

Mechanical/Electrical Scope of Work

SmartWatt will provide for turnkey installation of WSHPs:

- Provide engineering stamped drawings for complete installation
- Remove and demolish the existing WSHPs
- Purchase and install replacement WSHPs
- Install all WSHP accessories as indicated in the Schedule
- Install all electrical wiring to make operational
- Provide factory start-up, testing and adjustment of the new system.
- Instruct owner’s designated operators on the operation and maintenance of the new equipment

SmartWatt will install variable frequency drives and premium efficiency inverter duty motors on the two (2) WSHP loop pumps. Motors are 10 HP.

- Mount and wire new VFD drives. Bypass existing pump contactor wiring.
- Remove the existing 10 HP motors.
- Replace the existing 10 HP motors with premium efficient inverter duty motors.

Cut sheets for the equipment to be installed is included in Appendix C.

Controls Scope of Work

- The WSHPs will include a controller with a BACNET communications interface. The WSHPs system will be integrated with the existing Metasys EMS system. In addition, the JCI head end will be upgraded to Facility Explorer by JCI included a web based server.
- Existing controllers in the DSS, Jail, and Veterans building will be upgraded as summarized in the table below:

Building	Controls Upgrade
DSS	Add 46 new WSHPs (24 points per WSHP) to EMS
DSS	Replace unit controllers on 5 WSHPs to remain with new BACNET controllers and migrate points to EMS
DSS	Replace 1 existing LOOP controller with BACNET controller and migrate points to new web server.
Jail	Add 33 new WSHPs (24 points per WSHP) to EMS
Jail	Replace unit controllers on 6 WSHPs to remain with new BACNET controllers and migrate points to EMS
Jail	Replace 1 existing LOOP controller with BACNET controller and migrate points to new web server.
Jail	Migrate 7 Controllers for 23 existing exhaust fans to new Web Server. Existing unit controls to be replaced with new BACnet Controllers
Jail	Migrate 1 Controllers for 1 existing Isolation Room unit to new Web Server. Existing unit controls to be replaced with new BACnet Controllers
Veterans	Add 17 new WSHPs (24 points per WSHP) to EMS
Veterans	Replace unit controllers on 5 WSHPs to remain with new BACNET controllers and migrate points to EMS
Veterans	Replace 1 existing LOOP controller with BACNET controller and migrate points to new web server.

Savings Summary

Savings for this FIM are associated with energy conservation as well as reduced repair and replacement costs. Energy savings for this FIM are accomplished through an increase in cooling and heating efficiency of the new WSHP as compared to the existing units. A building simulation was conducted for each facility using Carrier Hourly Analysis Program (HAP) V4.90 to determine the baseline energy usage for the WSHPs. A spreadsheet savings model was developed and is presented in Appendix B. Existing efficiencies ratings were based on manufacturers specifications and are summarized in Table 12. Efficiency ratings of the proposed equipment is provided in the schedules on the last page of each drawing set in the pages above.

In addition, pumping power at the Jail (DSS and Veterans buildings already have VFDs on the transfer pumps) will be reduced by installing Variable Frequency Drives on the loop transfer pumps. Savings for the installation of a VFD were calculated using a spreadsheet model. The use of a variable speed drive will allow the pumps to modulate speed depending on system load. Energy savings are associated with a reduction in the power consumed by the pumps.

Energy savings were based on a motor load profile and pump laws in which the power of the motor decreases as a cubic function of the speed. A factor of 2.5 was used rather than 3 to ensure the savings estimates are conservative. The minimum VFD speed is limited at 60% to ensure proper operation of the system and to prevent damage to the motor. The calculations are provided in Appendix B utilizing a BIN temperature analysis as described below:

$$Energy\ Savings\ \left(\frac{kWh}{yr}\right) = Current\ Usage - Proposed\ Usage$$

$$Current\ Usage = \sum_{bin\ hours} Input\ Power\ (kW) \times Bin\ Hours$$

$$Proposed\ Usage = \sum_{bin\ hours} \frac{Input\ Power\ (kW) \times VFD\ Flow\ \%_{per\ bin}^{2.5} \times Bin\ Hours}{VFD\ Efficiency}$$

Repair and replacement savings are associated with the reduction in annual costs for replacing WSHPs as they fail. Calculations were performed to estimate failure rates based on historic data obtained from the County. A heat pump failure rate was determined based on the age of the heat pumps. Table 13 summarizes the failure rates and replacement savings for each of the buildings. The per unit replacement cost avoided is estimated at \$5,000 per unit and is escalated at 3% per year.

Table 13 – WSHP Failure Rate and Replacement Cost Summary

Facility	Total # WSHPs	Units Previously Replaced	Original Installation Year	Projected Failures Per Year					
				2016	2017	2018	2019	2020	2021
DSS	51	7	1995	4	5	6	8	10	11
Jail	39	6	1985/1994	5	7	9	12	0	0
Veterans	22	7	1988	3	4	5	3	0	0
Total	112	20		12	16	20	23	10	11
Avoided Replacement Cost				\$60,000	\$82,400	\$106,000	\$125,350	\$56,000	\$63,250

Baseline Usage and Cost

The energy baseline for this FIM is defined as the existing energy usage for cooling and heating. The usage and cost are at the energy rates provided in Table 6.

Facility	Electrical Consumption (kWh/yr)	Electrical Annual Cost (\$/yr)	Natural Gas Consumption (therm/yr)	Natural Gas Annual Cost (\$/yr)	Total Annual Cost
DSS WSHPs	198,424	\$17,858	5,129	\$4,401	\$22,259
Jail WSHPs	352,286	\$31,353	19,286	\$15,101	\$46,454
Jail Transfer Pumps	54,762	\$4,874	-	-	\$4,874
Veterans WSHPs	103,923	\$9,977	10,481	\$8,563	\$18,540
Total	709,395	\$64,062	34,896	\$28,065	\$92,127

Post Retrofit Energy Use and Cost

The projected energy use and cost for this FIM are shown in the table below.

Facility	Electrical Consumption (kWh/yr)	Electrical Annual Cost (\$/yr)	Natural Gas Consumption (therm/yr)	Natural Gas Annual Cost (\$/yr)	Total Annual Cost
DSS WSHPs	137,648	\$12,388	4,931	\$4,231	\$16,619
Jail WSHPs	238,613	\$21,237	18,250	\$14,290	\$35,527
Jail Transfer Pumps	16,203	\$1,442	-	-	\$1,442
Veterans WSHPs	73,821	\$7,087	9,797	\$8,004	\$15,091
Total	466,285	\$42,154	32,978	\$26,525	\$68,679

The energy savings are the difference between the Baseline and the Post Retrofit energy use and cost multiplied by a safety factor of 0.9 as summarized in the table that follows.

Facility	Electrical Consumption (kWh/yr)	Electrical Annual Cost (\$/yr)	Natural Gas Consumption (therm/yr)	Natural Gas Annual Cost (\$/yr)	Total Annual Savings
DSS WSHPs	54,699	\$4,923	178	\$153	\$5,076
Jail WSHPs	102,306	\$9,104	932	\$730	\$9,834
Jail Transfer Pumps	34,703	\$3,089	-	-	\$3,089
Veterans WSHPs	27,092	\$2,601	616	\$503	\$3,104
Total	218,800	\$19,718	1,726	\$1,386	\$21,103

Annual savings associated with equipment failure vary by year as shown in Table 13.

Utility Incentives

SmartWatt will apply for incentives through National Grid’s energy efficiency program. SmartWatt anticipates an incentive of \$32,893 for this FIM.