Grand Lake Public Works Authority: Water Treatment Plant

DWSRF Project No. P40-1021691-01

Green Business Case

Summary

- Installation of two high service pumps and motors, two backwash pumps and motors, three process pumps, and two backwash waste pumps and motors will utilize high efficient pumps and premium efficiency motors. Installation of premium efficiency motors will reduce the energy demand of the treatment process.
- Pumps will be VFD controlled.
- SRF Loan amount = $4,000,000
    - Estimated cost of premium efficiency pumps and motors: $159,491
    - Estimated cost of VFD control: $52,700
- Estimated annual energy savings = 100,887 kilowatt-hours (kWH) ($10,089 per year)

Background

- The proposed plant includes numerous pumps to operate the filters, supply backwash water, pump waste to the sanitary sewer system, and pump finished water to the distribution system.
- Energy requirements for pumping represents the largest energy demand of the treatment plant system.
- The high service pumps, backwash pumps, backwash waste pumps, and process pumps will be controlled by variable frequency drives (VFD).
- VFD control will allow energy savings at low-flow conditions by allowing pump motors to operate at a lower speed with reduced energy consumption.
    - Pump power is proportional to the cube of speed. Operating a pump at half speed requires one eighth of the power required at full speed. Varying pump speed as demand fluctuates will reduce total energy consumption.

Results

- The proposed new high-efficiency pumps will have a rated pump efficiency of 62% to 78% (see chart below)
- Standard efficiency pumps have rated pump efficiency ranging from 30% to 66%.
- The proposed new premium efficiency motors will have a rated efficiency of 92% to 95%
- Standard efficiency electric pump motors have a rated efficiency of 88% to 93%
    - Recent changes to motor manufacture requirements specify high motor efficiencies; the motor efficiency difference between standard and premium efficiency motors is not large.

Calculated Energy Efficiency Improvements

- The efficiency (wire-to-water) of standard pumps and motors = 65% * 89% = 58% (pump efficiency times motor efficiency, see table below)
- The efficiency (wire-to-water) of premium-efficiency pumps and motors = 78% * 95% = 74% (see table below)
- The power required for each pump to operate can be calculated based on the pump capacity and Total Dynamic Head (TDH) shown in the table below.
- The annual power consumption for process pumps and high service pumps is calculated assuming the pump operates at full capacity for twelve (12) hours per day.
- The annual power consumption for backwash supply and backwash waste pumps is calculated assuming filter backwash two (2) times per week and GAC backwash one (1) time per week.
- The annual pump energy consumption for standard pump motors is 509,448 kWh; the annual pump energy consumption for premium efficiency motors is 408,561 kWh.

Standard Efficiency Pumps

Pump	flow (gpm)	TDH (ft)	Power (Hp)	Power (kW)	Pump Efficiency	Motor Efficiency	Wire-to Water	Runtime (hour)	Annual Demand (kWh)
Process	575	90	20	14.9	65.1%	88.50%	57.6%	4380	226,764
Backwash	2730	57	75	55.9	65.7%	90.20%	59.3%	52	4,907
Backwash Waste	300	50	17	12.7	30.0%	91.00%	27.3%	182	8,451
High Service	1050	115	50	37.3	65.2%	93.00%	60.6%	4380	269,326

*See Notes Below

Premium Efficiency Pumps

Pump	Total Cost	flow (gpm)	TDH (ft)	Power (Hp)	Power (kW)	Pump Efficiency	Motor Efficiency	Wire-to Water	Runtime (hour)	Annual Demand (kWh)
Process	$56,181	575	90	20	14.9	77.3%	92.40%	71.4%	4380	182,914
Backwash	$60,076	2730	57	60	44.7	78.2%	95.00%	74.3%	52	3,132
Backwash Waste	$13,000	300	50	10	7.5	62.2%	92.00%	57.2%	182	2,372
High Service	$30,234	1050	115	50	37.3	78.5%	94.50%	74.2%	4380	220,144

*See Notes Below

Conclusions

- By installing premium efficiency pumps and motors for the two high service pumps, two backwash pumps, two backwash waste pumps, and three process pumps, with VFD control, the Grand Lake Public Works Authority will reduce annual energy use by 100,887 kWh.
- At 10 cents per kWh, energy savings from high efficiency pumps will be $10,089 per year.
- Assuming the total capital cost of purchasing premium efficiency pumps and corresponding VFDs is $212,191, then the simple payback for total pump cost, based on energy savings, is 21 years.

*Table Notes

a) Power (Hp) listed as indicated by pump manufacturer
b) Power (kW) = Power (HP) * (745.7 / 1000)
c) Wire-to-water efficiency = pump efficiency * motor efficiency
d) Runtime of Process and High Service pumps: 12 hours per day, 365 days per year
e) Runtime of Backwash Supply and Backwash Waste pumps assumes 2 backwash per week of filters, 1 backwash per week of GAC.
f) Annual demand (kWh) = Power Demand (kW) * Number of Operating Units / Wire-to-Water Efficiency
g) Total cost listed represents estimated purchase cost of all pumps; it is not an individual unit-cost.

Grand Lake Public Works Authority: Water Well Pumps

Plant DWSRF Project No. P40-1021691-01

Green Business Case

Summary

- Installation of five water well pumps and motors will utilize high efficient pumps and premium efficiency motors. Installation of premium efficiency motors will reduce the energy demand of the supply process.
- Pumps will be VFD controlled.
- SRF Loan amount = $4,000,000
  - Estimated cost of premium efficiency pumps and motors: $125,920
  - Estimated cost of VFD control: $41,750
- Estimated annual energy savings = 248,116 kilowatt-hours (kWH) ($24,811.60 per year)

Background

- The proposed water supply wells include sumbersible pumps to supply water to the raw water tanks at the inlet of the proposed water treatment plant.
- Energy requirements for pumping represents the largest energy demand of the water supply system.
- The water well pumps will be controlled by variable frequency drives (VFD).
- VFD control will allow energy savings at low-flow conditions by allowing pump motors to operate at a lower speed with reduced energy consumption.
  - Pump power is proportional to the cube of speed. Operating a pump at half speed requires one eighth of the power required at full speed. Varying pump speed as demand fluctuates will reduce total energy consumption.

Results

- The proposed new high-efficiency pumps will have a rated pump efficiency of 78% (see chart below)
- Standard efficiency pumps have rated pump efficiency of 65%.
- The proposed new premium efficiency motors will have a rated efficiency of 95%
- Standard efficiency electric pump motors have a rated efficiency of 90%
  - Recent changes to motor manufacture requirements specify high motor efficiencies; the motor efficiency difference between standard and premium efficiency motors is not large.

Calculated Energy Efficiency Improvements

- The efficiency (wire-to-water) of standard pumps and motors = 65% * 90% = 59.1% (pump efficiency times motor efficiency, see table below)
- The efficiency (wire-to-water) of premium-efficiency pumps and motors = 78% * 95% = 73.7% (see table below)
- The power required for each pump to operate can be calculated based on the pump capacity and Total Dynamic Head (TDH) shown in the table below.
- The annual power consumption for water well pumps and high service pumps is calculated assuming the pump operates at full capacity for twelve (12) hours per day.
- The annual pump energy consumption for standard pump motors is 452,551 kWh; the annual pump energy consumption for premium efficiency motors is 408,561 kWh.

Standard Efficiency Pumps

Pump	Flow (gpm)	TDH (ft)	Power (Hp)	Power (kW)	Pump Eff.	Motor Eff.	Wire-to Water	Runtime (hour)	Annual Demand (kWh)
Water Well (5)	250	1035	125	93.2	65.4%	90.3%	59.1%	4380	691,326

*See Notes Below

Premium Efficiency Pumps

Pump	Total Costs	Flow (gpm)	TDH (ft)	Power (Hp)	Power (kW)	Pump Eff.	Motor Eff.	Wire-to Water	Runtime (hour)	Annual Demand (kWh)
Water Well (5)	$125,920	250	1035	100	74.6	77.9%	94.6%	73.7%	4380	443,210

*See Notes Below

Conclusions

- By installing premium efficiency pumps and motors for the five water well pumps with VFD control, the Grand Lake Public Works Authority will reduce annual energy use by 248,116 kWh.
- At 10 cents per kWh, energy savings from high efficiency pumps will be $24,811.60 per year.
- Assuming the total capital cost of purchasing premium efficiency pumps and corresponding VFDs is $167,670, then the simple payback for total pump cost, based on energy savings, is 7 years.

*Table Notes

Power (Hp) listed as indicated by pump manufacturer
Power (kW) = Power (HP) * (745.7 /1000)
Wire-to-water efficiency = pump efficiency * motor efficiency
Runtime of Water Well pumps: 12 hours per day, 365 days per year
Annual demand (kWh) = Power Demand (kW) * Number of Operating Units / Wire-to-Water Efficiency
Total cost listed represents estimated purchase cost of all pumps; it is not an individual unit-cost.

Grand Lake Public Works Authority: Water Treatment Plant

DWSRF Project No. P40-1021691-01

Green Business Case: Energy Efficient Lighting

Summary

- Installation of lighting will include fluorescent and LED lighting.
- SRF Loan amount = $4,000,000
  - Estimated cost of energy efficient lighting fixtures and lamps: $23,500
- Estimated annual energy savings = kilowatt-hours 24,335 (kWH) ($2,434 per year)

Background

- The proposed plant includes energy efficient lighting for room illumination, emergency lighting, and exit sign lighting.
- Energy efficient lighting includes fluorescent and light emitting diode (LED) lighting.

Calculated Energy Efficiency Improvements

- The annual power consumption is calculated assuming lights are illuminated for eight (8) hours per day. The annual energy consumption for high efficiency lighting is 27,261 kWh; the annual energy consumption for standard efficiency lighting is 51,596 kWh.
- Energy efficiency cost comparisons cannot be made for exit lighting and emergency lighting; incandescent exit lighting is unavailable for purchase, and emergency lighting is used infrequently. Emergency lighting is designed to only illuminate during power outages. Exit lighting and emergency lighting will utilize high efficiency and LED lighting to maintain low power consumption.
- The following tables have been developed to compare standard efficiency and high efficiency lighting alternatives.

Standard Efficiency Lighting

Location	Description	Bulb Type	Total Fixture Cost	Total Power (watts)	Annual Energy Consumption (kWh)	Energy Cost
Chemical Bldg	1-lamp High Pressure Sodium	HP Sodium	$2,750	2,500	7,300	$730
Office Bldg	1-lamp recessed incandescent	INCANDESCENT	$3,960	7,920	23,126	$2,313
Treatment Bldg	1-lamp High Pressure Sodium	HP Sodium	$7,975	7,250	21,170	$2,117

High Efficiency Lighting

Location	Description	Bulb Type	Total Fixture Cost	Total Power (watts)	Annual Energy Consumption (kWh)	Annual Energy Cost
Chemical Bldg	2-lamp Fluorescent	FLUORESCENT	$2,381	960	2,803	$280
Office Bldg	3-lamp Fluorescent	FLUORESCENT	$6,339	2,112	6,167	$617
Treatment Bldg	4-lamp Fluorescent	FLUORESCENT	$10,568	6,264	18,291	$1,829
Chemical Bldg	Exit & Emergency Light	LED	$400			
Office Bldg	Exit & Emergency Light	LED	$1,200			
Treatment Bldg	Emergency Light	LED	$2,600			

Conclusions

- By installing high efficiency lighting for the treatment plant, office building, and chemical building, the Grand Lake Public Works Authority will reduce annual energy use by 24,335 kWh.
- At 10 cents per kWh, energy savings from high efficiency lighting will be $2,434 per year.
- Assuming the capital cost of purchasing high efficiency lighting is $23,500, then the simple payback for additional cost of high efficiency lighting, is ten (10) years.

Grand Lake Public Works Authority: Water Treatment Plant

DWSRF Project No. P40-1021691-01

Green Business Case: Energy Efficient Air Conditioning

Summary

- Installation of air conditioning system will include premium efficiency motors
- SRF Loan amount = $4,000,000
  - Estimated cost of energy efficient air conditioning: $18,000
- Estimated annual energy savings = $800 per year (8000 kWh)

Background

- The proposed plant includes an energy efficient cooling system. This system utilizes premium efficiency motors for air conditioning compressors and blowers.

Results

- The Seasonal Energy Efficiency Ratio (SEER) rating of standard air conditioning equipment is 13 SEER
- The SEER rating of premium efficiency air conditioning equipment is 18 SEER.
- Increased SEER rating results in higher equipment efficiency. Premium efficiency equipment rated at 18 SEER will use less energy than the equipment rated at 13 SEER.

Conclusions

- By installing premium efficiency motors and air conditioning equipment, the Grand Lake Public Works Authority will reduce annual energy use by 8,000 kWh.
- At 10 cents per kWh, energy savings from high efficiency air conditioning will be $800 per year.
- Assuming the capital cost of purchasing high efficiency air conditioning equipment is $18,000, the simple payback for the total cost of air conditioning equipment is 23 years.

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