Appendix 5

ENERGY ANALYSIS REPORT
FOR INITIATIVE 937
Hermiston, OR

ENERGY ANALYSIS REPORT
FOR
INITIATIVE 937

Plant-wide Energy Conservation Measures

Located At:

Hermiston Generating Facility – Hermiston, OR

Presented to:

PacifiCorp

Submitted By:

Cascade Energy

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CAS 3535-12

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DISCLAIMER

The intent of this energy analysis report is to estimate energy savings associated with recommended upgrades. Appropriate detail is included in Sections 2-4 of this report. However, this report is not intended to serve as a detailed engineering design document. It should be noted that detailed design efforts may be required in order to implement several of the improvements evaluated as part of this energy analysis. As appropriate, costs for those design efforts are included as part of the cost estimate for each measure.

While the Energy Conservation Measures in this report have been reviewed for technical accuracy and are believed to be reasonably accurate, the findings are estimates and actual results may vary. As a result, Cascade Energy Inc. is not liable if projected estimated savings or economics are not actually achieved. All savings and cost estimates in the report are for informational purposes, and are not to be construed as a design document or as guarantees. Project cost estimates shown in this report represent Cascade's best effort to work within the given time frame and with each facility's personnel.

PacifiCorp shall independently evaluate any advice or direction provided in this report. In no event will Cascade Energy Inc. be liable for the failure of the customer to achieve a specified amount of energy savings, the operation of customer's facilities, or any incidental or consequential damages of any kind in connection with this report or the installation of recommended measures.

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1.0 EXECUTIVE SUMMARY

1.1 Introduction and Background

PacifiCorp has seven generation facilities in their fleet that provide electricity to the State of Washington. These units vary from coal-fired to natural gas to wind. In 2006 the State of Washington passed clean energy legislation requiring PacifiCorp to complete all cost-effective energy efficiency measures in these generation facilities. A study of those measures at the Hermiston Generating Facility in Hermiston, OR was completed in 2013 by Cascade Energy and submitted to Pacific Power.

The purpose of this report is to update the systems investigated in that 2013 study and estimate savings for the measures that have not been completed. Therefore, the baseline for each measure is unchanged from the 2013 report. The updates noted since the 2013 study are based on a site visit conducted by Craig Phillips, Senior Project Engineer at Cascade Energy, on 15 July, 2021 and subsequent conversations with operations and maintenance managers at Hermiston Generating.

This information should be used by PacifiCorp as a starting point. Additional reliability and engineering studies may be needed on the outlined measures to identify further project lifecycle costs and impacts on facility availability.

1.2 Summary of Opportunities for Hermiston Generation Facility

1.2.1 Energy Conservation Measures (ECMs)

ECM 1: Lighting

Baseline: The exterior lighting consisted of various high-pressure sodium (HPS) fixtures that operated continuously because the existing sensors are not working correctly. Most of these fixtures have a significant amount of discoloration on the lenses that further reduces the lighting output. The interior lighting has a mixture of HPS, T12, and T8 fixtures. Most of the interior lighting is manually controlled and operates continuously.

Proposed: The recommended upgrade for this measure includes continuing the lighting retrofit efforts for both the remaining interior and exterior fixtures. For the exterior areas, it is recommended that the existing fixtures be replaced with LED fixtures. The recommendation for the interior lighting covers replacing the existing HPS and fluorescent T12 fixtures with more efficient LED fixtures with occupancy sensors.

ECM 2: Small Condensate Pump for Auxiliary Use

Baseline: Turbine gland seals in each unit are maintained by a 250-hp constant speed condensate pump when the plant is taken offline for short durations between startups. The condensate flow required for the gland steam system is much less than during normal operation. However, the only pumps available to provide condensate flow are the 250 hp condensate pumps.

Proposed: Since Hermiston Generating does not cycle either HRSG unit like they did in 2013, this ECM is no longer recommended.

ECM 3: HVAC

Baseline: Air Handling Units (AHUs) in the Raw Water building, Demin building, and Warehouse maintain internal air temperatures of 72-75°F despite the fact that these buildings are rarely occupied. Except for a small office in the Warehouse, operators typically spend from one to three hours per day in any of those facilities as they make their rounds each shift.

Proposed: This measure originally only included installing a programmable thermostat in each building that is occupied less than three hours per day, and maintain a temperature of 80°F in the summer and 60°F in the winter. The AHU is now close to end of useful life so it is also recommended that a more efficient unit be purchased when a new unit is needed.

This measure would add the following equipment:

- Thermostat controls in the Raw Water building that will:
  - Remain off unless the room temperature is above 80°F or below 60°F
  - Have the ability to be turned on manually for a short duration when needed, then automatically shut off again
- New, more efficient AHU for the Raw Water building

ECM 4: Compressed Air System Upgrades

Baseline: The facility compressed air system currently operates as two separate systems, Unit #1 and Unit #2. The header piping for Unit #1 and Unit #2 are connected, but the cross-connect valve between the two is closed so that each unit operates independently so that loss of air in one unit does not trip the other unit. The Unit #1 system consists of a 60 hp Sullair oil-flooded screw with VFD control and a 50 hp Atlas Copco oil-free screw that uses load/unload control. Both compressors are connected to heatless desiccant dryers. The Unit #2 system consisted of a single 60 hp Kaeser oil-flooded screw compressor with a heatless desiccant dryer, but this was upgraded to a 50 hp Atlas Copco compressor with VFD control. A new heatless desiccant dryer was also added. Both systems utilize the Combustion Turbine's compressor and AirTek Air Processing Unit's (APU) as the primary method of providing compressed air to the facility when generating power. Normally, the Sullair and Kaeser compressors operate continuously providing make-up air to the systems when the turbine compressors do not produce enough air.

Proposed: The recommended upgrades consist of installing dew-point demand controls on the heatless desiccant dryers. In addition, the facility should continue their leak reduction program to reduce the plant air demand.

1.3 ECM Costs and Savings for Hermiston Generating Facility

The table below shows the costs and savings of electrical efficiency measures for the Hermiston Generating Facility.

Table 1: ECM Economics for Hermiston Generating Facility

			Ann. Benefits	Initial Investments				Ann. Invest.	
ECM No.	Description	Measure Life (yrs)	Annual Energy Savings (MWh/yr)	Installed Costs ($)	EM&V Costs ($)	Engineering Fees ($)	Spare Parts Costs ($)	O & M Costs ($/yr)	Net Present Cost ($)
1	Lighting	10	505	$52,216	$500	$5,222	$1,566	$1,566	($70,421)
3	HVAC	10	4	$322	$2,500	$32	$10	$10	($2,932)
4	Compressed Air System Upgrades	10	106	$11,547	$4,000	$1,155	$346	$346	($19,462)
	Totals		**615**	**$64,086**	**$7,000**	**$6,409**	**$1,923**	**$1,923**	**($92,815)**

NOTES:

1. Estimates for engineering fees were based on 10% of installed cost.
2. Estimates for spare parts were based on 3% of installed cost.
3. Estimates for O&M fees were based on 3% of installed cost.
4. 2013 costs were increased by 14% to account for inflation to 2021 values

2.0 PLANT AUXILIARY BASELINE ENERGY USE

2.1 PLANT DESCRIPTION

The Hermiston Generating Facility began commercial operation in July 1996. Power is generated by two GE model MS7001FA combustion turbines operated in combined cycle mode, each with a synchronous 3600 RPM GE steam turbine. Each of these turbine sets is referred to respectively as Unit 1 and Unit 2. The facility has a nominal generating capacity of 474 MW. Power is generated in the combustion turbines at 18 kV and in the steam turbines at 13.8 kV, then transformed up to a distribution voltage of 230 kV. The cooling water for each unit's condenser is supplied by a four-cell, counterflow, mechanically-induced draft cooling tower.

The plant operated Unit 1 75% of the time and Unit 2 94% of the time over fiscal year 2020 (4/1/2020 to 3/31/2021), and both units ran continuously from October through March. During periods of lighter loading, the plant varies its capacity and occasionally operates just one combustion turbine in conjunction with its steam turbine. The facility has a contractual obligation to provide up to 100,000 lb/hr of intermediate pressure steam to a neighboring potato processing plant (50,000 lb/hr from each unit) when operating and when the potato plant can take it..

Auxiliary systems at the plant include a compressed air system for each unit, boiler feed-water treatment from a demineralization process, closed cooling water for numerous plant system cooling needs, and several wastewater pumps that send cooling tower discharge to the neighboring potato processing plant. A carbon dioxide fire suppression system is employed on the gas turbines while a 2,000 gpm electric motor-driven fire pump with diesel backup draws water from the cooling tower basins for fire suppression throughout the rest of the facility. Lighting at the plant consists of high pressure sodium fixtures throughout the turbine building and exterior, with linear fluorescents within the office building.

2.2 PLANT BASELINE DESCRIPTION

The baseline energy use per sub-system for the Hermiston Generation Facility is outlined in the table and show in the figure below.

Table 2: Baseline Energy Use per Sub-system for Hermiston Generation Facility

Subsytem	Energy Use (MWh/yr)	% of Total
Condensate System	2,652	7%
Boiler Feed Water	13,804	35%
Lighting	747	2%
HVAC	71	0%
Circulating Water	11,673	29%
Closed Cooling Water	790	2%
Compressed Air	367	1%
Cooling Tower	9,374	24%
Emissions Control	245	1%
Fire Protection	12	0%
Total	39,735	100%

The energy use per sub-system for the Hermiston Generation Facility is shown in Figure 1.

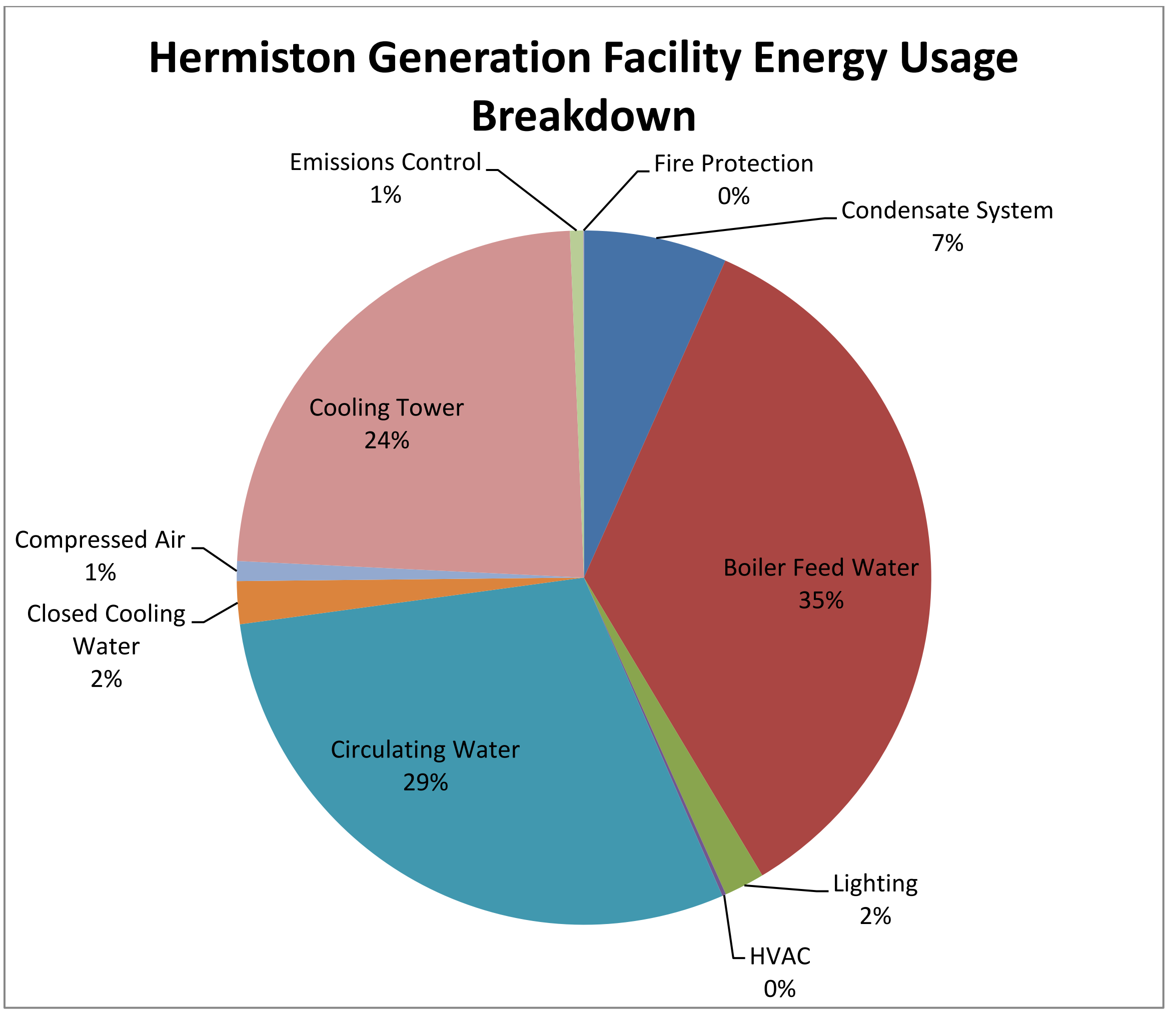

Figure 1: Energy Breakout per Sub-system for Hermiston Generating Facility

3.0 DETAILED DESCRIPTION OF PROPOSED EQUIPMENT AND OPERATION

3.1 ECM 1: LIGHTING

3.1.1 Changes Since 2013 Report

Approximately 33% of all facility lights have been replaced with LED (light-emitting diode) lights.

- An estimated 25% of field lights and 80% of indoor lights in administrative areas have been upgraded. Motion sensor controls have been installed with most of the upgraded field lights. Occupancy sensors were not added to the new light fixtures in the Admin building, but those are consistently switched off at the close of business hours each day.
- During the verification site visit, more than 100 upgraded light fixtures were inspected but an exact count of the total number of upgraded lights was not made. Instead, the estimate for the total percentage of new lights was provided by the maintenance manager who believes this is a conservative estimate.

3.1.2 Source of Energy Savings

- The remaining fixtures and lamps that have not been replaced are inefficient and many lamps are on continuously.
- Installing more energy efficient fixtures and reducing operating hours where appropriate will reduce energy usage.

3.1.3 Specific Equipment Recommendations

- Install high efficiency lighting system with occupancy sensors.
- The facility is planning on replacing the remaining high-intensity discharge (HID) and T12 lights in the Main Warehouse before the end of 2022.
- The remaining inefficient lights in the Raw Water building will likely be the last to be replaced due to the difficulty in accessing the lights, and the very low occupancy.
- Based on the facility’s experience with lights they have already replaced, they should either choose future replacements based on the LED’s that have resulted in the lowest cost of ownership, or consult with an experienced lighting contractor for specific upgrade recommendations.

3.1.4 Set-points Recommended to Achieve Energy Performance

- Install high efficiency lighting system.
- Install occupancy sensors on lighting system as outlined in the Appendix.
- Set-occupancy sensor time delay to the minimum delay time allowed by the manufacturer’s warranty.

3.2 ECM 2: SMALL CONDENSATE PUMP FOR AUXILIARY USE

3.2.1 Changes Since 2013 Report

The facility’s scheduled operational time has dramatically increased since 2013; they rarely cycle either Unit now and have no plans to cycle the Units in the foreseeable future. As a result, the potential savings from this ECM is negligible.

3.2.2 Source of Energy Savings

If the Units cycled, this measure would save energy by reducing the flow rate of the system when the turbine is idle but condensate must still flow to the gland steam and other systems.

- A properly sized pump will eliminate the recirculation and throttling currently required.
- Installing a smaller pump will improve the power draw at the required pressure and flow rate, while condensate circulation is required.

3.2.3 Specific Equipment Recommendations

- This measure is no longer recommended.

3.2.4 Set-points Recommended to Achieve Energy Performance

- No longer applicable.

3.3 ECM 3: HVAC

3.3.1 Changes Since 2013 Report

A programmable thermostat was added to the Main Warehouse building but not to the Demin building due to the humid environment, and because the minimum required temperature in that building is higher so that the caustic soda does not freeze. The Main Warehouse thermostat is programmed to maintain 78°F between 5:30 AM and 5:30 PM, Monday through Friday, and either 85°F or 55°F the remaining 108 hours of the week during the summer or winter, respectively.

In addition, several air conditioning systems have been replaced since 2013. These were not specifically recommended in the original report, but the new systems are more efficient than the replaced units. The facility also has plans to replace all aging R-22 systems with new air conditioning units by the end of 2023.

3.3.2 Source of Energy Savings

This measure would save energy by reducing the operating time of the system.

- Since the Raw Water, Demin and Warehouse buildings are rarely occupied, heating and cooling the conditioned space as if they were continuously occupied wastes energy.

3.3.3 Specific Equipment Recommendations

- Install a programmable thermostat in the Raw Water building.
- Replace all R-22 air conditioning units with heat pumps with a SEER rating of at least 16.

3.3.4 Set-points Recommended to Achieve Energy Performance

Set the thermostat in the Raw Water building to only turn on the AHUs when the following indoor air temperatures are met:

- 80°F between May and September
- 60°F between October and March

Note: this recommended temperature range (60-80°F) is more narrow – and not quite as energy efficient – as the range maintained in other areas of the plant (55-85°F) due to the electrical equipment in that building.

Check temperature storage requirements for product inventory stored in any of these buildings to ensure product damage does not occur. Energy savings are maximized by maintaining the highest possible temperatures in the summer and the lowest possible temperatures in the winter.

3.4 ECM 4: Compressed Air System Upgrades

3.4.1 Changes Since 2013 Report

The 60 hp fixed speed Kaeser air compressor on Unit 2 has been replaced with a smaller and more efficient 50 hp variable speed Atlas Copco ZT37 air compressor. The facility determined that opening the cross-connection between the Unit 1 and Unit 2 compressed air systems was not worth the increased risk of tripping both units due to an interruption in compressed air, so this has been removed from the recommendation list. The facility is achieving the same savings by operating each unit with a variable speed compressor.

The facility's fittings supplier has been performing site leak inspections approximately every 2-3 years, and the plant is working on creating a PM for regularly scheduled in-house leak sweeps.

In addition, the discharge pressure setpoint on the both Unit compressors was reduced from 113 psi to 105 psi, with low pressure alarms at 90 psi.

A new 75 hp Atlas Copco ZT55 fixed-speed, oil-free compressor and heatless desiccant dryer with timer purge control were also added to the Demin building compressed air system. This system replaced a similarly sized fixed-speed Kaeser compressor and desiccant dryer. Since the equipment was similar, no energy savings resulted from this capital investment.

3.4.2 Source of Energy Savings

Changing the compressor control set-points for the Sullair variable speed compressor will reduce its average energy use by approximately 2.5%. Dew-point demand controls on the heatless desiccant dryers will reduce the purge airflow based on plant air demand. A leak identification and elimination program will reduce the demand on the compressors.

3.4.3 Specific Equipment Recommendations

- Install dew point demand controls on the Sullair and Atlas Copco dryers.
- When the desiccant dryers are at end of useful life, consider replacing them with heated desiccant dryers, or blower purge desiccant dryers, both of which are more efficient than heatless dryers.

3.4.4 Set-points Recommended to Achieve Energy Performance

- Change the compressor set-point as follows
    - Sullair

        - Load/start: 105 psi
        - Target: 105 psi
        - Unload/off: 115 psi
    - Atlas Copco
        - Load/start: 93 psi
        - Unload: 103 psi
        - Unload delay to off: 10 minutes or less
- Operate the dryers in demand control mode
- Institute a leak identification and elimination program at the facility

4.0 ENERGY CONSERVATION MEASURE COSTS

The tables below provide an itemized cost breakout for each ECM based on information gathered for the 2013 report. A contingency of 10% was included and a 14% adder to account for inflation between 2013 and 2021.

Table 3: Project Costs for ECM 1

ECM 1: Lighting					
Item	**Description**	**Bidder**	**Qty.**	**Unit**	**Total**
1	Interior Fixture Upgrade	Evergreen	1	$28,780	$28,780
2	Exterior Fixture Upgrade	Evergreen	1	$55,440	$55,440
3	Estimated 50% of work already completed		1	-$42,110	-$42,110
Sub-Total					$42,110
Contingency				10%	$4,211
2013-2021 Inflation				14%	$5,895
Total Cost:					**$52,216**

Table 4: Project Costs for ECM 3

ECM 3: HVAC					
Item	**Description**	**Bidder**	**Qty.**	**Unit**	**Total**
1	Controls	Estimate	1	$100	$100
2	Installation	Estimate	1	$80	$80
3	Programming	Estimate	1	$80	$80
Sub-Total					$260
Contingency				10%	$26
2013-2021 Inflation				14%	$36
Total Cost:					**$322**

Table 5: Project Costs for ECM 4

ECM 4: Compressed Air System Upgrades					
Item	**Description**	**Bidder**	**Qty.**	**Unit**	**Total**
1	Dew-point Demand Controls	Rogers Machinery	2	$4,300	$8,600
2	Dew-point Demand Controls Installation	Rogers Machinery	2	$356	$712
Sub-Total					$9,312
Contingency				10%	$931
2013-2021 Inflation				14%	$1,304
Total Cost:					**$11,547**

5.0 BASELINE AND ANALYSIS OVERVIEW

5.1 ECM 1: LIGHTING

5.1.1 Baseline Description

The exterior lighting consists of various high pressure sodium (HPS) fixtures, most operate continuously because the existing sensors are not working correctly. Most of these fixtures have a significant amount discoloration on the lenses that reduces the lighting output. The interior lighting has a mixture of HPS, T12, and T8 fixtures. Most of the interior lighting is manually controlled and operates continuously.

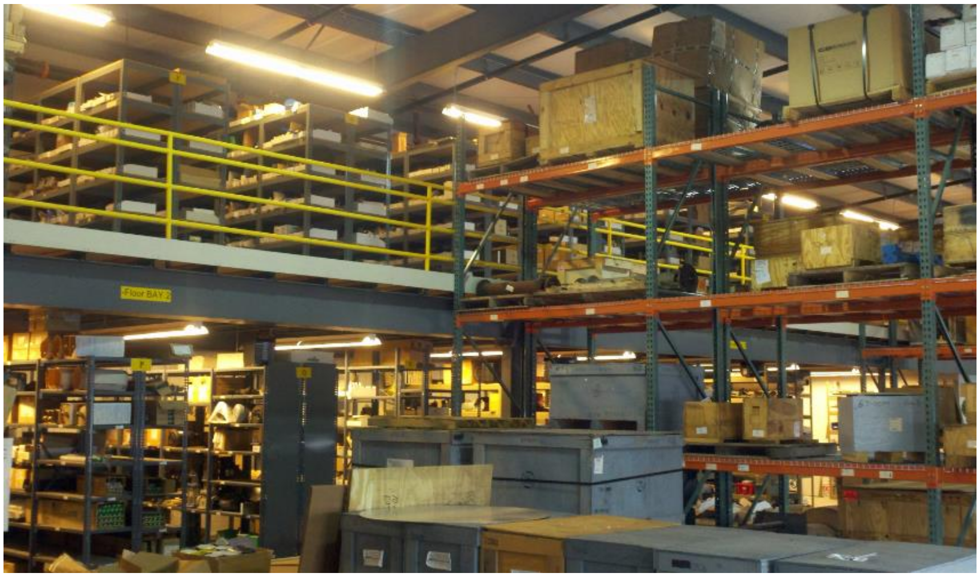

Figure 2: Fluorescent Lighting in Warehouse

Figure 3: High Pressure Sodium Lighting Outside Demin Building

5.1.2 Upgrade Description

The new exterior lighting consists of various LED fixtures, most with daylight sensors so they are only on at night. The new interior lighting also consists of various LED fixtures. Most of the new interior lighting is automatically controlled if occupancy is high, but for areas that are rarely occupied (once or twice a day for a few minutes), lights are manually controlled.

Figure 3: Outdoor LED Lighting on Unit 2 with Light Sensor

Figure 4: Maintenance Building LED Lighting with Occupancy Sensors

Figure 5: Unit 1 Steam Turbine Building LED Lighting

5.1.3 Overview of Technical Approach

A facility wide lighting count was performed and the control of each fixture was obtained for the 2013 study. In that study, the Pacific Power lighting calculator was used to determine baseline energy usage for the 279 interior fixtures while an excel spreadsheet was created to determine the baseline usage for the 346 exterior fixtures.

Most of the proposed indoor lighting upgrades in the 2013 study consisted of 32W fluorescent T8 fixtures, while most of the proposed outdoor lighting upgrades consisted of 100W or 150W pulse start metal halide fixtures. The exact make/model numbers of the upgraded LED lights were not collected, but based on experience with other lighting replacement projects, a conservative assumption is that the new LED lights use less than two-thirds of the energy as those T8 and lower wattage metal halide lights proposed in the 2013 study (i.e. each new fixture saves at least 150% as much as originally projected). Estimated savings is then the original savings estimate multiplied by the percentage of replaced fixtures, multiplied by the 150% fixture savings factor.

5.1.4 Control System Trend Data

- No trend data was collected for this analysis.

5.1.5 Key Assumptions

- 80% of interior lights have been replaced with lights that use only two-thirds of the energy projected in the 2013 study.
- 25% of the exterior lights have been replaced with lights that use only two-thirds of the energy projected in the 2013 study.
- The remaining savings opportunity is equal to the 2013 projected energy savings multiplied by the 150% fixture savings factor, minus the savings already achieved.

5.1.6 Summary of Baseline and Estimated Energy Savings

The summary of baseline and estimated achieved energy savings for ECM 1 are shown in the following table.

Table 8: Summary of Baseline and Estimated Achieved Energy Savings for ECM 1

	Baseline Energy	2013 Projected Energy Savings	% of Lights Already Replaced	Fixture Savings Factor	Energy Saved From Replaced Lights	Remaining Savings Opportunity	% Savings Remaining
Lighting	MWh/yr	MWh/yr	%	%	MWh/yr	MWh/yr	%
Interior	244	147	80%	150%	176	45	18%
Exterior	503	177	25%	150%	66	200	40%
Total	**747**	**324**			**242**	**244**	**33%**

5.2 ECM 2: Small Condensate Pump for Auxiliary Use

5.2.1 Baseline Description

Each unit employs a 250 hp, 4,160 V, 6-stage vertical turbine condensate pump to circulate condensate from the condenser, through the steam jet air ejector and gland steam condenser, and then to the low pressure drum. Each of these large pumps must still operate during periods of non-operation (when the turbine is idling and not producing power) in order to maintain flow to the gland seal and other auxiliary systems. The condensate flow rate needed for these auxiliary systems is much less than when generating electricity. However, condensate flow is still provided with the 2,080 gpm capacity 250 hp pump because the plant does not have any smaller condensate pumps. Currently, the condensate pumps must maintain a minimum flow rate of 375 gpm which is controlled by means of an automatic recirculation check valve and restricted flow orifice which recirculates excess flow back to the condenser. A smaller pump would be able to maintain the required condensate flow to the auxiliary systems when the turbines are not operational and use much less electrical energy to do so.

5.2.2 Overview of Technical Approach

The analysis was performed using hourly data from the PI System. Interval data was provided from 8/6/2011 to 8/6/2012. The following steps outline the technical approach for the baseline analysis.

5.2.3 Key Assumptions

- Plant availability will remain near or higher than 97%

5.2.4 Summary of Baseline and Estimated Energy Savings

Due to the reduced turbine downtime, this ECM is no longer recommended.

5.3 ECM 3: HVAC

5.3.1 Baseline Description

A single, 6-ton AHU provides conditioned air to the Raw Water building, while two 7.5-ton AHUs provide conditioned air to the Warehouse. These have thermostats that maintain temperatures between 72-75°F during the summer despite the fact that these buildings are only occupied between one and three hours a day. The Warehouse has an 8'x8' office for the inventory manager, but that person also has an office space in the main Administration building, and is only in the Warehouse part-time.

5.3.2 Overview of Technical Approach

A time-of-use data logger was installed on the southern Warehouse AHU unit from 8/8/12 to 9/24/12. A current transducer data logger was installed on the northern Warehouse AHU unit during the same time period. Power snapshots were taken for both units to correlate current and time-of-use to power. Ambient temperatures were also recorded during this same time.

Duty cycle was calculated as a function of ambient temperature. Typical meteorological year (TMY3) weather data from the National Renewable Energy Laboratory (NREL) for McNary Dam near Hermiston was then used to extrapolate the duty cycle during the data logging period to the entire year to finalize the calibrated baseline cooling model. The blue data points in Figure 4 show the linear relationship exhibited during the data logging period. Since data was not available during the winter months, the mirrored image of this linear relationship was assumed for the baseline heating model. The extrapolated model for both cooling and heating duty cycles can be seen for a typical meteorological year in Figure 5.

Power snapshot data of real power was combined with projected time of use from this baseline model to determine the estimated annual energy use for the Warehouse, Raw Water and Demin buildings.

ECM power was calculated by assuming that the AHU did not operate unless the ambient temperature was above 85°F for the cooling model, and below 36°F for the heating model. For ambient temperatures beyond these trigger points, ECM power was assumed to be equal to the baseline power.

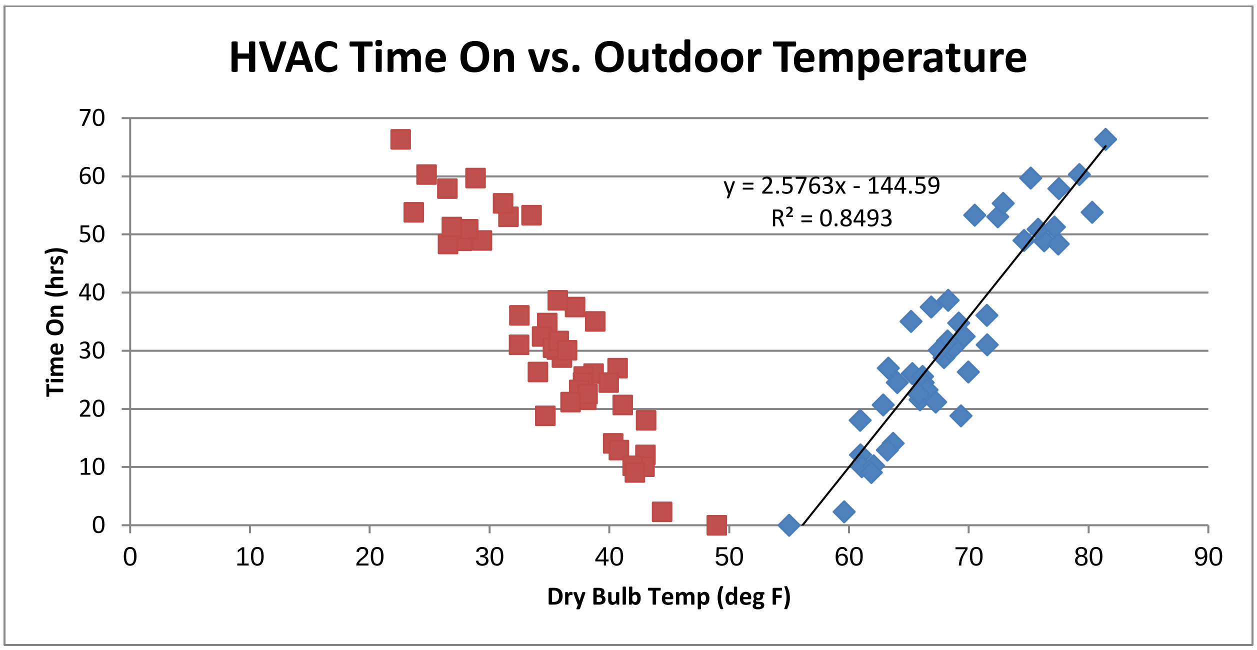

Figure 4: Warehouse AHU Logged Operating Time vs. Ambient Temperature

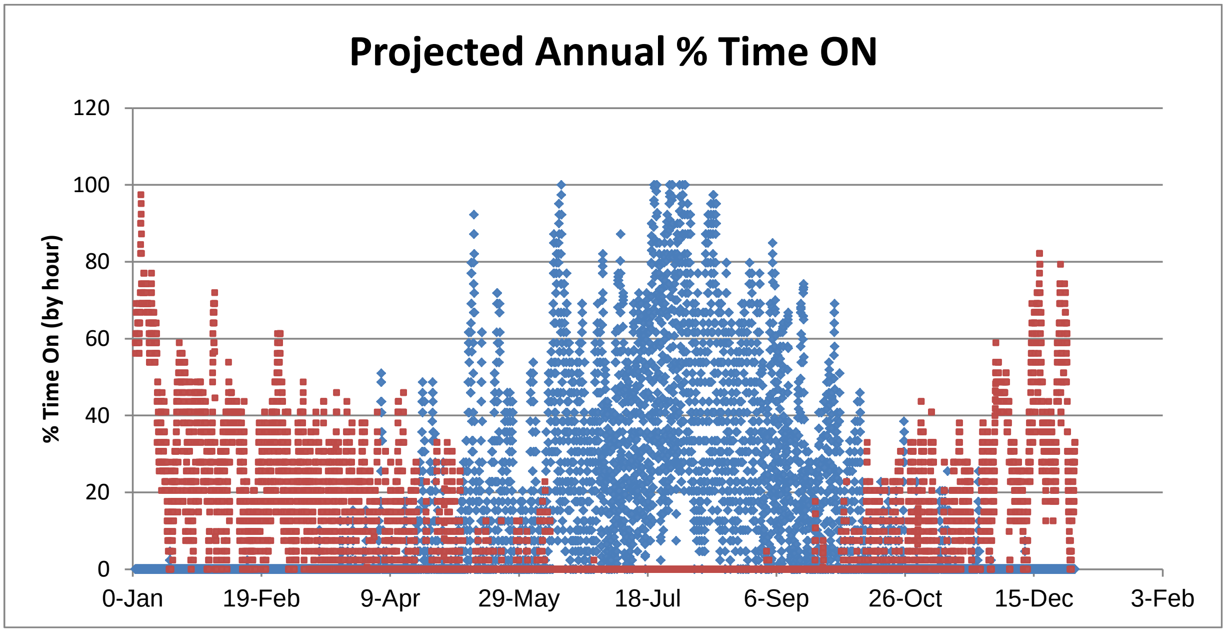

Figure 5: Heating and Cooling Model for TMY3

The 2013 savings analysis was updated to account for the reduction in total cooling capacity (6 tons in the Raw Water building versus 21 tons in the Raw Water and Warehouse) and for the tighter temperature control band (60-80°F instead of 55-85°F).

5.3.3 Control System Trend Results

The flowing summarizes the trends from the control system.

- A linear relationship existed between the duty cycle (% time on) and the ambient air temperature.
- The linear relationship is defined by a slope of 2.57 (i.e. a change in duty cycle of a little more than 2.5% per degree change in ambient temperature).

5.3.4 Key Assumptions

- Power snapshots are representative of the entire operational year.
- The heating duty cycle vs. ambient temperature model mirrors the cooling duty cycle (i.e. slope of -2.57).
- Historical TMY3 data from McNary Dam is representative of ambient conditions at Hermiston Generating facility.

5.3.5 Summary of Baseline and Estimated Energy Savings

The summary of baseline and estimated energy savings for ECM 3 is shown in the following table.

Table 10: Summary of Baseline and Estimated Energy Savings for ECM 3

Baseline	
Annual Operating Hours	8,760
Average kW	1.46
Annual kWh	12,801

ECM 3	
Average kW	0.98
Annual kWh	8,603
Annual kWh Savings	4,198

5.4 ECM 4: Compressed Air System Upgrades

5.4.1 Baseline Description of Compressed Air System

The facility compressed air system currently operates as two separate systems, Unit #1 and Unit #2. The compressed air system is used to provide dry, high pressure compressed air for both instrumentation and service tools throughout the plant. The header piping for Unit #1 and Unit #2 are connected, but the cross-connect valve between the two is closed. The Unit #1 system consists of a 60 hp Sullair oil-flooded screw with VFD control and a 50 hp Atlas Copco oil-free screw that uses load/unload control. The Atlas Copco compressor is back-up and did not operate during the system analysis period. Both compressors are connected to heatless desiccant dryers (250 SCFM).

The Unit #2 system consists of a single 50 hp oil-flooded Atlas Copco compressor. The Atlas compressor also has a heatless desiccant dryer (370 SCFM). Both systems utilize the Combustion Turbine's compressor and AirTek Air Processing Unit's (APU) to provide the facility with compressed air when the facility is generating power. Normally, the Sullair and Atlas compressors operate continuously providing make-up air to the systems when the turbine compressors do not produce enough air.

5.4.2 Overview of Technical Approach

The Sullair and Kaeser compressors were instrumented with temporary current logging equipment from 8/7/2012 to 9/24/2012. These loggers recorded the motor amps for the two compressors every five minutes. One time power measurements using a three-phase demand meter were used to correlate compressor amps to kW during this period. The recorded data was coupled with manufacturer's ratings to generate a flow profile from the monitoring period. The figures below outline the compressor current for the Sullair and Kaeser compressors.

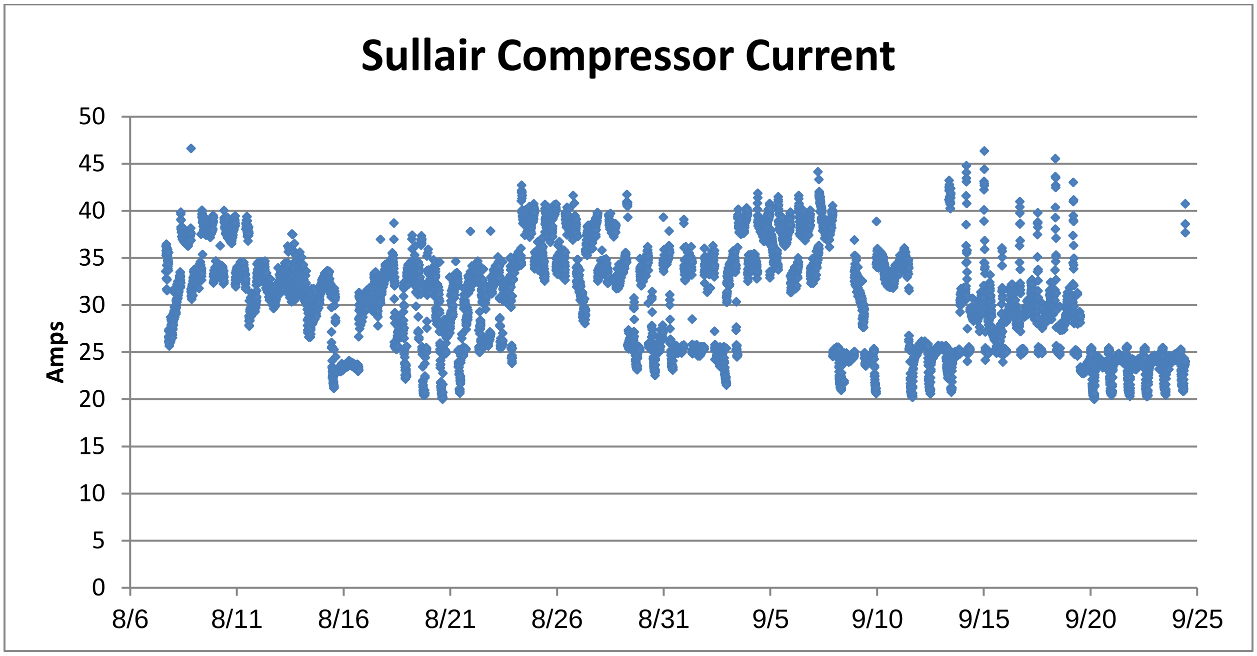

Figure 6: Unit 1 Air Compressor Motor Current

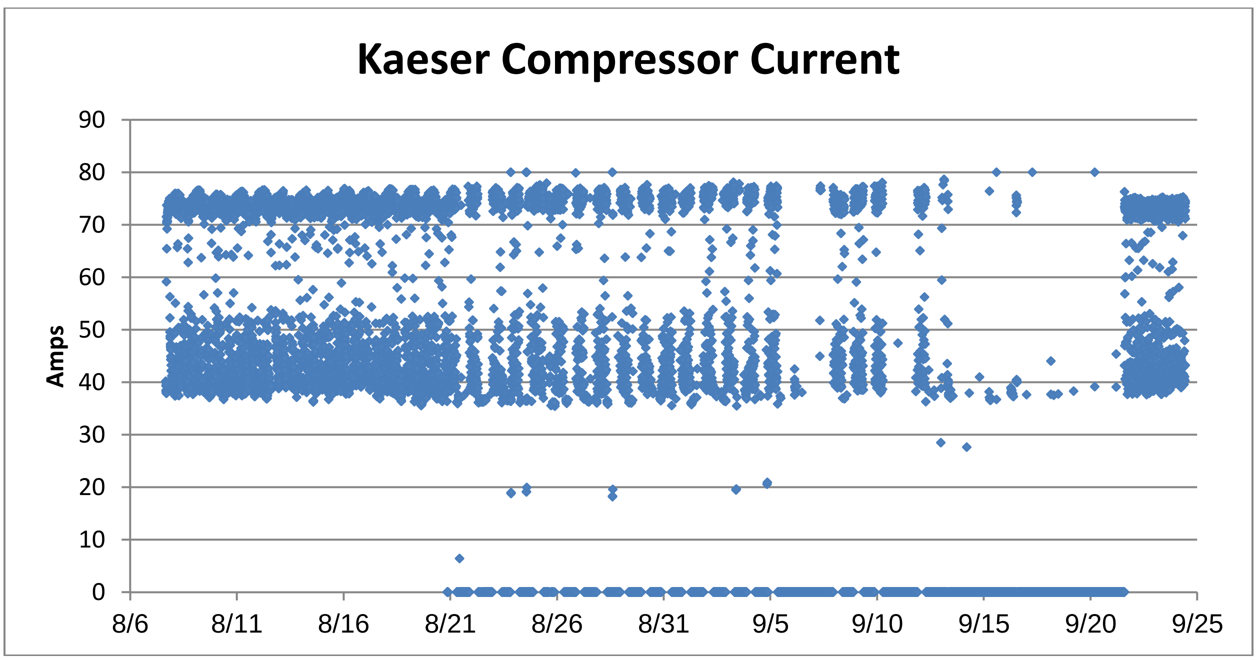

Figure 7: Unit 2 Air Compressor Motor Current

The motor current and power snapshots were used in conjunction with the compressor ratings to determine the airflow profile of both of the compressors. The power profiles for the two compressors were added together and averaged over the analysis period to determine the baseline energy usage, 366,545 kWh/yr. This was then reduced by 4% based on the 8 psi reduction in average operating pressure since 2013 and an estimated 1% savings for every 2 psi reduction in pressure. The new baseline energy use is therefore 351,889 kWh/yr The figure below displays the total airflow profile for all of the compressors.

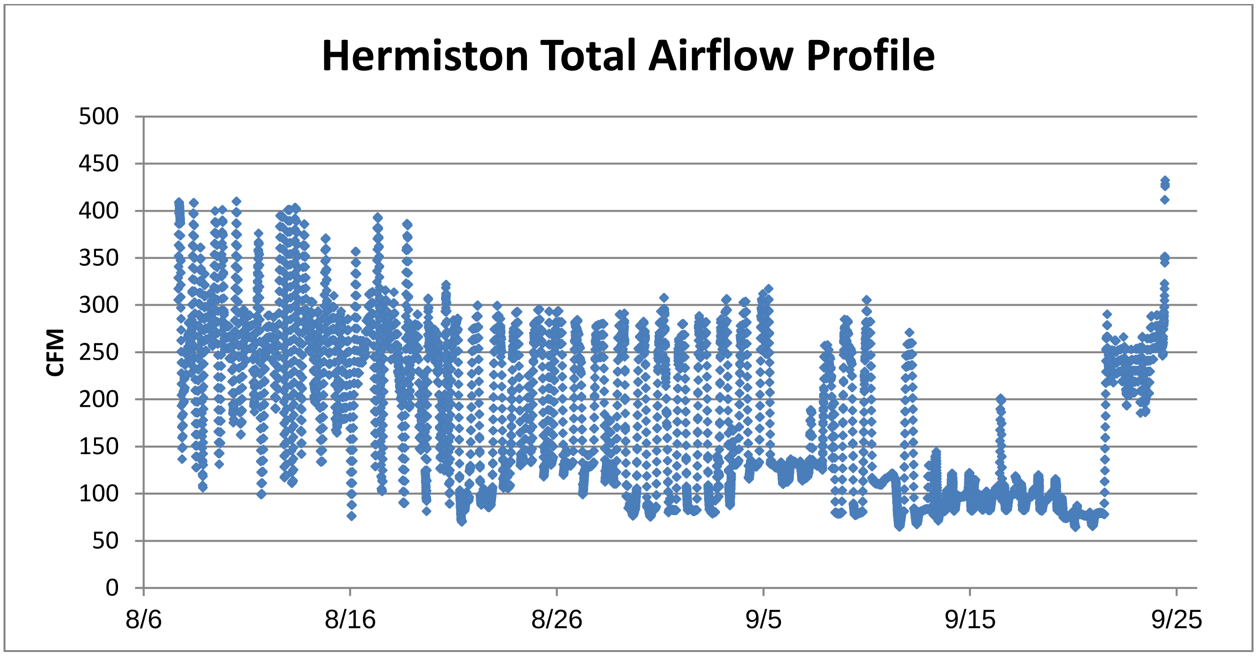

Figure 8: Hermiston Compressed Air Total Airflow Profile

The above airflow profile is averaged over 120 minutes to smooth out the data. The airflow of both compressors is added together because it is recommended the two systems be combined. The dryer purge air for the Sullair and Kaeser dryers was subtracted from the total airflow profile to create the plant airflow profile. The plant airflow profile was used as the starting point of the ECM analysis.

The plant airflow profile was used to determine the number of compressors needed. The number of compressors was used to determine the number of dryers needed. The number of dryers and capacity of the dryers was used to determine the purge rate for the compressors. The purge rate was added to the plant airflow profile to determine the total ECM airflow profile. The ECM total airflow profile was used to calculate the compressor capacity and power. The total compressor power profile was then averaged over the analysis period to determine the ECM energy usage, 245,970 kWh/yr.

5.4.3 Control System Trend Data

The calculated flow and power for the baseline and ECMs are shown in the following table.

Table 11: Compressed Air Overview

Operational Overview

Baseline Conditions	Full Load Capacity, ACFM	Average Airflow (Purge), ACFM	Peak Airflow, ACFM	Average Operating Plant Pressure, psig	Average Power, kW	Specific Efficiency, kW / 100 CFM	Annual Energy Consumption, kWh/yr
Sullair	260	103	164	110	21.4	20.8	187,371
Kaeser	197	80	291	113	20.5	25.7	179,174
Altas Copco	291	0	0	0	0.0	0.0	0
Sullair Dryer	254	38					
Kaeser Dryer	254	56					
Altas Copco Dryer	376	0					
Total	748	182	455	111	41.8	23.0	366,545

EEM	Full Load Capacity, ACFM	Average Airflow (Purge), ACFM	Peak Airflow, ACFM	Average Discharge Pressure, PSIG	Average Power, kW	Specific Efficiency, kW / 100 CFM	Annual Energy Consumption, kWh/yr
Sullair	260	136	260	105	27	20.0	238,546
Kaeser	197	2	138	105	1	34.6	7,424
Altas Copco	291	0	0	0	0	0	0
Sullair Dryer	254	19					
Kaeser Dryer	254	6					
Altas Copco Dryer	376	0					
Total	748	139	398	105	28	20.2	245,970

5.4.4 Control System Trend Results

The following summarizes the trends from the control system.

- In the baseline, the Sullair compressor operates 100% and the Kaeser compressor operates 55% of the time.

5.4.5 Key Assumptions for Baseline and ECM

- The compressed air system is pressurized year round.
- The total airflow profile represents year around operation.
- Heatless desiccant dryers operate when their respective compressor is on.
- The compressor ratings represent actual air production.
- The ECM compressors sequence as modeled.

5.4.6 Summary of Baseline and Estimated Energy Savings

The summary of baseline and estimated energy savings for ECM 4 is shown in the following table.

Table 6: Summary of Baseline and Estimated Energy Savings for ECM 4

Baseline	
Annual Operating Hours	8,760
Average kW	40.17
Annual kWh	351,889

ECM 4	
Average kW	28.08
Annual kWh	245,970
Annual kWh Savings	105,919

6.0 EVALUATION, MEASUREMENT AND VERIFICATION

6.1 Purpose of Evaluation, Measurement and Verification

The purpose of Evaluation, Measurement, and Verification is to ensure the ECMs are properly installed and working as intended. In addition, EM&V verifies the final energy savings from each ECM. The basic steps of this process are outlined below:

1. **Development an EM&V Plan:** Develop an EM&V plan for each ECM that was installed.
2. **Evaluation**: Evaluate the equipment to ensure that the equipment was installed as intended.
3. **Measurement:** System operation is reviewed and fine-tuned as necessary to maximize energy savings.
4. **Verification:** Energy savings are verified in a written report.

6.2 Monitoring Points Where Performance Must be Demonstrated Over Time

Power measurements and data logging for measurement and verification of energy savings will be ECM specific. Unless noted otherwise, all data logging shall be for a period of 4 weeks at intervals of five minutes or less.

If ECM 1 is installed, the following variables will need to be monitored:

- No variables need to be monitored

If ECM 3 is installed, the following variables will need to be monitored:

- Ensure controls have been installed as outlined
- Temperature control set points

If ECM 4 is installed, the following variables will need to be monitored:

- Motor amps on all three air compressors
- Compressor discharge pressure of all three compressors
- Desiccant dryer tower pressure on one tower for each of the three dryers

6.3 Personnel Required

One maintenance/electrical person will be required for approximately four hours for each ECM to assist in the inspection and monitoring of equipment. Hermiston Generating Facility may also be asked to retrieve data logging equipment and mail it to the commissioning engineer.

6.4 Logistical Requirements

Commissioning should be done during typical operation of each respective ECM.

6.5 List of Settings/Equipment to be Observed/Confirmed/Recorded

If ECM 1 is installed:

- Ensure new fixtures are installed as described
- Delay time for sensors, 15 minutes or less

If ECM 3 is installed:

- New temperature controls have been installed and set up as recommended

If ECM 4 is installed:

- Compressor control set-points for all three compressors
- Target discharge pressure for the system, 105 psi
- Installed and operating dryer demand controls
- One time power measurements for each compressor in order to verify the part load performance of the compressor

6.6 Reporting Requirements

- For each ECM, the report should document all key operating parameters in graphical form. All graphs need to be titled, the X & Y axis should be labeled properly, and a legend should be included if more than one series of data is shown on a graph.
- For each ECM, the report should document any differences between commissioned operations and the targeted operations outlined in the Evaluation, Measurement and Verification Plan. For example, if a minimum setting of 95 was recommended in the EAR but it was possible to achieve only 97, then this and similar differences should be noted.
- All EM&V data must be put into electronic format such that it can be reviewed and opened with a standard spreadsheet program.
- The final report must be submitted in electronic format.

7.0 ADDITIONAL SYSTEMS/EQUIPMENT REVIEWED

The following measures were identified and investigated to various levels in the 2013 report, and reexamined as part of this study update. They are not included in the final list of opportunities at this time due to low potential savings or reliability concerns. Some measures may be good candidates for further investigation in the future.

7.1 CURRENT EXEMPLARY PRACTICES

Several exemplary practices with regards to energy efficiency are already being implemented at Hermiston Generating. A VFD was installed on the Demin feedwater pump. Lighting has been upgraded in the Admin building. Heat trace controls and alarms appear to be functioning properly. Facility personnel are proactive in making their rounds, identifying problems, writing work orders and maintaining the equipment.

7.2 BOILER FEED WATER PUMP MODIFICATION

For each HRSG, condensate is pumped from the low pressure drum to both the intermediate pressure drum and the high pressure drum with a 1,750 HP boiler feed-water pump. Each pump has a total of 10 stages and the intermediate pressure take-off occurs at stage 3. Based on control system data, the pressure drop across the level control valves for the high pressure drum is about 600 ft. of H_2O and 500 ft. of H_2O for Unit 1 and Unit 2 respectively. Three alternatives exist to reduce this pressure drop and thus save electrical energy:

1. Install a VFD on the motor drive
2. De-stage the pump from 10 stages to 9 stages for the HP feed
3. Replace the impeller or impeller/diffuser combination

A VFD was not considered for this application because of the need to meet both HP and IP flow needs independently. If a VFD were to be installed and programmed to maintain a certain HP discharge pressure, then the IP flow would be affected which would require additional programming time and expense. An experienced design engineer for this pump manufacturer cautioned against de-staging these types of pumps without careful review by the designer, noting that the impact on the diffuser can cause major and unexpected problems with the pump performance. The most common approach for this particular pump is to replace the impeller or impeller/diffuser combination.

The energy savings were modeled the same way for both of the latter options so the determining factors are cost, complexity and reliability. The energy savings for both boiler feed water pumps is estimated to be 358 MWh/yr.

7.3 SCR BLOWERS

Selective catalyst reactor (SCR) blowers feed hot exhaust air (~570°F) through an ammonia vaporizer. The vapor is then fed through a feed header and distributed into an SCR to remove NO_x from the exhaust air. The temperature of the air must remain high enough to prevent the formation of undesired compounds that can foul the catalyst and downstream equipment. The vapor flow rate and pressure must meet minimum requirements for effective distribution through the distribution header. There is one 580 SCFM blower per HRSG, powered by a 25 hp, 460 V 3-phase Teco motor. The blowers do not have any controls, but simply blow the maximum amount of air available.

Premium efficiency motors were investigated as potential replacements for the existing blower motors, which would increase their efficiency from 90% to 94%. This resulted in an energy savings of only 0.6 MWh/yr per motor and therefore did not justify implementation.

VFDs were also considered for the blowers, but the blowers have been designed for specific operating conditions. The flow rate and pressure need to be maintained to guarantee even distribution through the SCR Feed Header. Without significant study and possible retrofits to the distribution header or the entire SCR system, the blowers cannot be slowed down without risking a reduction in NOx abatement.

7.4 Cooling Tower Fan VFDs

Both Units 1 and 2 have a water cooled condenser with an associated cooling tower. Each cooling tower has four 200 HP axial fans driven by single-speed, 460 V, 1800 RPM motors. Upgrading these fans with VFDs was considered as an energy efficiency measure. However, the only opportunity to reduce speed is when one, two, or three fans are shut down. When all fans are running, maximum cooling is achieved which results in increased turbine efficiency. When no fans are running, the unit is shut down. Turning off a portion of the fans is typically only done during winter operations in order to reduce risk of freezing. In addition, a separate air-conditioned building would be required to house the VFDs, which would also required significant rewiring.

A review of historical data showed that Unit 1 operated all four fans at 100% capacity for 277 days of the year, and Unit 2 255 days of the year. The days in which at least one fan was shut off for any portion of the day were analyzed for potential savings with a VFD. The estimated savings for Unit 1 were 117 MWh/yr and the savings for Unit 2 were 202 MWh/yr.

7.5 Electric Heat Trace

Most of the exterior piping has electrical heat tracing to prevent freezing during the winter. The facility provides this capability via four electric heat trace panels, each of which has a primary and secondary temperature sensor that enables and disables the electric heat trace based on outdoor temperature. Power is supplied to each heat trace panel transformer at 480 volts, then stepped down to 208/120 volts at that panel transformer. These panels can be switched from “Auto” to “Hand” or “Off”. Thermostats that are not functioning properly or are controlled manually have the potential to run when not needed and waste energy. Hermiston Generating has incorporated the heat trace control panels into its DCS, which indicates loss of voltage to a circuit, and indicates on which panel it has occurred. Each circuit rated for at least 20 amps also has a trip time delay to prevent false trouble alarms.

All panels were in “Auto” mode during our site visit. There is a prescribed maintenance work order to periodically check that the circuit indication lights are working properly. The DCS did not indicate any problems with any of these control panels during our site visit and operators confirmed that the system works well. Based on these controls and O&M practices, data logging was not viewed as worthwhile, nor were any energy savings opportunities judged to be likely.

7.6 Water Fire Suppression System

The source of fire protection water for the facility is the circulating water stored in the cooling tower basins. Each basin can supply two hours of water at system rated capacity. Each basin can be filled within eight hours via the plant raw water makeup line from the Columbia River. An underground fire main supplies water to plant fire hydrants and fixed water-based suppression systems.

The primary fire protection pump is a 3-stage, vertical Fairbanks Morse pump, rated for 2,000 gpm at 120 psig which takes suction from the Unit 1 cooling tower basin. This is powered by a 200 hp US Electric motor. A Metron Series M420 controller activates the pump if the system pressure falls below 90 psi.

This electric fire pump is backed up by a diesel-fueled fire pump which is identical to the electric fire pump (3-stage, vertical Fairbanks Morse 15H-7000F pump), but is powered by a 208 hp Cummins diesel engine and is connected to the Unit 2 cooling tower basin. The pump controller automatically starts the diesel fire pump when system pressure falls below 75 psi.

Finally, a 5 hp Fairbanks Morse jockey pump maintains a normal system operating pressure of 95-105 psig on each Unit while the system is in standby. If the jockey pump cannot maintain system pressure, the fire pump controller starts the main electric fire pump.

Since the main electric and diesel pumps are designed to only operate during a fire, no energy savings opportunities were investigated for them. However, a time-of-use logger was installed on the jockey pump to determine if system leaks were excessive and calculate potential energy savings that would result from fixing those leaks. This pump only operated 0.1% of the time, or only 16 hours of the year. Thus this system was judged to be very tight and no energy savings opportunities were identified.

7.7 Zero Discharge System

The Zero Discharge Waste Cooling Tower is a two cell (1 fan per cell), counterflow cooling tower designed to circulate 2,600 gpm of waste water from the main cooling tower blow down discharge. This cooling tower, coupled with the associated chemical treatment in the reactor clarifier, is designed to remove all solids from the cooling tower blow down streams, and thereby not discharge any water from the plant site. Each cooling tower fan is powered by a single speed, 30 hp General Electric motor. This cooling tower has not been used in many years, and the facility has no intentions of operating it in the near future, therefore there were no opportunities to pursue. If the plant chooses to operate this cooling tower in the future, it should be evaluated for potential ECMs.

7.8 Condensate Make-up Pumps

Two 15-hp Goulds centrifugal condensate make-up pumps provide demineralized water from the Demin water storage tank to the condenser of each unit. These two pumps are also piped such that they provide redundancy to each other – either can provide make-up water to either condenser, as well as wash water to either turbine. These pumps are controlled by a flow control valve that responds to the condenser water level, but which is also tied to the condensate pumps.

For the 2013 report, a time-of-use logger was installed on these make-up pumps and a power snapshot was taken to determine their baseline energy use and potential for energy savings if a VFD were installed to regulate flow instead of relying on the control valve. It was discovered that these pumps only draw an estimated 3,400 kWh/yr each because they only ran an average of 243 hours per year. Plant personnel indicated these run even less now than they did in 2013. These pumps are primarily used at start-up only. Once a vacuum is established within the condensers, condensate make-up water flows from the Demin storage tank to the condenser hotwell by means of that pressure differential. Because of this low baseline energy use, a VFD was determined to not be economical.

7.9 Condensate Pumps

Condensate is pumped from the condenser hotwell to the low pressure drum of the HRSG by means of a 250 HP, 4160 V, 2080 gpm capacity condensate pump. A three-way valve directs condensate to the LP drum either through or around the LP feedwater heater. A second flow control valve regulates feedwater flow from either the feedwater heater or bypass to the LP drum to maintain a constant drum water level.

Typically a pump drawing full power followed by a partially open control valve is an opportunity for energy savings. However, the cost to install a VFD on this pump is relatively expensive because the pump is medium voltage, and because of the additional complexity involved because of the three-way valve and interdependent flows. For these reasons, further investigation of pressure drops and flow rates of the various condensate streams was not undertaken.

7.10 Gland Steam Exhausters

Two gland steam exhausters operate in parallel on the gland steam condenser of each unit to remove non-condensable gases from the gland steam condenser. Only one exhauster operates at a time, and use is alternated to promote balanced equipment wear. Each blower inlet has a butterfly valve which is partially closed. Installing a VFD on a motor and allowing the butterfly valve to fully open is more energy efficient than operating the blower at full power and choking flow through this valve. Since 2013, three of the four fans and motors have been replaced and are now being controlled by the plant's DCS.

For the 2013 report, a time-of-use logger was installed on one of the 5 hp Unit, 2 exhauster blower motors and a power snapshot was taken to determine the baseline energy use. It was discovered that each operating blower only draws an estimated 2,900 kWh/yr while only operating approximately 1,989 hours per year. Because of this low baseline energy use, a VFD was determined to not be economical.