ENERGY EFFICIENCY STUDY FOR LAKE TAHOE COMMUNITY COLLEGE

Main Building
Technology Wing
Duke Theatre
Student Center
Library
Physical Education Center

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Preface

This study was prepared through Digital Energy's Energy Partnership Program as a result of the Lake Tahoe Community College's request for assistance. This program assists in identifying projects that can cut energy use and costs in existing and planned facilities while concurrently enhancing building performance. The program can provide additional assistance towards implementing the identified projects through the financing of low interest loans. These loans provide competitive financing and are structured so that the estimated project savings are the basis for the loan repayments. This study was conducted for Digital Energy by Cogent Energy, Inc. Both Digital Energy and Cogent Energy appreciate the assistance offered by all college personnel during the study efforts.

Disclaimer

This letter report is a Preliminary Technical Energy Audit which investigates possible energy efficiency improvements. It is based on the plans available, field surveys, information provided and interviews of site operating and maintenance personnel. The recommendations are based on an analysis of conditions observed and information gathered at the time of the survey.

This report, by itself, is not intended as a basis for the engineering required to adopt any of these recommendations. Its intent is to inform the customer as to the potential cost savings of the recommendations. Development of design documents and specifications will be required, conforming to the details of this audit, to successfully implement the project.

Reference to specific products or manufacturers is not an endorsement of that product or manufacturer by Cogent Energy, Inc.

Section 1 – Executive Summary

Focus and Scope of the Audit

Paul Just and Mark Goldberg of Cogent Energy, Inc. visited Lake Tahoe Community College on August 26th and 27th, 2009 to make a preliminary assessment of the opportunities available for energy efficiency improvements. Maintenance and building engineers of the Lake Tahoe Community College gave tours of the campus facilities, and were extremely helpful in providing a thorough understanding of the HVAC systems. This Preliminary Energy Audit report summarizes the observations and recommendations, and focuses on identifying energy saving projects at the campus facilities listed below. This report discusses the results of the energy audit and provides information on the next steps for project implementation.

(a) Main Building
    a. Technology-Wing
    b. Duke Theater
    c. Student Center
    d. Library

(b) Physical Education Center (PEC)

The scope of Cogent Energy's audit includes all lighting systems and HVAC systems in the Main Building, including the four additions, with the exception of the HVAC systems serving the library. The lighting systems in the PEC are included in the audit, however the HVAC systems in the PEC, as well as all HVAC and lighting systems in the Garden classrooms and the Child Development Center, are not included in the scope of this audit.

Annual Energy Use and Cost

During a recent 12-month period, the Lake Tahoe Community College campus spent $212,086 for electricity and $119,240 for natural gas. Based on a combined facility area of 163,069 square-feet, the total energy cost per square foot is $2.03/sq.ft. per year. This represents 2,062,209 kWh per year and 116,920 therms of natural gas per year. The overall energy usage for the campus is 114,860 Btu/GSF/yr.

Project Recommendations

The report identifies several projects that may reduce the campus' overall energy use and cost. If implemented, these projects represent an annual aggregate energy usage savings of 267,126 kWh and 41,862 therms, resulting in an estimated cost savings of $53,858. Included are projects which address specific items such as lighting and controls.

Table 1: Lighting Energy Conservation Measures for Lake Tahoe Community College

ID	Project Description	Site	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Project Costs ($)	Annual Cost Savings ($)	Simple Payback (Years)	Estimated Incentive ($)	Project Cost with Incentive ($)	Simple Payback with Incentives (Years)
L-1	De-lamp Overlit Rooms	Main Campus & Student Center	0.73	1,634	$ 1,186	$ 163	7.3	$ -	$1,186	7.3
L-1	De-lamp Overlit Rooms	Duke Theater	1.02	2,302	$ 1,779	$ 230	7.7	$ -	$1,779	7.7
L-1	De-lamp Overlit Rooms	Library	0.76	1,708	$ 1,240	$ 188	6.6	$ -	$1,240	6.6
L-1	De-lamp Overlit Rooms	Physical Education Center	5.95	13,397	$ 701	$ 1,340	0.5	$ -	$701	0.5
L-2	Daylighting Controls	Tech Wing	0.00	405	$ 529	$ 41	13.1	$ -	$529	13.1
L-2	Daylighting Controls	Main Campus & Student Center	0.00	3,578	$ 1,587	$ 358	4.4	$ -	$1,587	4.4
L-2	Daylighting Controls	Dining	0.00	275	$ 529	$ 28	19.2	$ -	$529	19.2
L-2	Daylighting Controls	Duke Theater	0.00	3,803	$ 3,174	$ 380	8.3	$ -	$3,174	8.3
L-2	Daylighting Controls	Library	0.00	720	$ 1,058	$ 72	14.7	$ -	$1,058	14.7
L-3	Install Occupancy Sensors	Main Campus & Student Center	0.00	383	$ 317	$ 38	8.3	$ -	$317	8.3
L-3	Install Occupancy Sensors	Library	0.00	405	$ 317	$ 41	7.8	$ -	$317	7.8
L-4	Install LED Exit Signs	Main Campus & Student Center	1.19	10,381	$ 2,282	$ 1,038	2.2	$ -	$2,282	2.2
L-4	Install LED Exit Signs	Duke Theater	0.60	5,234	$ 1,212	$ 523	2.3	$ -	$1,212	2.3

ID	Project Description	Site	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Project Costs ($)	Annual Cost Savings ($)	Simple Payback (Years)	Estimated Incentive ($)	Project Cost with Incentive ($)	Simple Payback with Incentives (Years)
L-5	Replace 32w T8 with 25w	Tech Wing	0.85	1,901	$ 5,366	$ 190	28.2	$ -	$5,366	28.2
L-5	Replace 32w T8 with 25w	Main Campus & Student Center	12.63	28,526	$ 59,510	$ 2,853	20.9	$ -	$59,510	20.9
L-5	Replace 32w T8 with 25w	Dining	0.69	1,559	$ 2,927	$ 156	18.8	$ -	$2,927	18.8
L-5	Replace 32w T8 with 25w	Duke Theater	6.13	13,788	$ 26,341	$ 1,379	19.1	$ -	$26,341	19.1
L-5	Replace 32w T8 with 25w	Library	3.80	8,539	$ 16,390	$ 854	19.2	$ -	$16,390	19.2
L-5	Replace 32w T8 with 25w	Physical Education Center	1.71	3,841	$ 10,244	$ 384	26.7	$ -	$10,244	26.7
L-6	Replace metal halide lighting with high bay fluorescent	Physical Education Center	6.96	15,660	$ 14,407	$ 1,566	9.2	$ -	$14,407	9.2
L-7	Repair incorrect wiring	Dining			$ 71	$ -	0.0	$ -	$71	0.0
Total			**43.00**	**118,036**	**$ 151,166**	**$ 11,821**	**12.8**	**$ -**	**$151,166**	**12.8**

Table 2: HVAC Energy Conservation Measures for Lake Tahoe Community College

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-1	Scene Shop AH-2 CAV to VAV	3,566	0.2	$259	201	$126	$386	$9,014	23.4
ECM-2	Main Bldg. controls to DDC	80,040	-	$5,440	5,710	$5,820	$11,260	$124,429	11.1
ECM-3	Student Cntr. MZ-2 CAV to VAV	15,133	2.4	$1,406	1,823	$1,131	$2,537	$14,118	5.6
ECM-4	Bakery Exhaust Heat Recovery	(3,114)	(0.9)	$(193)	660	$409	$216	$5,995	27.7
ECM-5	Variable Speed Kitchen Exhaust	5,553	-	$344	1,394	$864	$1,208	$30,253	25.0
ECM-6	Heat recovery from refrigerators	150	-	$9	60	$37	$47	$3,045	65.5
ECM-7	Replace Main Bldg. cond. units	13,461	9.4	$3,131	-	$-	$3,131	$54,138	17.3
ECM-8	VFD on CT pump	9,318	7.3	$1,205	-	$-	$1,205	$4,646	3.9
ECM-9	Electronic water treatment system	-	-	$-	-	$-	$-	$6,445	N/A
ECM-10	Replace (1) of two existing boilers	-	-	$-	17,306	$10,869	$10,869	$64,754	6.0
ECM-11	Reduce elevator use	3,020	-	$390	-	-	$390	N/A	N/A
ECM-12	D-wing AH-3-7, CAV to VAV	21,965	2.2	$1,662	859	$540	$2,202	$33,658	15.3
ECM-13	Off-line buildings, isolate heating	-	-	$-	13,849	$8,586	$8,586	$14,228	1.7
	Total	**149,090**	**20.6**	**$13,650**	**41,862**	**$28,380**	**$42,037**	**$364,723**	**9.9**

Section 2 – Facility Descriptions

The main campus of the Lake Tahoe Community College is located in South Lake Tahoe, California, in the central part of El Dorado County, at an elevation of approximately 6,200 ft. above sea level. The main campus contains four main structures totaling approximately 163,000 square feet, all of which were constructed between 1986 and 2005. The structures are the Main Building, a Child Development Center, Garden Classrooms and the Physical Education Center. The Main Building is composed of the original two-story structure and several additions, namely the Technology Wing, Duke Theater, the Student Center and the Library. The Main Building, along with the Technology Wing and Duke Theater, have a combined area of 86,262 square feet. Approximately 3,500 students are enrolled every year with about 1,800 students that are full-time.

Technology Wing

The Technology Wing was built in 1996 and contains classrooms, administrative offices, and a computer services center. Two fan coil units and five air handling units serve the area. Sierra Pacific Power Company provides electricity under the A-3 rate schedule. Southwest Gas Corporation provides natural gas under the SLT-40 rate schedule.

Duke Theater

The Duke Theater was built in 1996 and has a large main theater, a scene shop, a drawing art lab, a ceramic art lab, choral room, practice rooms, offices and a piano lab. Sierra Pacific Power Company provides electricity under the A-3 rate schedule. Southwest Gas Corporation provides natural gas under the SLT-40 rate schedule.

Student Center

The Student Center has a total building area of 11,167 square feet and was built in 2002. The Student Center building contains classrooms, a dining center, a kitchen and administrative offices. Sierra Pacific Power Company provides electricity under the A-3 rate schedule. Southwest Gas Corporation provides natural gas under the SLT-40 rate schedule.

Library Wing

The Library has a total building area of 27,000 square feet and was built in 2005. The library wing contains an art gallery, conference rooms, board rooms, and a library that includes administrative offices and study rooms. Sierra Pacific Power Company provides electricity under the A-3 rate schedule. Southwest Gas Corporation provides natural gas under the SLT-40 rate schedule.

Operating Schedules

The Lake Tahoe Community College operates Monday through Saturday from 8 am to 10 pm. The college offers four quarters of instruction and operates year-round except for six weeks of summer break, three weeks winter recess, and one week spring recess. The school year typically begins in the middle of August and ends in late May. Classes are

generally held from 8:00 am to 10:00 pm Monday through Friday. The college does not have student dormitories or on-campus housing.

Section 3 – Energy Usage

Utility data provided by the College shows that the main building used a combined 1,573,558 kWh of electricity in the past year. Table 3 below summarizes the selected buildings' age, square footage and electric energy usage and costs. Figure 1 compares the energy consumption on a square foot basis for the buildings included in the audit.

Table 3: Site Electrical Consumption

Building	Square Footage	Annual Electrical Use-kWh/yr	Annual Electrical Cost	kWh/GSF	$/GSF	Site Btu/GSF	Rate ($/kWh)**
Main Building (Tech-Wing and Duke Theater)	86,262	1,090,890	$109,089	13	$1.26	43,162	$0.100
Student Center	11,167	141,221	$14,122	13	$1.26	43,162	$0.100
Library	27,000	341,448	$34,145	13	$1.26	43,162	$0.100
TOTAL	**124,429**	**1,573,558**	**$157,356**			**129,485**	

*The Annual Electrical Cost, kWh/GSF, $/GSF, and Site Btu/GSF values in Table 1 are prorated based on GSF as the campus has only one main electric meter.
**$0.10 per kWh flat electric rate is obtained based on one year actual utility bills.

Figure 1: Site Electrical Energy Consumption Comparison

At Lake Tahoe Community College, the heating demand is served by natural gas. For audited buildings, the Lake Tahoe Community College district consumes 92,325 therms of natural gas per year.

Table 4 below summarizes the selected buildings' age, square footage and approximate thermal energy cost and usage. Figure 2 compares the thermal energy usage of the four buildings on a square foot basis.

Table 4: Site Thermal Energy Consumption

Building	Square Footage	Natural Gas Cost ($)	Therms/ GSF	$/GSF	Site Btu/GSF	Blended Rate ($/Therm)
Main Building (Duke Theater, Student Center, Library, Tech-Building)	124,429	$94,413	0.74	$0.76	74,199	$1.02

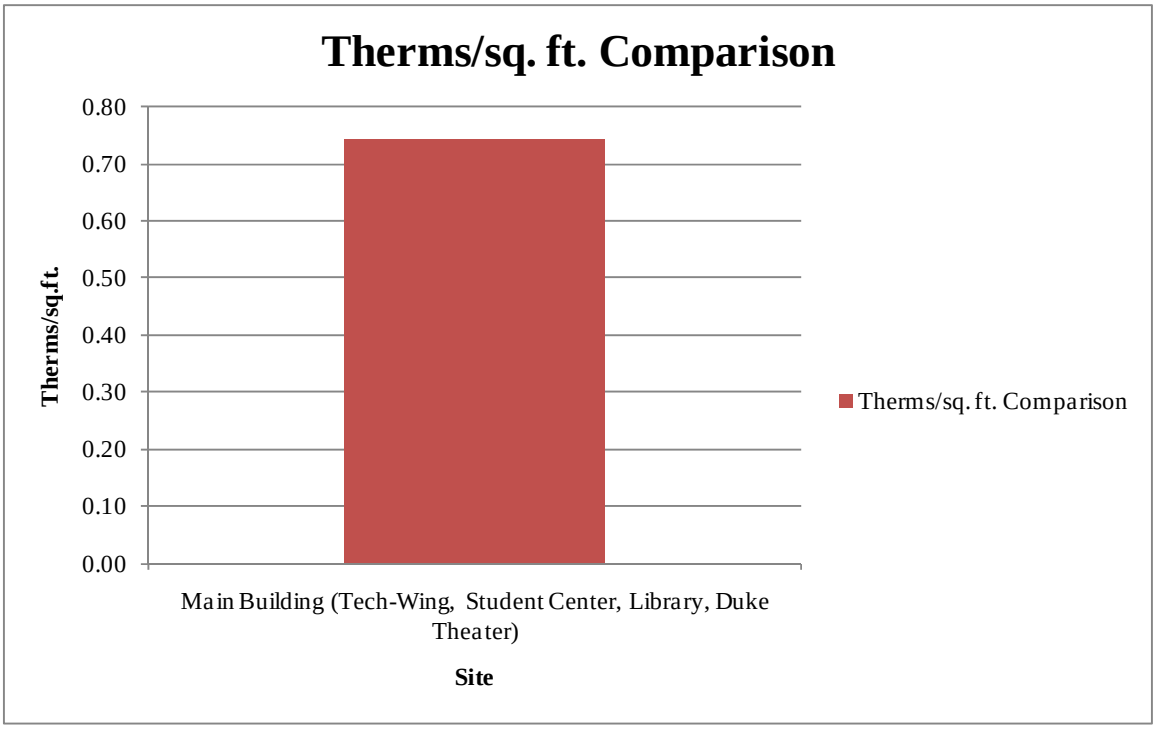

Figure 2: Site Thermal Energy Consumption Comparison

Section 4 – Energy Using Systems

This section describes the energy using systems at each of the buildings.

Main Campus & Student Center

The Main Campus & Student Center is lit mostly by 48" T8 32 watt bulbs in 1, 2, 3, 4, or 6 bulb fixtures with electronic rapid-start ballasts. Some areas of the Student Center were noted to be significantly over-lit. The hallways with exterior windows were noted to be lit both by daylight as well as overhead lighting, even when this was not necessary. Various restroom lamps are on manual switches. Exit signs in the Main Campus & Student Center building are two bulb incandescent fixtures. The Main Campus & Student Center does not currently have lighting controls.

Eighty-four fan coil units serve the main spaces. These units have fixed economizers, hot water coils, pneumatic zone controls and are controlled by time clocks. Four of these fan coil units have D/X cooling added. Two Ajax boilers each rated at 2,200 MBH provide hot water to the main building, Duke Theater, student dining and Technology Wing. There are 10 new split system D/X units also serving the main spaces. These systems have fixed economizers and hot water coils. Five of these systems are controlled by the Novar system.

The energy management system is a Novar system. The user interface is line based and not graphical and cannot generate trend data. The control system is maintained by LNH Airco.

Table 5: Main Campus Boilers

TAG	*Manuf.*	*Model*	*Input (MBH)*	*Output (MBH)*	*Eff. (%)*
B-1	Ajax	WCFD-2750	2,750	2,200	80%
B-2	Ajax	WCFD-2750	2,750	2,200	80%

Table 6: Main Campus Condensing Units

TAG	*Manuf.*	*Model*	*Fan HP*	*Mtr. Eff.*	*Refrig.*	*Volt / FLA*	*Notes*
CU-4A	Carrier	38AEH060630	-	-	R-22	230 / 2.5	
CU-4B	Carrier	HS20-211-1P	0.17	-	R-22	230 / 1.2	

Table 7: Main Campus Fan Coil Units

No.	*Manuf.*	*Model*	*Fan HP*	*Notes*
84	Various	NA	Various	Fixed Economizers

Duke Theater

The Duke Theater building and associated classrooms are lit mostly by 48” T8 32 watt bulbs in 2 lamp fixtures with electronic rapid-start ballasts. Some areas of the theater are noted to be over-lit. The hallway leading to the Main Campus is lit during the day when day lighting from the large windows provides more than adequate illumination. Exit signs in the Duke Theater wing are two bulb incandescent fixtures. Duke Theater does not currently have lighting controls.

The Duke Theater is served by two single zone air handling units AHU-1 and AHU-2, and two multi-zone air handling units MZ-1 and MZ-2. Supply fans on the AHUs are variable speed drives which modulate to maintain a static pressure setpoint. A Baltimore Air Coil cooling tower provides free cooling to the air handling units. The 7.5 hp cooling tower fan is provided with a variable speed drive which modulates to maintain a condenser water temperature setpoint. Two 3 horsepower chilled water pumps circulate chilled water to the four air handler cooling coils. One 7.5 hp condenser water pump circulates water through the cooling tower. The domestic hot water is provided by one AO Smith 86 gallon gas fired hot water heater. The water temperature is set at 100°F.

Table 8: Duke Theater Air Handling Units

TAG	Manuf.	Model	Fan HP	Mtr. Eff.	Frame	Volt / FLA	Notes
AHU-1	Temtrol	WF-DH52R	20	92.40%	-	460 / 24	SZ VFD, serve theater
AHU-2	Temtrol	WF-DH65	3	-	-	-	SZ no VFD, serve scene shop
MZ-1	Temtrol	WF-D3Z27P	15	91%	254T	460 / 20.3	MZ VFD, serve hallway, offices, music rooms (5 zones)
MZ-2	Temtrol	WF-B3C13P	5	88.50%	184T	460 / 6.4	MZ VFD, serve hallway, offices, music rooms (4 zones)

Table 9: Duke Theater Cooling Towers

TAG	Manuf.	Model	Fan HP	Mtr. Eff.	Frame	Volt / FLA	Notes
CT-1	BAC	FXT200R	7.5	91.00%	231T	460 / 9.2	VFD, manf 1993

Table 10: Duke Theater Pumps

TAG	GPM / FT	Mtr. hp	Voltage / Amps	Frame	Motor Eff.	Make / Model
CHWP-1	108 / 35	3	460 / 4.2	-	Std	Baldor / 35M217-2112 (AHU side)
CHWP-2	108 / 35	3	-	-	Std.	Taco / CE2007E2 (AHU side)
CHWP-2	432 / 70	7.5	460 / 9.2	-	91%	B&G / - (CT side)

Technology-Wing Building

The Technology Wing is lit mainly by 48” T8 32 watt bulbs in 2 lamp fixtures with electronic rapid-start ballasts. The hallway leading to the Main Campus is lit during the day when day lighting from the large windows provides more than adequate illumination. Exit signs in the Technology Wing are two bulb incandescent fixtures. The Technology Wing maintains on/off lighting controls, which sweeps the area lighting on at approximately 7am and off at 11pm. The system has manual override capacity allowing users to activate lighting between 11pm and 7am.

The technology wing is served by six constant volume air handling units. These air handling units are provided with return fans, chilled water coils, hot water coils and economizers. Two fan coil units are present; one is a heating only unit, the other is a split system with a direct expansion cooling coil. The air handling units in the zones are

controlled by a Novar system. A 25 ton VFD driven Carrier chiller provides chilled water to the cooling coils. A 10 ton Rheem package unit with gas heating provides conditioned air to the server room.

Table 11: Technology-Wing AHUs

TAG	*Manuf.*	*Model*	*Fan HP*	*Mtr. Eff.*	*Frame*	*Volt / FLA*	*Notes*
AHU-1	Carrier	39TVXNAR-JRJH-AA	15	-	254T	460 / 20.3	CV, 19470 cfm, ODP
AHU-3	Temptrol	WF-DH5S	2	-	254T	/ 2.6	
AHU-4	Temptrol	WF-DHTS	3	-	254T	/ 3.7	
AHU-5	Temptrol	WF-DH5S	2	-	254T	/ 2.6	
AHU-6	Temptrol	WF-DH6S	2	-			
FC-1,2	Magic Aire	24-BVW-BVXA	1/3	-	-	/ 2.11	SZ, 2WV
AHU-7	Temptrol	WF-DH5S	2	-	254T	/ 2.6	

Table 12: Technology Wing Chiller

TAG	*Manuf.*	*Model*	*Capacity*	*Eff.*	*Frame*	*Volt / FLA*	*Notes*
CH-1	Carrier		25 tons		231T	460 / 9.2	VFD, manf 1993

Student Dining Area

The Student Dining Area is lit mostly by 48” T8 32 watt bulbs in 1, 2 or 3 bulb fixtures with electronic rapid-start ballasts. The hallways with exterior windows were noted to be lit both by daylight as well as overhead lighting, even when this was not necessary. Exit signs are LED signs. The Cafeteria maintains on/off lighting controls, which sweeps the area lighting on at approximately 7am and off at 11pm. The system has manual override capacity allowing users to activate lighting between 11pm and 7am.

The student dining area is served by one multi-zone unit equipped with an economizer, a hot deck with hot water coil and a cold deck with a D/X cooling coil. The Novar controls system controls both the air handling unit and the zones. The kitchen air handling unit is abandoned in place.

Table 13: Student Dining Area Condensing Units

TAG	*Manuf.*	*Model*	*Fan HP*	*Mtr. Eff.*	*Refrig.*	*Volt / FLA*	*Notes*
CU-4A	Carrier	38AEH060630	-	-	R-22	230 / 2.5	
CU-4B	Carrier	HS20-211-1P	0.17	-	R-22	230 / 1.2	

Library

The Library is mostly lit by 48” T8 32 watt bulbs in 1, 2, 3, 4, or 6 lamp fixtures with electronic rapid-start ballasts. Some areas of the library are noted to be significantly over-lit. The hallway leading to the Main Building is lit during the day when day lighting from the large windows provides more than adequate illumination. Exit signs in the Library are LED signs. The Library maintains on/off lighting controls, which sweeps the area lighting on at approximately 7am and off at 11pm. The system has manual override capacity allowing users to activate lighting between 11pm and 7am.

The Library is equipped with six (6) air handling units. These are split system DX units with natural gas burners. The library is served by one (1) boiler, which provides heating hot water for the fin-tube heating units installed under windows. The heating hot water system includes one (1) circulating pump and approximately seven (7) pumps serving the fin-tube heating units. The HVAC equipment in the Library is controlled by the Novar system.

Physical Education Center

The Physical Education Center is mostly lit by 48” T8 32 watt bulbs in 1, 2, or 3 lamp fixtures with electronic rapid-start ballasts. The main floor of the gym is lit by 400w metal halide bulbs in high-bay fixtures. Some areas of the gym are noted to be significantly over-lit, including the floor itself. Exit signs in the Physical Education Center are LED signs. The PEC maintains on/off lighting controls, which sweeps the area lighting on at approximately 7am and off at 11pm. The system has manual override capacity allowing users to activate lighting between 11pm and 7am.

The Physical Education Center is served by seven (7) air handling units which are equipped with heating coils. Two (2) of the air handling units are split system DX units with refrigerant. The remaining five (5) air handling units rely on chilled water in conjunction with a cooling tower and chilled water pump. The PEC heating load is served by one (1) boiler, one (1) hot water supply pump, and one (1) hot water return pump. The HVAC equipment in the PEC is controlled by the Novar system.

Section 5 – Energy Efficiency Opportunities

The following represents a list of energy efficiency opportunities for consideration.

Regarding the lighting projects, please note that the analyses were applied concurrently to prevent double-counting of savings. Analyses were applied in the order of the measure (L-1, then L-2 etc…). If a subset of the measures is implemented, the savings may be greater for each measure. Due to the overlapping nature of the HVAC projects, they are analyzed independently from one another. A result of the independent analysis is that if all projects are implemented in aggregate, the total savings may decrease. An electric rate of $0.10 /kWh (obtained based on one year actual utility bills) is used to estimate the cost of savings of lighting projects while the time of day rate structure is used to estimate HVAC projects savings.

Lighting Projects

Lighting Project – 1: *De-lamp Over lit Rooms*

Project Description

Several of the rooms are currently lit to levels far above required lighting levels. In rooms with multiple lamp fixtures, lighting levels can be decreased by decreasing the number of lamps per fixture. This will result in a significant savings in energy as well as a more appropriate lighting level.

Implementation Scope of Work

De-lamping may be accomplished by re-wiring fixtures and reusing existing fixtures and ballasts. Alternatively, depending on the configuration of the existing fixtures, de-lamping may require the installation of new reflectors and ballasts. Project steps are:

1. Re-wire fixtures and replace ballasts and/or reflectors as necessary.
2. Follow all local, state, and federal regulatory guidelines when disposing of removed materials.

Analysis Summary

Table 14: Summary of Lighting Project - 1 Costs and Savings

ID	Project Description	Site	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Project Costs ($)	Annual Cost Savings ($)	Simple Payback (Years)	Estimated Incentive ($)	Project Cost with Incentive ($)	Simple Payback with Incentives (Years)
L-1	De-lamp Overlit Rooms	Main Campus & Student Center	0.73	1,634	$ 1,186	$ 163	7.3	$ -	$ 1,186	7.3
L-1	De-lamp Overlit Rooms	Duke Theater	1.02	2,302	$ 1,779	$ 230	7.7	$ -	$ 1,779	7.7
L-1	De-lamp Overlit Rooms	Library	0.76	1,708	$ 1,240	$ 188	6.6	$ -	$ 1,240	6.6
L-1	De-lamp Overlit Rooms	Physical Education Center	5.95	13,397	$ 701	$ 1,340	0.5	$ -	$ 701	0.5
Total			**8.46**	**19,040**	**$ 4,906**	**$ 1,921**	**2.6**	**$ -**	**$ 4,906**	**2.6**

Lighting Project – 2: *Day lighting controls in hallways*

Project Description

Many of the hallways connecting the main building to additions are over lit during the day. Floor to ceiling windows provide significant light, but the lighting controls are manual and are left on during the day. Installation of day lighting controls for each of the circuits that serve a space with significant natural light will allow lights to be turned off automatically when natural light is available. This will also reduce the cooling load in the building by reducing the lighting power consumption.

Implementation Scope of Work

The following is a description of the scope of this measure:

1. For hallways and lobby areas identified as over lit, install day lighting controls.
2. Verify that the day lighting controls turn off the lamps when adequate natural light is present and automatically turn them on when it is not.

Analysis Summary

Table 15: Summary of Lighting Project - 2 Costs and Savings

ID	Project Description	Site	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Project Costs ($)	Annual Cost Savings ($)	Simple Payback (Years)	Estimated Incentive ($)	Project Cost with Incentive ($)	Simple Payback with Incentives (Years)
L-2	Daylighting Controls	Tech Wing	0.00	405	$ 529	$ 41	13.1	$ -	$ 529	13.1
L-2	Daylighting Controls	Main Campus & Student Center	0.00	3,578	$ 1,587	$ 358	4.4	$ -	$ 1,587	4.4
L-2	Daylighting Controls	Dining	0.00	275	$ 529	$ 28	19.2	$ -	$ 529	19.2
L-2	Daylighting Controls	Duke Theater	0.00	3,803	$ 3,174	$ 380	8.3	$ -	$ 3,174	8.3
L-2	Daylighting Controls	Library	0.00	720	$ 1,058	$ 72	14.7	$ -	$ 1,058	14.7
Total			**0.00**	**8,780**	**$ 6,876**	**$ 878**	**7.8**	**$ -**	**$ 6,876**	**7.8**

Lighting Project – 3: *Install Occupancy Sensors in Restrooms with Manual Switches*

Project Description

Many of the restrooms have manually switched lighting. Restrooms are a good candidate for occupancy sensor controls as they may be infrequently used.

Implementation Scope of Work

The following is a description of the scope of this measure:

1. Install occupancy sensors in restrooms that currently have manual switches.
2. Verify that occupancy sensors work properly after installation.

Analysis Summary

Table 16: Summary of Lighting Project - 3 Costs and Savings

ID	Project Description	Site	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Project Costs ($)	Annual Cost Savings ($)	Simple Payback (Years)	Estimated Incentive ($)	Project Cost with Incentive ($)	Simple Payback with Incentives (Years)
L-3	Install Occupancy Sensors	Main Campus & Student Center	0.00	383	$ 317	$ 38	8.30	$ -	$ 317	8.30
L-3	Install Occupancy Sensors	Library	0.00	405	$ 317	$ 41	7.84	$ -	$ 317	7.84
Total			**0.00**	**788**	**$ 635**	**$ 79**		**$ -**	**$ 635**	**8.1**

Lighting Project – 4: *Replace Incandescent exit signs with LED exit signs*

Project Description

Incandescent exit signs consume up to 40 watts and are lit 24 hours a day, 365 days per year. LED based signs are available that consume only 2.5 or 5 watts for a single or double sided sign respectively. Additionally, the LEDs offer significantly longer lifetimes than incandescent bulbs, so there is an additional savings from the decreased service requirements.

Implementation Scope of Work

The following is a description of the scope of this measure:

1. Replace exit signs with a single or double sided LED based sign, as appropriate.
2. Follow all local, state, and federal regulatory guidelines when disposing of removed materials.

Analysis Summary

Table 17: Summary of Lighting Project - 4 Costs and Savings

ID	Project Description	Site	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Project Costs ($)	Annual Cost Savings ($)	Simple Payback (Years)	Estimated Incentive ($)	Project Cost with Incentive ($)	Simple Payback with Incentives (Years)
L-4	Install LED Exit Signs	Main Campus & Student Center	1.19	10,381	$ 2,282	$ 1,038	2.20	$ -	$ 2,282	2.20
L-4	Install LED Exit Signs	Duke Theater	0.60	5,234	$ 1,212	$ 523	2.32	$ -	$ 1,212	2.32
Total			**1.78**	**15,615**	**$ 3,494**	**$ 1,561**		**0**	**$ 3,494**	**2.2**

Lighting Project – 5: *Replace 32w T8 fluorescent bulbs with 25 watt bulbs*

Project Description

The replacement of high output 32w fluorescent bulbs with high efficiency 25w bulbs will result in significant energy savings. The 25w bulb will likely require a different ballast to be installed in the fixture that is compatible with the bulb.

LTCC is currently in the process of replacing magnetic ballasts with electronic ballasts when the existing magnetic ballasts fail. The magnetic ballasts are Motorola type M2-RN-T8-ILL-D-277, and the electronic ballasts are Triad form Universal type, B232IUNVHP-B. The analysis for this measure is independent of ballast factor for either ballast, and instead relies on the industry standard fixture wattages for the given fixtures. For a detailed breakdown of fixtures, refer to Appendix B.

Implementation Scope of Work

The following is a description of the scope of this measure:

1. Identify and install the required ballast for each fixture type.
2. Install 25w T8 bulb.
3. Follow all local, state and federal regulatory guidelines when disposing of removed materials.

Analysis Summary

Table 18: Summary of Lighting Project - 5 Costs and Savings

ID	Project Description	Site	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Project Costs ($)	Annual Cost Savings ($)	Simple Payback (Years)	Estimated Incentive ($)	Project Cost with Incentive ($)	Simple Payback with Incentives (Years)
L-5	Replace 32w T8 with 25w	Tech Wing	0.85	1,901	$ 5,366	$ 190	28.22	$ -	$ 5,366	28.22
L-5	Replace 32w T8 with 25w	Main Campus & Student Center	12.63	28,526	$ 59,510	$ 2,853	20.86	$ -	$ 59,510	20.86
L-5	Replace 32w T8 with 25w	Dining	0.69	1,559	$ 2,927	$ 156	18.77	$ -	$ 2,927	18.77
L-5	Replace 32w T8 with 25w	Duke Theater	6.13	13,788	$ 26,341	$ 1,379	19.10	$ -	$ 26,341	19.10
L-5	Replace 32w T8 with 25w	Library	3.80	8,539	$ 16,390	$ 854	19.19	$ -	$ 16,390	19.19
L-5	Replace 32w T8 with 25w	Physical Education Center	1.71	3,841	$ 10,244	$ 384	26.67	$ -	$ 10,244	26.67
Total			**25.80**	**58,154**	**$120,776**	**$5,815**		**0**	**$ 120,776**	**20.8**

Lighting Project – 6: *Replace metal halide high bay lights with fluorescent lights*

Project Description

The gym is lit with inefficient, high powered metal halide lights. These lights may be replaced by efficient T8 fluorescent high bay fixtures. In addition to the efficiency gain, the quality of light produced by the fluorescent fixtures is higher and the start-up time for the lights is much shorter. The shorter start-up time allows for turning the lights on and off in accordance with gym usage as compared to leaving the lights on during unoccupied time periods to avoid start-up lag times. The bulbs are also significantly more economical.

The library is also equipped with numerous metal halide lights. These lights are distributed over the book-stack area and provide constant-use lighting throughout the day. Although there may be significant energy savings available through replacing these metal halide fixtures with high bay fluorescent fixtures, this replacement was not included in the analysis due to the preferences for the existing library lighting expressed by facility staff during the audit. Therefore, the following analysis reflects only the replacement of the metal halide lighting in the PEC.

Implementation Scope of Work
The following is a description of the scope of this measure:

1. Install fluorescent high-bay fixtures in place of the existing metal halide fixtures.
2. Ensure proper operation of the fixtures as installed.
3. Follow all local, state, and federal regulatory guidelines when disposing of removed materials.

Analysis Summary

Table 19: Summary of Lighting Project - 6 Costs and Savings

ID	Project Description	Site	Peak Demand Savings (kW)	Annual Electric Savings (kWh/yr)	Project Costs ($)	Annual Cost Savings ($)	Simple Payback (Years)	Estimated Incentive ($)	Project Cost with Incentive ($)	Simple Payback with Incentives (Years)
L-6	Replace metal halide lighting with high bay fluorescent	Physical Education Center	6.96	15,660	$ 14,407	$ 1,566	9.20	$ -	$ 14,407	9.20
Total			**6.96**	**15,660**	**$14,407**	**$1,566**		**0**	**$ 14,407**	**9.2**

Lighting Project – 7: *Repair Incorrect Wiring*

Project Description
The exterior lighting at the entry door and walkway to the student dining area is cross-wired to the emergency lighting circuit. As a result, the emergency lights shut off on a time schedule and the exterior lights never shut off.

Implementation Scope of Work
The following is a description of the scope of the measure:

1. Re-wire the control circuits to operate properly.

HVAC Projects

HVAC Project – 1: *Convert constant-air-volume (CAV) air-handling unit AH-2 serving the scene shop to a variable-air-volume (VAV) system*

Project Description
AH-2 is a single-zone air-handling unit with a 3 hp supply fan motor that serves the scene shop (Room F112) in the Duke Theatre. Currently, this motor is constant speed and the air volume supplied by AH-2 does not vary. Installing a VFD to modulate the speed of the supply fan motor will allow the airflow to modulate in response to the actual zone demand. Since the fan power consumption follows a cubic relationship with fan speed,

even a small reduction in fan speed can result in substantial energy savings. It is assumed that a turndown of 25% is possible without significant deterioration in heating and cooling coil performance. Since the existing motor is a high efficiency motor, it is expected that it will be acceptable for inverter-duty.

Implementation Scope of Work
The following is a description of the scope of work for this measure.

1. Install a 3 hp VFD to control the speed of the fan motor.
2. Program the Novar controller of AH-2 to turn down airflow under low-load conditions. Typically, two stage heating/cooling works best, wherein the first stage is a change in discharge air temperature at fixed minimum airflow and the second stage is an increase in fan speed from minimum to full speed.

Analysis Summary

Table 20: Summary of HVAC Project - 1 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-1	Scene Shop AH-2 CAV to VAV	3,566	0.2	$259	201	$126	$386	$9,014	23.4

HVAC Project – 2: *Replace pneumatic controls of the HVAC systems serving the Main Building with DDC controls*

Project Description
The Main Building is the oldest part of the campus. Manually-operated pneumatic controls and manual timers control the operation of the HVAC equipment serving the Main Building. A Novar direct-digital-controls (DDC) system operates and monitors most of the equipment in the additions to the Main Building. Substantial operation and maintenance cost savings may result from extending the DDC system to the Main Building. Pneumatic controllers tend to drift out of calibration and suffer from 'offset'. DDC controllers can maintain effective control under changing load conditions. Additionally, DDC systems can log trends, allowing facility staff to develop historical records on the operating characteristics of a building to improve performance. The DDC system also allows for comprehensive alarm management in the event of an HVAC system malfunction. DDC scheduling will eliminate the need to change various time clocks for holidays and schedule changes. A significant portion of the savings available through the installation of DDC controls at the college results from time-of-day controls

Implementation Scope of Work
The following is a description of the scope of work for this measure.

1. Install DDC controls including sensors, controllers and wiring on all HVAC equipment serving the Main Building.
2. Program the controllers to adequately control the equipment.
3. Provide a front-end computer with graphics for monitoring and making adjustments.
4. Commission the control system and provide training to facility staff covering operation and maintenance of DDC controls.

Analysis Summary

Table 21: Summary of HVAC Project - 2 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-2	Main Bldg. controls; pneumatic to DDC	80,040	-	$3,902	5,710	$2,290	$6,192	$124,429	11.1

HVAC Project – 3: *Convert CAV multi-zone air-handling unit MZ-1 serving the Student Center to a VAV system*

Project Description

Multi-zone air-handling unit MZ-1 provides conditioned air to four zones of the Student Center. Boilers B-1 and B-2 provide hot water to the heating coil of the hot deck of the unit. A direct expansion (DX) coil provides cooling to the cold deck. A 30-ton Carrier condensing unit serves the DX coil. Each of the four zones has a set of mixing dampers. Each set of dampers is on a common shaft actuated by a single actuator. For each zone, the thermostat in the zone modulates its mixing damper to mix the hot and cold airstream, thus achieving the correct temperature in the space. The supply fan of the unit has a 10 hp motor that runs at constant speed. As mentioned in HVAC Project – 1, a VFD may be used to modulate the speed of the fan in response to zone demand. Given the difficulties associated with DX coil operation at low airflow, a turndown of no more than 75% of the design airflow was assumed. Since this unit serves more than one zone, additional work will be required at the zone level.

Implementation Scope of Work

The following is a description of the scope of work for this measure.

1. Install a VFD to control the speed of the supply fan motor.
2. Install a duct static sensor in the cold deck before the damper sections to control the output of the VFD.

3. Separate the hot deck and cold deck dampers for each zone. Provide independent actuators for the hot deck and cold deck dampers of each zone.
4. Modify controller programming to modulate hot deck and cold deck dampers independently with a 'dual-minimum' strategy.
5. Alternate – if it is unfeasible to isolate the hot and cold deck dampers, VAV terminal units with re-heat coils may be installed for each zone. In this case, the hot deck may be abandoned, and the heating piping shall be extended to the terminal units.

Analysis Summary

Table 22: Summary of HVAC Project - 3 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-3	Student Cntr. MZ-2; CAV to VAV	15,133	2.4	$1,406	1,823	$1,131	$2,537	$14,118	5.6

HVAC Project – 4: *Install run-around heat recovery on bakery hood exhaust to pre-heat outside air intake for the Student Center*

Project Description

The bakery has a 3 hp exhaust fan that serves a hood over the oven. Unlike the main kitchen exhaust, the exhaust from the bakery does not have grease accumulation issues. A run-around loop may be used to transfer energy between oven exhaust and ventilation air. Run-around loops circulate a fluid between two air streams using additional coils and a circulating pump. The air streams do not need to be next to one another and there is no cross-contamination. Run-around loops have a sensible effectiveness between 55% and 65%. Although this measure results in gas savings, there is an increase in power consumption of the hood fan and the supply air fan due to the additional pressure drop of the run-around coil. The coil pump also consumes a small amount of electricity. The energy savings assumes the bakery hood fan is operational for 500 hours in the winter. If the actual hours of operation are different, the savings estimate can be adjusted roughly proportionally.

Implementation Scope of Work

The following is a description of the scope of work for this measure.

1. Install coil sections in the exhaust duct and outdoor air intakes.
2. Install a coil pump and connect the coils.
3. Provide insulation as required.
4. Install controls to start the pump when the bakery exhaust is ON and the outdoor air temperature is low.

Analysis Summary

Table 23: Summary of HVAC Project - 4 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-4	Bakery Exhst. Heat Recovery	(3,114)	(0.9)	$(193)	660	$409	$216	$5,995	27.7

HVAC Project – 5: *Install a variable-speed kitchen hood control system*

Project Description

Besides the bakery exhaust, two more hood exhaust fans of motors sizes 3 hp and 10 hp each serve the kitchen in the Student Center. Currently, both exhaust fans run continuously at full speed when cooking is in progress. This measure provides for the installation of a variable-speed kitchen hood exhaust control. This type of system uses a temperature sensor and an optical sensor to modulate the speed of the fan to provide thermal and visual comfort to the chef. Potential savings may be realized by reducing the speed of the kitchen hood exhaust fans during slack periods between peak meal preparations. Gas savings may also be expected, because the outdoor air that makes up for the exhaust air will have to be heated. The energy savings from this measure increase and the payback decreases if the annual operating hours of the kitchen exhaust fans are higher than the 2,000 hours assumed in the analysis.

Implementation Scope of Work

The following is a description of the scope of work for this measure.

1. Install variable-speed kitchen hood exhaust control to control 10 hp and 3 hp kitchen exhaust fans.

Analysis Summary

Table 24: Summary of HVAC Project - 5 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-5	Variable Speed kitchen exhaust	5,553	-	$344	1,394	$864	$1,208	$30,253	25.0

HVAC Project – 6: *Install a shell-and-tube heat exchanger to recover heat from refrigeration systems to pre-heat domestic hot water*

Project Description

The refrigerator systems in the kitchen of the Student Center reject heat using air-cooled outdoor condensing units. Instead, the hot refrigerant gas can be circulated through a once-through shell-and-tube heat exchanger arrangement to reject this heat to city water, presumably at 65 °F. The pre-heated water can be fed to the domestic hot water tank-heater serving the building. If the domestic water demand is not enough to satisfy the heat rejection requirements, then an automatic valve will shut-off the flow of water and the air-cooled condenser will cool the refrigerant as before. Exact details regarding the refrigeration systems were not available during the audit. A heat rejection load of 12,000 Btu/hr is assumed for 500 hours every year, during which domestic hot water would also be required. The savings results from less natural gas required to heat the domestic hot water and reduced fan electricity consumption of the air-cooled condenser fans.

Implementation Scope of Work

The following is a description of the scope of work for this measure.

1. Install a shell-and-tube heat exchanger of the appropriate size.
2. Modify refrigerant piping and charge to suit the new arrangement.
3. Install an automatic shut-off valve controlled off the level of the domestic hot water tank heater.

Analysis Summary

Table 25: Summary of HVAC Project - 6 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-6	Heat recovery from refrigerators	150	-	$9	60	$37	$47	$3,045	65.5

HVAC Project – 7: *Replace air-cooled condensing units serving the Main Building with high efficiency units*

Project Description

This measure involves replacing fourteen existing outdoor condensing units ranging in capacity from two to five tons that serve indoor fan sections with direct expansion cooling coils at various locations in the Main Building. Typically, older air cooled condensing units have an Energy Efficiency Ratio (EER) between 7 and 8. Newer units are available with an EER of as high as 15. EER is the ratio of the heat removed from the space in Btu to the total power input measured in watts. This means that the higher the

EER, the more cooling can be obtained per watt of input energy. As the operating hours of the individual units increase, the savings associated with this measure also increase and the payback becomes shorter. This measure has additional savings benefits if the equipment is at the end of its useful life.

Implementation Scope of Work
The following is a description of the scope of work for this measure.

1. Replace (14) condensing units that serve various sections of the Main Building.
2. Replacement condensing units shall have a minimum EER of 14.

Analysis Summary

Table 26: Summary of HVAC Project - 7 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-7	Replace Main Bldg. cond. units	13,461	9.4	$3,131	-	$-	$3,131	$54,138	17.3

HVAC Project – 8: *Install a VFD to modulate the speed of the cooling tower pump that serves the Duke Theater free-cooling system*

Project Description
A nominal 200-ton cooling tower provides cooling water to the cooling coils of air-handling units that serve the Duke Theater. This is called a free-cooling loop since an energy-intensive chiller is not used and the relatively high temperature cooling water provided by the tower is sufficient to satisfy space cooling need in the mild summers at South Lake Tahoe. A centrifugal pump with a 7.5 hp motor circulates tower water around this loop. Currently, this pump runs at a constant speed when the tower is available for service during the summer months. Installing a VFD on the pump motor will allow the pump to slow down when the demand for cooling water is low. It is assumed that the pump may be slowed down to as much as 60% of full speed without resulting in dry areas on the cooling tower fill. The tower return water temperature sensor may be used to control the pump speed as well. Due to the existing plate and frame heat exchanger between the cooling tower and the cooling coils, the installation of VFD control is not expected to require a retrofit of the existing cooling coil valves.

Implementation Scope of Work
The following is a description of the scope of work for this measure.

1. Install a 7.5 hp VFD to control the speed of the BAC tower pump motor.

2. Program the VFD to turn down the speed of the pump in response to load. The tower entering water temperature sensor may be used to determine the cooling load.

Analysis Summary

Table 27: Summary of HVAC Project - 8 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-8	VFD on CT pump	9,318	7.3	$1,205	-	$-	$1,205	$4,646	3.9

HVAC Project – 9: *Install a water treatment system with conductivity controller on the cooling tower to regulate blow down*

The cooling tower loop has serious levels of scale and particulates, which requires flushing the end of the loop daily. Non-chemical water treatment system can reduce the amount of particulate buildup on the system. These technologies utilizes high frequency magnetic pulses to cause minerals in the water to precipitate onto particles in the water, which prevents scale from forming on the pipes and boiler tubes. This will increase the life of the system and increase the capacity of the system. Reducing the amount of scale built-up on the system will increase the heat transfer effectiveness of the system. When the chemical free water treatment is initially installed, the scale built up on the system will start to come off. The system will need to be flushed until the scale has been removed. The system should also be cleaned prior to installing the water treatment system.

Implementation Scope of Work

The following is a description of the scope of work for this measure.

1. Furnish and install a pulsed power water treatment system or equivalent on the cooling tower system.

Analysis Summary

Table 28: Summary of HVAC Project - 9 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-9	Chem treatment for CT-1	-	-	$-	-	$-	$-	$6,445	N/A

The primary savings from the installation of the Dolphin water treatment will be maintenance, chemical costs, and water savings since the cooling tower loop will not need to be flushed daily. This project is estimated to cost $6,400.

HVAC Project – 10: *Replace one of two existing forced-draft boilers with a larger high efficiency boiler*

Project Description

Currently, two forced-draft natural gas-fired 2,750 MBH input hot water boilers are used to heat the facility. The boilers were installed in 1988 and are at the end of their expected life. Even though the nameplate efficiency of these boilers is 80%, they may be operating at efficiency as low as 75%. One of these boilers may be replaced with a new boiler to serve up to 80% of the design load, with the remaining old boiler picking up the remainder of the load on the few days that it is needed. A condensing boiler is available with efficiency as high as 95%, but the return water temperature in this system is not low enough to make this a viable option. Therefore, a high efficiency boiler of input capacity 3,800 MBH that may be up to 85% efficient may be installed. The College is considering a geothermal heating system in the future. If a geothermal system is installed, then the new boiler can serve as standby and the remaining old boiler can be retired. Besides reduction in gas usage, the new boiler will ensure compliance with air quality norms.

Implementation Scope of Work

The following is a description of the scope of work for this measure.

1. Remove one of the two existing forced-draft boilers.
2. Design a non-condensing high efficiency boiler installation that will meet the heating loads of the facility and provide sufficient redundancy in case of a failure.
3. Install the new boiler.
4. Integrate the boiler start/stop and temperature controls with the Novar DDC system (HVAC Project – 2).

Analysis Summary

Table 29: Summary of HVAC Project – 10 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-10	Replace (1) of two existing boilers	-	-	$-	17,306	$10,869	$10,869	$64,754	6.0

HVAC Project – 11: *Relocate disabled student learning and media centers to a more convenient first floor location to minimize elevator use*

Project Description

The second floor of the Main Building currently houses a learning center and a media center equipped for disabled students. The elevator serving the second floor is a Dover 2-stop hydraulic elevator, with a 25 horsepower motor. By moving these centers to first floor locations, building staff estimate that 80% of the elevator use can be eliminated. There are numerous first floor media centers of similar size to the second floor learning and media centers, therefore it is assumed that the wiring and space demands of the learning center and the media center can be met in already existing areas. According to elevator manufacturer's literature, the daily electrical use of an elevator with a hydraulic drive, serving one floor, can be modeled at 12 kWh/day. The implementation costs of this project would vary based on available labor and the feasibility of transferring first floor locations to meet the requirements of the disable student learning and media centers.

Implementation Scope of Work

1. Relocate all equipment specific to the second floor learning and media centers to similarly sized first floor media rooms.
2. Use existing second floor leaning center and media center space for displaced first floor computer rooms.

Analysis Summary

Table 30: Summary of HVAC Project - 11 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-11	Reduce elevator use	3,020	-	$390	-	-	$390	N/A	N/A

HVAC Project – 12: *Convert CAV air-handling units AH-3, AH-4, AH-5, AH-6 and AH-7 serving the Technology Building (D wing) to VAV systems*

Project Description

AH-3, AH-4, AH-5, AH-6 and AH-7 are single-zone air-handling units each with a 2 or 3 hp supply fan motor serving various zones in the 'D' wing of the Technology Building. Currently, each fan is constant speed and the air volume supplied by each AH does not vary. Installing a VFD to modulate the speed of the supply fan motor will allow the airflow to modulate in response to the actual zone demand. It is assumed that a turndown of 30% is possible without significant deterioration in heating and cooling coil performance and allowing code-required minimum ventilation.

Implementation Scope of Work

The following is a description of the scope of work for this measure.

1. Install VFDs of appropriate sizes to control the speed of the fan motor for each of AH-3, AH-4, AH-5, AH-6 and AH-7.
2. Program a two stage heating/cooling strategy to turn airflow down if zone demand decreases. The first stage is a change in discharge air temperature at fixed minimum airflow and the second stage is an increase in fan speed from minimum to full speed.

Analysis Summary

Table 30: Summary of HVAC Project - 12 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-12	D-wing AH-3-7, CAV to VAV	21,965	2.2	$1,662	859	$540	$2,202	$33,658	15.3

HVAC Project – 13: *Isolate 'off-line' building areas from central heating hot water loop when heating is not needed*

Project Description

During the audit, it was observed that no means exist to isolate the various sections and building additions that are connected to the central heating hot water loop. As a result, there may be a substantial loss of heating energy due to unnecessary heating. Some buildings require heating for more hours and longer seasons than others. EMS controlled isolation valves can be used to shut-off the flow of hot water to buildings that do not need heating automatically. A building engineer at the campus estimated an approximate therms savings of 30% for isolating hot water to buildings that do not need heating

automatically. However, based on observed conditions of the HVAC equipment, a more conservative estimate was used. For the analysis, isolating off-line areas represents energy savings equal to 15% of the annual natural gas usage of the Main Building.

Implementation Scope of Work

The following is a description of the scope of work for this measure.

1. Install automatic isolation valves to shut-off flow to buildings that need heating for fewer hours than others.
2. The automatic isolation valves may be controlled off outdoor air temperature sensors, manual timers or scheduling through the energy management system.

Analysis Summary

Table 31: Summary of HVAC Project - 13 Costs and Savings

ID	ECM	Total Electric Energy Savings (kWh/yr)	Peak Electric Demand Savings (kW)	Total Electric Cost Savings ($/yr)	Total Gas Energy Savings (therms/yr)	Total Gas Cost Savings ($/yr)	Total Utilities Cost Savings ($/yr)	Total Project Cost ($)	Simple Payback (yrs)
ECM-13	Off-line buildings, isolate heating	-	-	$-	13,849	$8,586	$8,586	$14,228	1.7

Section 6 - Selected Pictures

Main Building Ajax Boiler

Student Dining Center kitchen hood exhaust