4,612	$6,127
100	1200	TEFC	94.1%	95.0%	96.0%	$9,005	$5,896	$7,677
125	1200	TEFC	94.1%	95.0%	96.0%	$10,193	$7,057	$9,319
150	1200	TEFC	95.0%	95.8%	96.8%	$11,456	$8,134	$10,842
200	1200	TEFC	95.0%	95.8%	96.8%	$14,153	$9,764	$13,148
250	1200	TEFC	95.0%	95.8%	96.8%	$21,763	$10,815	$14,636
300	1200	TEFC	95.0%	95.8%	96.8%	$27,337	$13,293	$18,140
350	1200	TEFC	95.0%	95.8%	96.8%	$38,576	$24,766	$34,370
400	1200	TEFC	95.0%	95.8%	96.8%	$41,591	$28,224	$39,260
450	1200	TEFC	95.0%	95.8%	96.8%	$43,738	$31,975	$44,566

500	1200	TEFC	95.0%	95.8%	96.8%	$45,772	$33,093	$46,149
1	1800	TEFC	82.5%	85.5%	86.5%	$530	$637	$769
1.5	1800	TEFC	84.0%	86.5%	87.5%	$555	$682	$832
2	1800	TEFC	84.0%	86.5%	87.5%	$575	$680	$829
3	1800	TEFC	87.5%	89.5%	90.5%	$670	$706	$866
5	1800	TEFC	87.5%	89.5%	90.5%	$723	$740	$914
7.5	1800	TEFC	89.5%	91.7%	92.7%	$883	$936	$1,191
10	1800	TEFC	89.5%	91.7%	92.7%	$986	$1,067	$1,376
15	1800	TEFC	91.0%	92.4%	93.4%	$1,852	$1,973	$2,393
20	1800	TEFC	91.0%	93.0%	94.0%	$2,050	$2,179	$2,684
25	1800	TEFC	92.4%	93.6%	94.6%	$2,333	$2,442	$3,057
30	1800	TEFC	92.4%	93.6%	94.6%	$2,577	$2,639	$3,335
40	1800	TEFC	93.0%	94.1%	95.1%	$3,074	$3,003	$3,850
50	1800	TEFC	93.0%	94.5%	95.5%	$3,388	$3,269	$4,227
60	1800	TEFC	93.6%	95.0%	96.0%	$4,470	$3,981	$5,233
75	1800	TEFC	94.1%	95.4%	96.4%	$5,226	$4,612	$6,127
100	1800	TEFC	94.5%	95.4%	96.4%	$6,879	$5,896	$7,677
125	1800	TEFC	94.5%	95.4%	96.4%	$8,151	$7,057	$9,319
150	1800	TEFC	95.0%	95.8%	96.8%	$9,248	$8,134	$10,842
200	1800	TEFC	95.0%	96.2%	97.2%	$11,059	$9,764	$13,148
250	1800	TEFC	95.0%	96.2%	97.2%	$16,099	$10,815	$14,636
300	1800	TEFC	95.4%	96.2%	97.2%	$23,183	$13,293	$18,140
350	1800	TEFC	95.4%	96.2%	97.2%	$25,580	$24,766	$34,370
400	1800	TEFC	95.4%	96.2%	97.2%	$32,962	$28,224	$39,260
450	1800	TEFC	95.4%	96.2%	97.2%	$34,948	$31,975	$44,566
500	1800	TEFC	95.8%	96.2%	97.2%	$36,717	$33,093	$46,149
1	3600	TEFC	75.5%	77.0%	78.0%	$580	$637	$769
1.5	3600	TEFC	82.5%	84.0%	85.0%	$566	$682	$832
2	3600	TEFC	84.0%	85.5%	86.5%	$604	$680	$829
3	3600	TEFC	85.5%	86.5%	87.5%	$649	$706	$866
5	3600	TEFC	87.5%	88.5%	89.5%	$742	$740	$914
7.5	3600	TEFC	88.5%	89.5%	90.5%	$828	$936	$1,191
10	3600	TEFC	89.5%	90.2%	91.2%	$919	$1,067	$1,376
15	3600	TEFC	90.2%	91.0%	92.0%	$1,785	$1,973	$2,393
20	3600	TEFC	90.2%	91.0%	92.0%	$2,099	$2,179	$2,684
25	3600	TEFC	91.0%	91.7%	92.7%	$2,321	$2,442	$3,057
30	3600	TEFC	91.0%	91.7%	92.7%	$2,666	$2,639	$3,335
40	3600	TEFC	91.7%	92.4%	93.4%	$3,238	$3,003	$3,850
50	3600	TEFC	92.4%	93.0%	94.0%	$3,644	$3,269	$4,227
60	3600	TEFC	93.0%	93.6%	94.6%	$4,641	$3,981	$5,233
75	3600	TEFC	93.0%	93.6%	94.6%	$5,402	$4,612	$6,127
100	3600	TEFC	93.6%	94.1%	95.1%	$7,411	$5,896	$7,677
125	3600	TEFC	94.5%	95.0%	96.0%	$8,807	$7,057	$9,319
150	3600	TEFC	94.5%	95.0%	96.0%	$10,274	$8,134	$10,842
200	3600	TEFC	95.0%	95.4%	96.4%	$12,284	$9,764	$13,148

250	3600	TEFC	95.4%	95.8%	96.8%	$19,134	$10,815	$14,636
300	3600	TEFC	95.4%	95.8%	96.8%	$28,384	$13,293	$18,140
350	3600	TEFC	95.4%	95.8%	96.8%	$32,541	$24,766	$34,370
400	3600	TEFC	95.4%	95.8%	96.8%	$39,215	$28,224	$39,260
450	3600	TEFC	95.4%	95.8%	96.8%	$37,797	$31,975	$44,566
500	3600	TEFC	95.4%	95.8%	96.8%	$38,664	$33,093	$46,149

References:

1. CEE (Consortium for Energy Efficiency) Premium Efficiency Motors Initiative - Source for premium motor efficiencies, EPAct standard motor efficiencie
2. NYSERDA (New York State Energy Research and Development Authority), Energy $mart Programs Deemed Savings Database - Source for coincidence factor and useful lif
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 factc
4. Not used
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. Net-to-gross factor from Program Evaluation in 2010 by third party and other sources for new products
7. Example is constructed based on the methodology presented in Esource Document, adapted to 200 hp motor. Originally from: Blake Ogden (January 2006), Senior Applications Engineer, Power Efficiency Corp., 702-697-0377 ext 101, bogden@powerefficiencycorp.com.
8. Installed costs gathered by E-Source presented in TAS-F-1, March 2007 from: Power Efficiency Corp.'s PowerGenius, Blake Ogden (January 2006) 4; Somar International's Powerboss, Paul Isom(January 2007), Vice President for Business Development, Mialink Companies, paul@mialink.com; Motortronics' XLD Series, Southland Electrical Supply, from www.southlandelectrical.com (January 2007); and Magnetek's RVS-DN Series, Joliett Technologies, from www.joliettech.com (January 2007).
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 Controller
11. Comprehensive Process and Impact Evaluation of the (Xcel Energy) Colorado Motor and Drive Efficiency Program, FINAL, March 28, 2011, TetraTecl
12. Not used
13. US DOE Advanced Manufacturing Office Energy Tips, Motor Systems Tip Sheet #11, Adjustable Speed Drive Part-Load Efficiency, https://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/motor_tip_sheet11.pdf
14. Xcel Energy well pump and high static head custom motor rebates
15. Bonneville Power Association, Variable Frequency Drives, http://www.bpa.gov/EE/Sectors/agriculture/Pages/Variable-Frequency-Drives.asp
16. Department of Energy (DOE) Guidelines for Estimating Unmetered Landscaping Water Use, http://www1.eere.energy.gov/femp/pdfs/est_unmetered_landscape_wtr.pd
17. How Many Acres Are Needed for an 18 Hole Golf Course?, http://golftips.golfsmith.com/many-acres-needed-18-hole-golf-course-1812.htm

18. APPENDIX TO: Evaluation Measurement and Verification of the California Public Utilities Commission HVAC High Impact Measures and Specialized Commercial Contract Group Programs 2006-2008 Program Year
Final Consultant Report Submitted: February 10, 2010 Volume 2: Appendices Table Q-4, p 175
19 Baldor Standard Product Catalog http://www.baldor.com/mvc/DownloadCenter/Files/CA501
20. US Motor Online Catalog http://ecatalog.motorboss.com/
21. Honeywell VFD Pricing Guide. customer.honeywell.com/en-US/support/commercial/estimatingtools/vfd/Pages/default.aspx> US_VFD_PricingTool_Effective August_29_2015.xl
22. AC Drives and Soft Starters 8800PL9701R01/14 Class 8800. Schneider Electric Catalog. <http://www2.schneider-electric.com/resources/sites/SCHNEIDER_ELECTRIC/content/live/FAQS/174000/FA174840/en_US/Price%20Guide%208800PL9701R0114.pdf>
23. Motor and Drive Pricebook. TECO Westinghouse. Effective 6/14/15
24. RS Mean 2016 Cost Data Book
25. Energy Conservation Program: Energy Conservation Standards for Commercial and Industrial Electric Motors
https://www.energy.gov/sites/prod/files/2014/05/f15/electric_motors_ecs_final_rule.pdf
Table 5 - page 288
26. DOE pump equipment classes and nominal speed, defined in the Rulemaking
http://www.pumps.org/DOE_Pumps.aspx
27. These values were derived in CIP_FR_LCC_2015-09-21_CL_baselinePEI.xlsm as an estimate of the current market average efficiency level. This is based on the Table 8.3.4 (located on Reference Tab) of shipments by pump class and efficiency level.
28. Irrigation hours are taken from metering shown in the Green Motors Rewind UES workbook
Industrial hours are the average hours for pump applications in the NW Motor Database
Commercial water circulation hours are from the Circulator Pump Working Group
Municipal hours are based on assumed hours close to 8760 with redundant pumps
29. Work product is included a Utility titled "ComIndAgPumps_1_1" based upon **CIP_FR_LCC_2015-09-21_CL_CL_LoadFactor.xlsm**
30. Work product from utility work paper based upon **CIP_FR_LCC_2015-09-21_Costs.xlsm**
31. Supplyhouse.com shows variable speed 1 HP circulator pumps from $1400-$3100; non variable speed are under $1000, some data available at the following website
32. Pump Energy Index (PEI) based upon the Regional Technical Forum (RTF) approved Northwest Energy Efficiency Alliance (NEEA) pump ECS savings analysis from the Efficient Commercial and Industrial Pumps (ECIP) project, the Federal Standard is under Title 10 Section 431.462 for the Department of Energy (DOE) Energy Conservation Standard (ECS) for commercial, industrial and agricultural clean water pumps.
33. Historical total VFD costs (Labor and Equipment) provided by Colorado Xcel Customers participating in the Motors and Drives program, 2018.