Energy Analysis – Construction Documents

University of Wyoming Visual Arts Facility

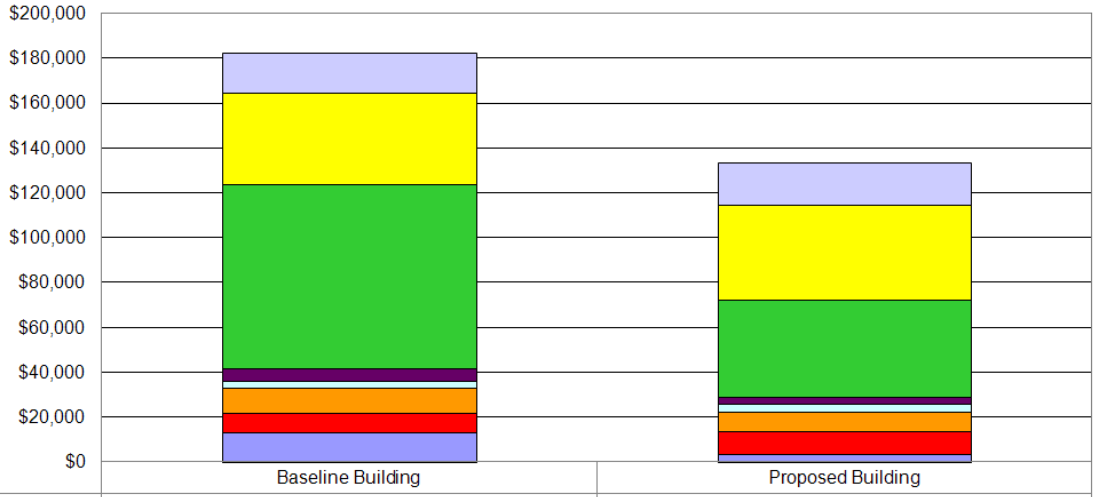
1.0 Project Narrative

The project is located in Laramie, Wyoming and consists of approximately 78,285 square feet of new construction. Primary spaces include classrooms, design studios, common spaces, fine arts workshops (print making, sculpting, work and metal work, ceramics, drawing and painting) and offices.

The project goal is to reduce the facilities energy consumption as much as is economically practical. Additionally, the project is required to achieve LEED Silver Certification at a minimum and is therefore required to achieve at least 2 points under Energy and Atmosphere Credit 1 (EAc1), Optimize Energy Performance. An energy model was created using eQUEST computer-based energy simulation software in order to determine the building energy performance.

The 100% Construction Documents as analyzed (excluding the solar thermal hot water array) achieves a 26% energy cost reduction below the ASHRAE 90.1-2007 Baseline Building. This energy savings is worth a maximum of 8 LEED points. Additional LEED points will be pursued with the addition of the solar thermal collector system, exemplary performance, regional priority credit and innovation in design.

Baseline Building Energy Cost: $182,336 ***Baseline Building EUI: 176 Kbtu/SF/yr***
Proposed Building Energy Cost: $133,373 ***Proposed Building EUI: 126 Kbtu/SF/yr***



	Baseline Building	Proposed Building
Interior Lighting	$18,077	$18,560
Process Loads	$40,729	$42,391
Heating	$81,974	$43,591
Cooling	$5,599	$2,730
Pumps	$2,964	$3,539
Fans	$11,433	$8,764
Domestic Hot Water	$8,773	$10,144
Exterior Lighting	$12,921	$3,584

Figure 1-1: Baseline vs Proposed Design Annual Energy Cost

2.0 Energy Analysis

2.1 Building Input Summary

The following method and inputs were used to create the Baseline Building analysis. The energy model mirrors the 100% Construction Documents. The model has been created with inputs from the design team and user group regarding exhaust rates, heat gains, and occupancy schedules. Per LEED V3 requirements, the campus District Energy System, or DES (the campus district steam system in the case of the Visual Arts Facility) was incorporated into the energy model in order to achieve more than 2 LEED points.

2.1.1 Summary of Energy Cost Reduction Measures

- Increased wall and roof insulation
- High performance windows
- Interior lighting power reduced from 123.8 kW to 120.4 kW
- Daylight control for respective spaces
- Exterior lighting power reduced from 54.0 kW to 13.9 kW
- Evaporative cooling
- Natural cooling for corridors and exterior offices
- Task exhaust control
- Demand control ventilation

2.1.2 Baseline Building Code

ASHRAE Standard 90.1-2007 Appendix G Performance Rating Method was used for compliance. The project is located in ASHRAE Climate Zone 6B.

2.1.3 Simulation Software

eQUEST energy simulation software was used.

2.1.4 Weather Data

The Typical Meteorological Year (TMY3) data for Laramie, Wyoming was used.

2.1.5 Utility Data

Utility rates assumed in the analysis are described in Table 2-1. Electric rates are assumed based on Rocky Mountain Power Schedule 28. Coal-based steam rates have been assumed based on utility information provided by The University of Wyoming.

Table 2-1: Utility Rate Information

Energy Source	Cost
Electricity	- **$25.00 per month 3-phase basic charge, $13.22 per kW demand charge, $0.0105 per kWh energy charge, and a 4% city franchise fee.**
Coal	- **$274.16 per short ton of coal[1]**

Notes:
1. A rate of $274.16 per short ton of coal is equivalent to $13.17 per MMbtu of steam. Steam rate is the delivered rate that the end building user pays for steam (which includes operation & maintenance, capital recovery and other costs to operate the plant).

2.1.6 Geometry

The building geometry is based on the 100% Construction Documents dated July 14, 2010 developed by [redacted] Figure 2-1 is a graphical representation of the eQUEST energy model for the Visual Arts Facility.

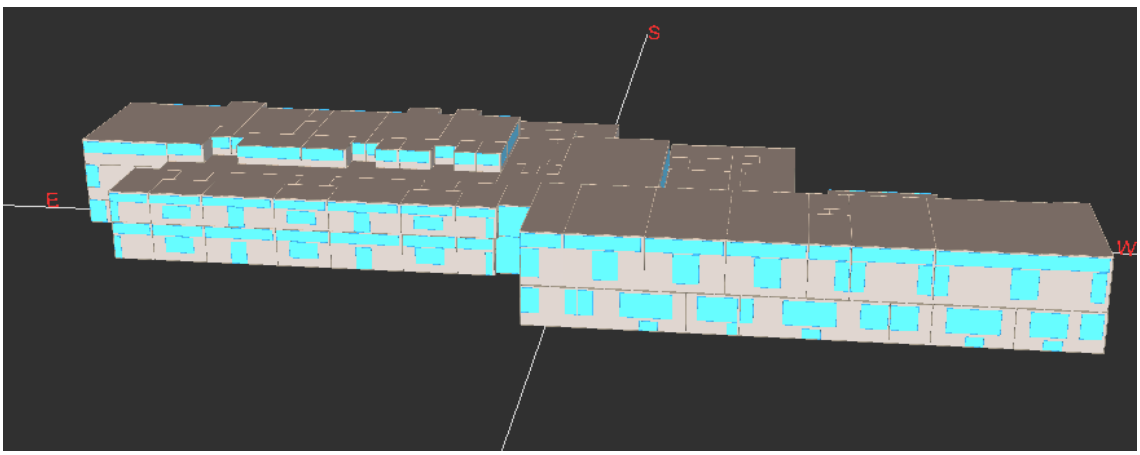


Figure 2-1: Graphical Representation of Visual Art Facility eQUEST Model

2.1.7 Envelope

Building envelope characteristics for the Baseline Building represent minimally compliant performance criteria for building envelopes in Climate Zone 6B (ASHRAE 90.1-2007, Table 5.5-5). Building envelope characteristics for the Proposed Building represent the 100% Construction Documents drawings referenced.

Table 2-2: Baseline Building Envelope Characteristics

Building Envelope Criteria	ASHRAE 90.1-2007 Baseline
Roof Insulation; Entirely Above Deck	R-20 continuous, U=0.048 for assembly
Wall Insulation; Steel Framed	R – 13 batt + R – 7.5 continuous, R – 15.6 for assembly (U = 0.064)
Assumed Vertical Glazing Percentage	34%
Vertical Glazing U-Value (overall assembly)	0.45

Vertical Glazing SHGC	0.40
Unheated Slab-on-Grade Floor	R-10 insulation for 24 inches
Exterior Shading	None
Roof Albedo	0.30 reflectivity

Table 2-3: Proposed Building Envelope Characteristics

Building Envelope Criteria	Design Development Documents
Roof Insulation; Entirely Above Deck	R-42 Average
Stone Veneer Wall	R-13.2 insulation, U-0.070 for assembly
Precast Wall	R-19.8 insulation, U-0.048 for assembly
Metal Siding Wall	R-22.3 insulation, U-0.042 for assembly
Assumed Vertical Glazing Percentage	34%
North-Facing Vertical Glazing U-Value (overall assembly)	0.29
North-Facing Vertical Glazing SHGC	0.4
Non-North-Facing Vertical Glazing U-Value (overall assembly)	0.28
Non-North-Facing Vertical Glazing SHGC	0.27
Unheated Slab-on-Grade Floor	R-15 insulation for 24 inches
Exterior Shading	None
Roof Albedo	0.30 reflectivity

2.1.8 Space Temperatures

The proposed space temperatures for controlling cooling and heating occupied and unoccupied thermostat setpoints are listed in table 2-4 below.

Table 2-4: Space Temperature Setpoints

Space Control Function	Space Thermostat Setpoint
Evaporative Cooling, Occupied	72
Natural Cooling, Occupied	80
Cooling, Unoccupied	82
Heating, Occupied	70
Heating, Unoccupied	64

2.1.9 Internal Lighting Loads

Lighting power densities are shown in Table 2-5 below. The lighting power Baseline budget is based on ASHRAE Standard 90.1-2007, Table 9.6.1. The Proposed Building lighting power densities are based on the 100% Construction Document Lighting Design. Internal lighting loads seen by both, the Baseline and Proposed Buildings, result from scheduling the amount of lighting which operates for each hour of the day over the course of a typical year. Building schedules are elaborated on in Section 2.1.16 of this report. In addition, the Proposed Building was modeled with day-lighting controls per the 100% Construction Documents. Galleries, Lobbies and Common spaces are controlled with full range dimming, while Studios and Labs are partially staged off.

Table 2-5: Lighting

Space Type	Baseline Lighting (W/sf)	Proposed Lighting (W/sf)
Galleries, Critique	1.0 (based on museum general exhibition)	0.49
Studios, Workshops	1.9	2.05
Classrooms	1.4	1.99
Drawing / Painting Labs	1.9 (based on workshop)	2.05
Office Spaces	2.1	1.77
Corridors	1.5	0.43
Active Storage	0.8	0.97
Restrooms	0.9	1.01
Mechanical Rooms / Electrical Rooms	1.5	1.3

2.1.10 Internal Occupant Loads

The total number of building occupants is based on the number of students, faculty, and staff for the University of Wyoming Art Department. Internal occupant loads seen by the building result from scheduling the number of occupants as a fraction of the total for each hour of the day over the course of a typical year. Building schedules are elaborated on in Section 2.1.16 of this report.

Table 2-6: People

Building Total	**308 Occupants Total (code based and is not simultaneous)**

2.1.11 Internal Plug Loads and Process Loads

Due to the unique nature of this building, there is a significant amount of electrical plug, electrical process and gas process loads due to the various pieces of equipment used in the building. The total electrical load for each space was tabulated based on the size of transformers which serve the powered equipment for each space. A percentage of these loads were then scheduled as being operated by building occupants throughout the day. Electrical energy use seen by the building due to plug and process loads result from scheduling the amount of equipment use for each hour of the day over the course of a typical year. Building schedules are elaborated on in Section 2.1.16 of this report. For the purposes of LEED, these loads are considered process energy as outlined in Section 2.5 of this report. See Appendix B for detailed information on energy demand of process equipment.

2.1.12 External Loads

External loads consist of exterior lighting. The Baseline Building external lighting load is based on parking lot areas, walkway and plaza areas, and linear footage of exterior doorways per AHSRAE 90.1-2007, Table 9.4.5. The Proposed Building external lighting load is based on the 100% Construction Documents. The Baseline and Proposed Buildings are scheduled to operate during the evening and night hours when insufficient daylight is present.

Table 2-7: Exterior Lighting

Location	Baseline Lighting Power	Proposed Lighting Power
All Locations	54.0 kW	13.9 kW

2.1.13 Mechanical Systems

Baseline inputs are based on building size and type according to ASHRAE Standard 90.1-2007 Appendix G Performance Rating Method for a 2-story building which is approximately 78,285 square feet. Proposed inputs are based on the 100% Construction Documents.

Table 2-8: Baseline Mechanical System Summary

System Component	ASHRAE 90.1-2007 Baseline
Air Handling	
System Type	System 5 – Packaged VAV with reheat (Packaged rooftop air conditioner, variable volume, direct expansion, steam heat)
Fan Operation	Variable Volume
Economizer	High-Limit Shutoff of 75 F for Climate Zone 6B
Outdoor Air Ventilation	Same as Proposed Building
Demand Control Ventilation	None

Supply Air Temperature Reset	From 55 F to 60 F at minimum cooling load
Exhaust Controls	Same as Proposed Building
Heating	
Heating Type	(2) Equally sized coal fired steam boilers designed per ASHRAE 90.1, Appendix G
Heating Efficiency	77% Thermal Efficiency (Coal Fired Steam Boiler)
Reheat Source	Hot Water
Hot Water Temperature Reset	180 F linearly down to 150 F when outside temperature changes from 20 F to 50 F.
Cooling	
Cooling Type	Direct expansion
Cooling Efficiency	9.5 EER (1st & 2nd Floor AHUs), 10.8 EER (1st Floor Radiant Floor & 24 Hr AHU), 11.0 EER (2nd Floor Radiant Floor)
Service Water Heating	
Heater Type	On-site coal fired domestic water heater, 80% Thermal Efficiency

Table 2-9: Proposed Mechanical System Summary

System Component	**Proposed Description**
Air Handling	
System Type	VAV air handlers with hot water heat and evaporative cooling serving fine arts, design studios and classroom. Exterior offices and commons areas with natural ventilation.
Fan Operation	Variable Volume
Economizer	Evaporative cooling extends economizer cycle - 100% OSA during cooling.
Outdoor Air Ventilation	Based on ASHRAE 62.1
Demand Control Ventilation	Not Simulated.
Supply Air Temperature	63 F
Exhaust Controls	Spaces with general exhaust run continuous during occupied mode. Task exhaust operates per scheduled occupancy usage.
Heating	
Heating Type	Coal-fired campus district steam plant provides heating water for radiant flooring. Additional heat at AHU and VAV box reheat.
Heating Efficiency	See Table 2-10 below
Reheat Source	Hot Water (converted from steam)

Hot Water Temperature Reset	120 F design temperature for radiant floor and non-radiant floor heating water. All heating converted from campus steam.
Cooling	
Cooling Type	Direct Evaporative Cooling for VAV spaces. Exterior offices and Commons with natural cooling. *Per LEED requirements, proposed building modeled with DX cooling and efficiencies per ASHRAE 90.1 Appendix G to meet unmatched load hours.*
Service Water Heating	
Heater Type	Steam-to-Water heat exchanger using campus district steam, 67.5% Source-to-Site Efficiency.

2.1.14 Campus District Energy System (DES)

Per LEED V3 requirements, the campus DES plant efficiencies and piping losses must be included in the Proposed Building model if the project wishes to achieve more than 2 LEED points. This boiler must be modeled against an on-site boiler with baseline ASHRAE 90.1-2007 efficiencies in the Baseline Model. Campus steam boiler efficiencies and steam piping losses have been provided by a third party consultant to the energy modeling team and have been incorporated into the energy model. See Appendix D for detailed plant information.

Table 2-10: Proposed Building DES Efficiency Summary

DES Component	Description
Steam Plant Efficiency	77.8% based on data for Fiscal Year 2009
Steam Piping Losses	86% based on the amount of condensate returned to the central plant for Fiscal Year 2009
Total Plant Efficiency used in Model	67.5% total plant efficiency based on multiplying 77.8% by 86%.

2.1.15 Building Exhaust

Special attention has been given to the building exhaust. The building will have several spaces with specialized exhaust requirements to protect the building occupants. Most design studios have multiple task exhaust stations with manual timer switches or occupancy sensors, while others require 24-hour exhaust. Exhaust rates have been based on the HVAC design shown in the 100% Construction Documents. For the purposes of LEED documentation, the Baseline Building and the Proposed Building exhaust loads must be modeled with identical capacities

and schedules. See Appendix C for detailed information on building exhaust loads and schedules.

While exhaust loads must be modeled identical per Appendix G of ASHRAE 90.1, additional energy savings will be provided with the implementation of timer switches, occupancy sensors and heat recovery. *Innovation in Design credit* shall be attempted to account for this additional energy savings. Refer to LEED Innovation in Design credit template documentation for further detailed information on this subject.

2.1.16 Schedules

Annual building use is based on spring, summer, and fall school semesters. Annual schedules have been created for occupants, lighting, electrical equipment (i.e. process load equipment like saws and kilns which are specific to each space function), and exhaust airflow. Annual schedules are divided into week schedules with occupied and unoccupied weeks based in the University of Wyoming 2009 school schedule. Week schedules are divided into occupied and unoccupied days based on the University of Wyoming 2009 schedule for the Art Department.

See Appendix A for detailed information regarding occupancy schedule assumptions. Each occupied and unoccupied day over the course of a year is divided up into 24 hours with fractional occupancies (a value of one indicates full building occupancy for a particular hour, a value of zero indicates no building occupants for a particular hour) for each hour. Information is based on the University of Wyoming 2009 Schedule for the Art Department and input from the Art Department Faculty. These annual, week, and day schedules are then applied to the items listed in this section.

2.2 Baseline and Proposed Building Energy Use

The Baseline and Proposed Buildings' energy usage by end use is indicated in the Figures 2-2.1 and 2-2.2. The annual Proposed Building electrical energy use total is 1,007.9 x 10^3 kWh. This is 303.9 x 10^3 kWh (23%) less than the annual Baseline Building's electrical energy usage of 1,311.8 x 10^3 kWh. The annual Proposed Building's steam energy use total is 4,080 x 10^6 BTU. This is 2,786.2 x 10^6 BTU (41%) less than the Baseline Building's steam energy usage of 6,866.2 x 10^6 BTU. Natural gas energy use for process equipment is the same for both cases in accordance with LEED requirements.

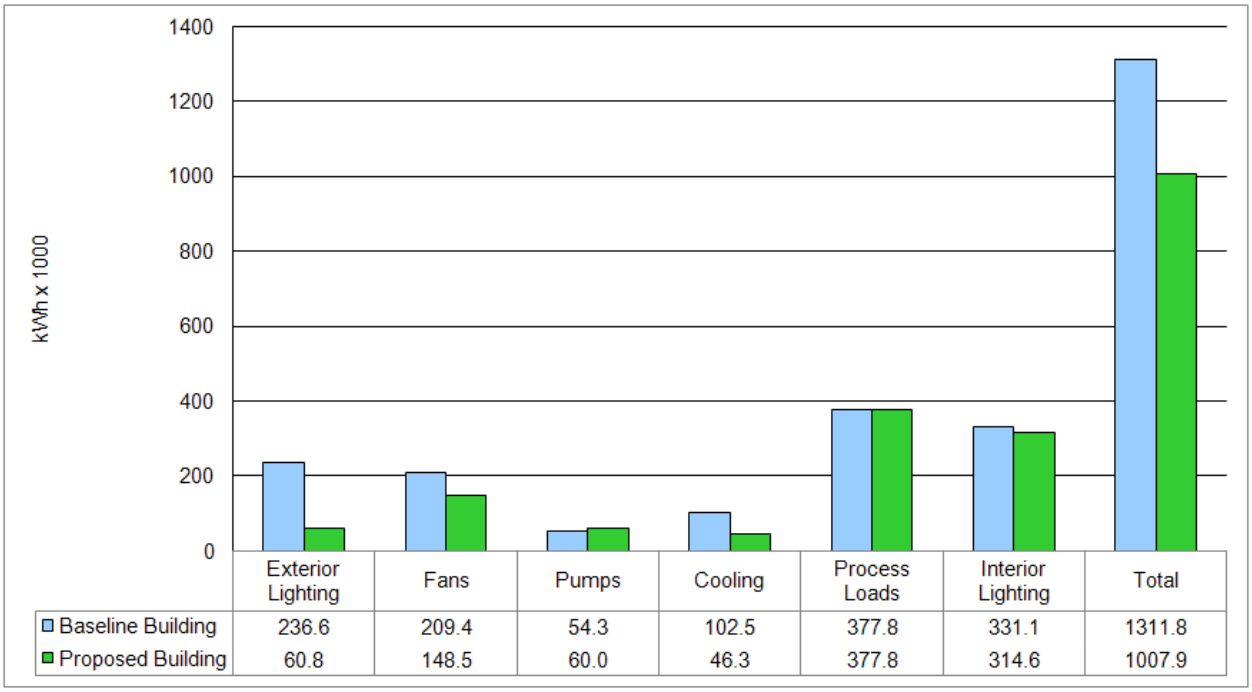


Figure 2-2.1: Baseline vs Proposed Electrical Energy Use

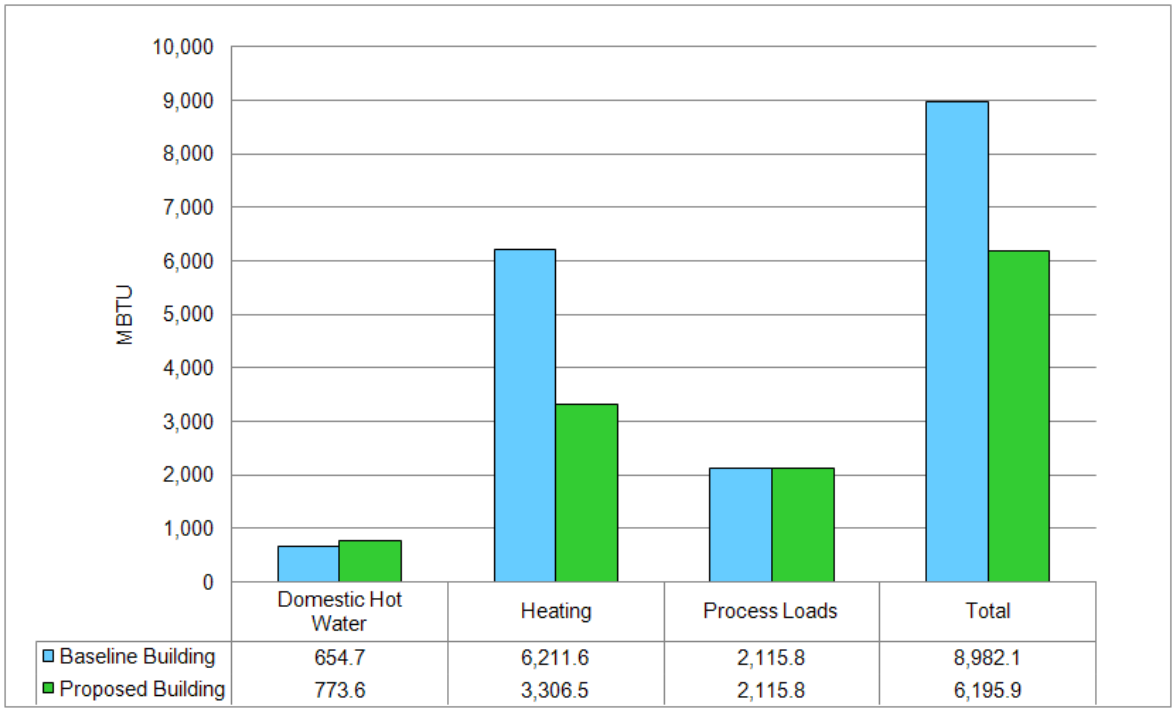


Figure 2-2.2: Baseline vs Proposed Steam and Natural Gas Energy Use

2.3 Baseline Energy Analysis Cost Results

Based on the assumptions stated previously, modeling results for the ASHRAE 90.1-2007 Baseline Building are presented in Figure 2-3. The occupied schedules are based on previous discussions and represent normal classroom hours plus intermittent off-hour usage. The Baseline Building was modeled in the directional orientation shown in the Design Documents. The Baseline Building was then rotated and modeled in orientations that are 90 degrees, 180 degrees, and 270 degrees for that shown in the Design Documents. The results of these model runs were then averaged to calculate the results for the Baseline Building shown herein to meet LEED requirements.

Baseline annual energy cost = $182,336

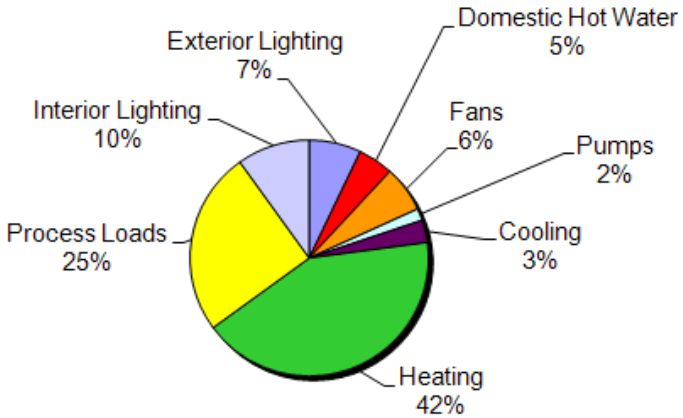


Figure 2-3: Baseline Energy Cost Breakdown

2.4 Proposed Energy Analysis Cost Results

Based on the assumptions stated previously, modeling results for the Proposed Building are presented in Figure 2-4.

Proposed annual energy cost = $133,373

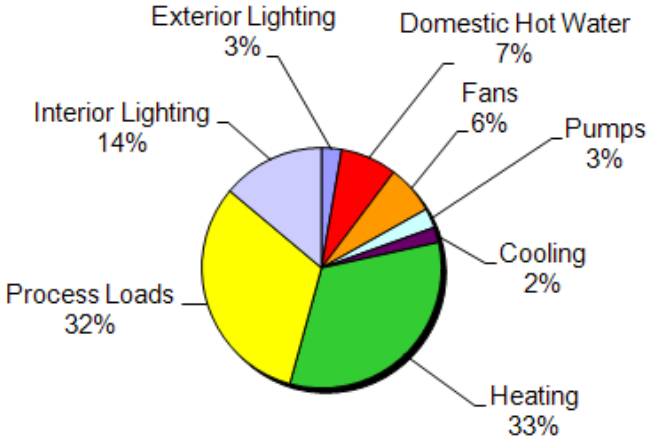


Figure 2-4: Proposed Energy Cost Breakdown

2.5 Process Energy Use

Per LEED requirements, the Baseline Building's process energy use must be at least 25% of the total Baseline Building's energy cost. The Baseline Building has been modeled and analyzed with the process loads as outlined in Sections 2.1.11 and 2.1.15 of this report. Process energy use items have been identified in the LEED EA Prerequisite 2: Minimum Energy Performance template. From the LEED EAP2 template, it has been proven that the Visual Arts Facility process load energy use meets the LEED requirements.

2.6 Renewable Energy – Solar Thermal Collector System

Currently, the building's total energy usage as designed, without solar heating, is approximately 9.636 x 10^9 BTU/yr with the heating portion (including domestic water) equal to 4.08 x 10^9 BTU/yr of the overall total. The designed building, without solar heating, currently shows a 26% energy cost savings above the ASHRAE 90.1 baseline. By incorporating a Solar Thermal Collector Heating System, the total energy cost savings increases to 34% above the baseline.

Table 2-11 is based on theoretical calculations. Actual experience will differ from these calculations due to variations such as weather, building use profile (exhaust and outdoor air requirements), number of students, hours of operations, misc. energy use and/or change in utility rates.

Table 2-11: Solar Thermal Collector Summary

Solar Thermal Collector Summary	**3 Rows**
Estimated Energy Saved (Btu/Avg. Yr)[1]	1,134,329,000
Estimated Energy Saved as a % of Overall Heating	27%
Reduction of Coal used (Short Tons/Avg. Yr)[2]	51
Reduction in Carbon Emissions[3] (Carbon Dioxide, Sulfur Dioxide & Nitrogen Oxide)	108-120 Tons(IP)/Yr

1 Estimated values are based on average value of theoretical building heating load, conditioning of outdoor air used for make-up air and ventilation, domestic water use and schedule of occupancy.

2 Based on 20,770,000 btu per short ton of coal.

Adding the solar thermal collector system will reduce an estimated 5,000 to 6,000 Tons of carbon emissions over the next 50 years, reduce the impact and costs associated with expanding the existing central plant, potential central plant updates to meet future DOE and EPA regulations, as well as providing some independence from a predicted escalation of utility costs. While it may take some time for a traditional return on investment, based on Wyoming's

current low cost of coal, the positive impacts on the environment will be recognized immediately.

2.7 Conclusions

Based on the Energy Analysis, the following conclusions can be made:

Baseline Building Energy Cost: $182,336	**Baseline Building EUI: 176 Kbtu/SF/yr**
Proposed Building Energy Cost: $133,373	**Proposed Building EUI:126 Kbtu/SF/yr**
Prop. Bldg w/ Solar Energy Cost: $118,039	**Prop. Bldg w/ Solar EUI:112 Kbtu/SF/yr**

- The ASHRAE 90.1-2007 Baseline energy model has an annual energy cost of approximately $182,336 and an EUI of 176 Kbtu/SF/yr.
- The current documents analyzed and reviewed herein result in an annual energy cost of approximately $133,373 and an EUI of 126 Kbtu/SF/yr. This provides an estimated annual energy cost savings of 26**%** over the Baseline Building.
- With incorporating the 3-Row Solar Thermal Collection System, the proposed building annual energy cost is reduced to approximately $118,039 and an EUI of 112 Kbtu/SF/yr. This provides an estimated annual energy cost savings of 34**%** over the Baseline Building.
- The proposed building must be modeled with DX cooling per LEED requirements as prescribed in ASHRAE 90.1 2007, Appendix G.
- Exhaust loads must be modeled identical in the baseline and proposed buildings per ASHRAE 90.1 2007, Appendix G. Additional energy savings will be provided with the implementation of timer switches, occupancy sensors and heat recovery. *Innovation in Design credit* shall be attempted to account for this additional energy savings.
- The Solar Thermal Collector Heating System may provide approximately 4 to 6 additional LEED points, depending on exemplary performance and regional priorities associated with EAc1.

Notes:

1. Neither the *proposed building performance* nor the *baseline building performance* are predictions of actual energy consumption or costs for the proposed design after construction. Actual experience will differ from these calculations due to variations in occupancy, building operation and maintenance, weather, energy use not covered by this procedure, changes in energy rates between design of the building and occupancy, and the precision of the calculation tool.
2. A calibrated energy simulation may be performed as part of the LEED Measurement & Verification Credit to reconcile the variations noted above between this energy analysis and the post-occupancy energy consumption. The calibrated simulation may then be used along with metered performance data to diagnose opportunities for energy savings.

Appendix A:

Occupancy Schedules

Occupancy Schedule

Building Closed Schedule

Jan 1- Jan 10 (Winter Break)
March 13 - March 18 (Spring Break)
May 15 - June 13 (Between Semesters)
Aug 7 - Aug 22 (Between Semesters)
Nov 25 - Nov 28 (Thanks Giving Break)
Dec 18 - Dec 31 (Winter Break)

Building Non-Finals Week

Jan 11-March 12
March 19 - May 7
June 14 - Aug 6
Aug 23 - Nov 24
Nov 29 - Dec 10

Building Finals Week

May 8 - May 14
Dec 11 - Dec 17

Office Areas / Student Areas

Area	Occupant	Time of Day	Percentage of occupants S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
	Faculty and Staff	Mdnt -1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0
		1-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0
		2-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		3-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		4-5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		5-6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		6-7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		7-8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		8-9	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.9	0.9	0.9	0.9	0.9	0.0050	0.0050	0.9	0.9	0.9	0.9	0.9	0.0050
		9-10	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.9	0.9	0.9	0.9	0.9	0.0050	0.0050	0.9	0.9	0.9	0.9	0.9	0.0050
		10-11	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.9	0.9	0.9	0.9	0.9	0.0050	0.0050	0.9	0.9	0.9	0.9	0.9	0.0050
		11-Noon	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.9	0.9	0.9	0.9	0.9	0.0028	0.0028	0.9	0.9	0.9	0.9	0.9	0.0028
		Noon-1	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.5	0.5	0.5	0.5	0.5	0.0028	0.0028	0.5	0.5	0.5	0.5	0.5	0.0028
		1-2	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.5	0.5	0.5	0.5	0.5	0.0050	0.0050	0.5	0.5	0.5	0.5	0.5	0.0050
		2-3	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.5	0.5	0.5	0.5	0.5	0.0050	0.0050	0.5	0.5	0.5	0.5	0.5	0.0050
		3-4	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.5	0.5	0.5	0.5	0.5	0.0050	0.0050	0.5	0.5	0.5	0.5	0.5	0.0050
		4-5	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.5	0.5	0.5	0.5	0.5	0.0039	0.0039	0.5	0.5	0.5	0.5	0.5	0.0039
		5-6	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.4	0.4	0.4	0.4	0.4	0.0016	0.0016	0.4	0.4	0.4	0.4	0.4	0.0016
		6-7	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.25	0.25	0.25	0.25	0.25	0.0005	0.0005	0.25	0.25	0.25	0.25	0.25	0.0005
		7-8	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.25	0.25	0.25	0.25	0.25	0.0005	0.0005	0.25	0.25	0.25	0.25	0.25	0.0005
		8-9	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.25	0.25	0.25	0.25	0.25	0.0005	0.0005	0.25	0.25	0.25	0.25	0.25	0.0005
		9-10	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.25	0.25	0.25	0.25	0.25	0.0005	0.0005	0.25	0.25	0.25	0.25	0.25	0.0005
		10-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.25	0.25	0.25	0.25	0.25	0.0	0.0	0.25	0.25	0.25	0.25	0.25	0.0
		11-Mdnt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0

			Percentage of Occupants							Percentage of Occupants							Percentage of Occupants						
	Students	Mdnt -1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		1-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		2-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		3-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		4-5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		5-6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		6-7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		7-8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		8-9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		9-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		10-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.75	0.75	0.75	0.75	0.75	0.75	0.75
		11-Noon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.75	0.75	0.75	0.75	0.75	0.75	0.75
		Noon-1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.75	0.75	0.75	0.75	0.75	0.75	0.75
		1-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.75	0.75	0.75	0.75	0.75	0.75	0.75
		2-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.75	0.75	0.75	0.75	0.75	0.75	0.75
		3-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.75	0.75	0.75	0.75	0.75	0.75	0.75
		4-5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.75	0.75	0.75	0.75	0.75	0.75	0.75
		5-6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		6-7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		7-8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		8-9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		9-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		10-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		11-Mdnt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Appendix B:

Energy Demand of Process Equipment

Energy Demand of Process Equipment

Space	Approximate Equipment Load, kW
Foundry	25,032
Steel Fab	88,644
Electric Kilns	165,200
Clay Recycle	8,320
Paint Resin	600
Ceramics Lab	1,800
Wood Lab	36,540
Sculpture Lab	9,360
Print Making	15,808
Small Metals	27,672
Ceramic Shell	1,176
Sculpture Work Yard	1,656
Invest	1,200
Ceramics Work Yard	49,200

Appendix C:

Building Exhaust Schedules

Building Exhaust Loads

Space	General Exhaust	Min Exhaust	Max Exhaust	Minimum Exhaust Ratio (%)	Assigned Flow Schedule*
Foundry	380	0	10,600	3.58	10
Steel Fab	360	0	9,800	3.67	10
Wax Modler	1,500	0	1,500	100.00	100
Ceramic Shell	3,750	0	3,750	100.00	100
Senior Studios 150J	400	50	400	12.50	10
Plaster	2,200	450	2,200	20.45	20
Sculpture Lab	4,800	1,000	4,800	20.83	20
Paint Resin	5,000	0	5,000	100.00	100
Typical Faculty Studio	400	75	400	18.75	20
Shop Tech	400	0	400	100.00	100
Wood Lab	1,100	230	1,100	20.91	20
Senior Studios 142	920	220	920	23.91	20
Ceramics Lab	3,080	1,200	3,080	38.96	50
Clay Recycling	1200	1,200	0	100.00	100
Plaster Molds	1,800	0	1,800	100.00	100
Electric Kilns	3,000	0	3,840	78.13	66
Glaze Mixing Studio	2,700	2,100	2,700	77.78	66
Chem Storage	600	600	600	100.00	100
Spray 119A	2400	0	2500	100.00	100
Painting Lab	4,785	900	4,785	18.81	20
2D Foundations Lab	800	0	800	100.00	100
3D Foundations Lab	800	0	800	100.00	100
Senoir Studios 242	1415	140	1,415	9.89	10
Small Metals	3,900	900	3,900	23.08	20
Invest	600	30	600	5.00	10
Graphic Design Workroom	800	450	800	56.25	50
Spray Room 233	2500	0	2500	100.00	100
Dark Room	200	25	200	12.5	10
Print Making	4,750	900	4,750	18.95	20
Total:	**56,540**	**10,470**	**75,940**		

*=Refer to Building Exhaust Schedule for assigned Columns

Example: Smaller Non-Zero Value (General or Min EA) / Max EA * 100 = Min EA Ratio --> Assigned Schedule
Max EA is scheduled per the assigned building exhaust column.

Building Exhaust Schedules

Time of Day	10% Exhaust Flow	20% Exhaust Flow	50% Exhaust Flow	66% Exhaust Flow	100% Exhaust Flow	Off
Mdnt -1	0.0	0.0	0.0	0.0	0.0	0.0
1-2	0.0	0.0	0.0	0.0	0.0	0.0
2-3	0.0	0.0	0.0	0.0	0.0	0.0
3-4	0.0	0.0	0.0	0.0	0.0	0.0
4-5	0.0	0.0	0.0	0.0	0.0	0.0
5-6	0.0	0.0	0.0	0.0	0.0	0.0
6-7	0.0	0.0	0.0	0.0	0.0	0.0
7-8	0.0	0.0	0.0	0.0	0.0	0.0
8-9	0.1	0.2	0.5	0.66	1.0	0.0
9-10	1.0	1.0	1.0	1.0	1.0	0.0
10-11	0.1	0.2	0.5	0.66	1.0	0.0
11-Noon	1.0	1.0	1.0	1.0	1.0	0.0
Noon-1	0.1	0.2	0.5	0.66	1.0	0.0
1-2	0.5	0.5	0.5	0.50	1.0	0.0
2-3	0.0	0.0	0.0	0.0	0.0	0.0
3-4	0.0	0.0	0.0	0.0	0.0	0.0
4-5	0.0	0.0	0.0	0.0	0.0	0.0
5-6	0.0	0.0	0.0	0.0	0.0	0.0
6-7	0.0	0.0	0.0	0.0	0.0	0.0
7-8	0.0	0.0	0.0	0.0	0.0	0.0
8-9	0.0	0.0	0.0	0.0	0.0	0.0
9-10	0.0	0.0	0.0	0.0	0.0	0.0
10-11	0.0	0.0	0.0	0.0	0.0	0.0
11-Mdnt	0.0	0.0	0.0	0.0	0.0	0.0

Max EA CFM is scheduled per the assigned building exhaust column.
CFM is multiplied by scheduled factors during occupied hours from Appendix A.

Appendix D:

Plant Efficiency Data

Boiler Efficiency Summary

	2006	2007	2008	2009	2010
Steam Production (lb per year)	350,800,000	370,882,000	394,543,000	382,579,000	411,931,000
Qout (MMBtu steam per year)	373,637	395,026	420,228	407,485	438,748
Qin (MMBtu coal per year)	474,785.63	504,050.46	532,093.37	523,477.68	533,099.76
Annual Plant Efficiency	78.7%	78.4%	79.0%	77.8%	*82.3%

* = Incomplete; Full annual data has not been collected for the 2010 at the time of this report

Data provided to [redacted] from thrid party consultant 08/2010

FY09 DATA

	Aug-08	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	**FY 09**
CEP MEASUREMENTS:	July Data	Aug Data	Sept Data	Oct Data	Nov Data	Dec Data	Jan Data	Feb Data	Mar Data	Apr Data	May Data	June Data	**TOTALS**
COAL													
COAL TONNAGE	693.04	407.14	1,745.70	2,085.39	2,679.35	3,051.54	3,193.84	2,872.05	2,547.87	2,409.05	1,095.29	985.24	23,765.50
COAL MMBTU, As- Received	15,458.95	9,255.11	39,052.01	45,212.09	58,742.07	67,325.52	69,436.79	62,228.99	56,309.73	53,851.07	24,519.05	22,086.30	523,477.68
COAL COST TOTAL	37,446.52	22,213.81	93,967.34	110,717.28	141,831.98	163,256.97	167,177.92	150,449.12	136,213.25	131,964.90	60,730.78	53,049.47	1,269,019.34
COAL COST $/MMBTU	2.42	2.40	2.41	2.45	2.41	2.42	2.41	2.42	2.42	2.45	2.48	2.40	2.42
COAL COST $/Ton	54.03	54.56	53.83	53.09	52.94	53.50	52.34	52.38	53.46	54.78	55.45	53.84	53.40
GAS AT CEP COST													
MMBTU of gas at CEP	-	-	-	-	-	-	-	-	-	-	-	7,674.10	7,674.10
GAS AT CEP COST	-	-	-	-	-	-	-	-	-	-	-	62,885.50	62,885.50
CHILLED WATER													
CEP chilled water ton-hours BY CHLR	275,397.20	364,522.70	280,682.20	271,280.60	78,122.20	-	-	-	13,162.50	44,402.40	235,848.30	253,191.50	1,816,609.60
CEP chilled water ton-hours BY FP	-	-	-	-	71,489.70	128,849.80	112,320.00	110,448.50	89,488.40	19,274.70	-	-	531,871.10
Peak chilled water Demand - Tons	838.00	1,055.00	932.00	902.00	394.00	-	-	-	394.00	524.00	677.00	779.00	1,055.00
STEAM													
STEAM PRODUCTION /lbs	13,842,000	6,798,000	22,764,000	34,932,000	40,224,000	50,745,000	51,265,000	42,330,000	42,085,000	36,305,000	24,113,000	17,176,000	382,579,000
CAMPUS WIDE MEASUREMENTS													
MMBTU of gas	2,411.40	2,666.00	4,106.70	5,695.70	8,371.80	17,092.90	14,557.20	16,522.60	10,629.70	11,507.20	7,210.40	12,304.40	113,076.00
COST OF GAS	$ 33,478.51	$ 31,373.14	$ 26,444.45	$ 64,950.28	$ 91,023.58	$ 173,005.11	$ 162,030.18	$ 149,945.58	$ 105,929.81	$ 95,350.82	$ 47,475.59	$ 98,772.25	$ 1,079,779.30
Average Cost $/MMBTU	$ 13.88	$ 11.77	$ 6.44	$ 11.40	$ 10.87	$ 10.12	$ 11.13	$ 9.08	$ 9.97	$ 8.29	$ 6.58	$ 8.03	$ 9.55
Gallons of Propane	0	0	710.1	465.4	300.3	-	1,249.50	1,031.30	331.40	469.70	578.60	1,279.30	6,415.60
Cost of Propane	$ 210.00	$ -	$ 1,772.02	$ 1,215.48	$ 690.39	$ -	$ 2,702.96	$ 2,414.60	$ 693.71	$ 865.17	$ 1,008.70	$ 2,246.08	$ 13,819.11
Average Cost $/gal			$ 2.50	$ 2.61	$ 2.30		$ 2.16	$ 2.34	$ 2.09	$ 1.84	$ 1.74	$ 1.76	$ 2.15
KWH - CAMPUS	5,113,808	5,175,202	4,512,246	5,835,420	5,828,964	6,251,962	5,354,653	5,757,903	5,659,303	5,455,407	5,561,285	5,518,302	66,024,455
KWH - CAMPUS COST	$ 296,547.75	$ 297,100.96	$ 276,874.69	$ 357,515.43	$ 347,223.84	$ 345,218.53	$ 310,944.37	$ 329,122.16	$ 330,177.25	$ 318,011.76	$ 325,938.45	$ 329,132.52	$ 3,863,807.71
Average $/KWH Cost	$ 0.0580	$ 0.0574	$ 0.0614	$ 0.0613	$ 0.0596	$ 0.055	$ 0.058	$ 0.057	$ 0.058	$ 0.058	$ 0.059	$ 0.060	$ 0.059
Off Campus KWH	84,745	76,150	90,031	104,314	102,648	114,241	123,024	112,525	116,055	101,912	84,456	94,191	1,204,292
Off Campus Elec. Cost	$ 9,518.58	$ 8,400.45	$ 9,028.84	$ 10,873.48	$ 11,257.78	$ 11,653.51	$ 13,165.21	$ 12,443.31	$ 12,373.55	$ 11,462.73	$ 10,000.04	$ 10,019.34	$ 130,196.82
Off Campus $/KWH	$ 0.1123	$ 0.1103	$ 0.1003	$ 0.1042	$ 0.1097	$ 0.1020	$ 0.1070	$ 0.1106	$ 0.1066	$ 0.1125	$ 0.1184	$ 0.1064	$ 0.1081
City Water Usage KGal	13,818	28,717	17,974	14,845	11,891	8,618	8,571	6,774	10,198	9,657	9,148	12,837	153,048
CIty Water Cost	$ 55,834.86	$ 84,944.49	$ 67,641.25	$ 60,103.74	$ 62,512.02	$ 47,340.43	$ 47,604.02	$ 38,647.86	$ 53,646.67	$ 50,833.29	$ 48,536.71	$ 56,391.48	$ 674,036.82
Average Cost $/Kgal	$ 4.041	$ 2.958	$ 3.763	$ 4.049	$ 5.257	$ 5.493	$ 5.554	$ 5.705	$ 5.261	$ 5.264	$ 5.306	$ 4.393	$ 4.404
RLDS Water Usage Kgal	6,011	9,600	6,470	4,302	4,276	3,349	3,207	2,601	3,758	3,420	3,299	4,507	54,800
RLDS Water Cost	$ 29,104.64	$ 44,672.57	$ 31,832.95	$ 23,576.66	$ 22,083.05	$ 18,003.94	$ 17,341.42	$ 15,011.56	$ 19,735.82	$ 18,240.17	$ 17,747.50	$ 23,067.40	$ 280,417.68
RLDS Water $/Kgal	$ 4.8419	$ 4.6534	$ 4.9201	$ 5.4804	$ 5.1644	$ 5.38	$ 5.41	$ 5.77	$ 5.25	$ 5.33	$ 5.38	$ 5.12	$ 5.12
Fine Arts Well Kgal usage	3,139.4	7,000.0	9,200.0	6,130.0	-	-	-	-	-	-	6,062.80	10,430.70	41,962.90
15th and Willett Well Kgal usage	6,860.2	791.3	3,410.3	1,171.2	-	-	-	-	-	-	201.60	255.30	12,689.90
City land fill fees	$ 3,712.20	$ 3,529.50	$ 4,854.90	$ 7,485.25	$ 3,701.50	$ 3,638.20	$ 3,703.00	$ 4,763.40	$ 4,235.00	$ 3,928.25	$ 3,668.95	$ 3,603.00	$ 50,823.15
City land fill quantities, CY	500	470	645	1015	490	538	500	630	580	530	490	480	6,868
Monthly Utility Cost w/o RLDS H2O	$ 436,748.42	$ 447,562.35	$ 480,583.49	$ 612,860.94	$ 658,241.09	$ 744,112.75	$ 707,327.66	$ 687,786.03	$ 643,269.24	$ 612,416.92	$ 497,359.22	$ 553,214.14	$ 7,081,482.25
Monthly Utility Accounts													
CEP Utility Acc FT2010-12316 Transfers In/Out	$6,332,539.00	$ 65,000.00	$ -	$ -	$ -	-	-	11.60	3.65	9.20	166,746.97	4.75	11.60
CEP Utility Acc FY2010-12316 usage	$ 3,768.87	$ 385,296.97	$ 447,513.19	$ 475,803.71	$ 119,907.44	$ 1,090,208.09	$ 511,444.74	$ 586,554.77	$ 917,519.45	$ 422,887.26	$ 864,881.82	$ 738,499.66	$ 6,564,285.97
CEP Utility AccFY2010-12316 ending balance	$6,328,770.13	$ 6,008,473.16	$5,560,959.97	$ 5,085,156.26	$4,965,248.82	$ 3,875,040.73	$ 3,363,595.99	$ 2,777,041.22	$ 1,859,521.77	$1,436,634.51	$ 738,499.66	$ -	$ -
CEP - State FY2010-12309 Transfers In/Out	$ 249,040.00	$ -	$ -	$ -	$ -	$ -	$ -	$ (5,000.00)	$ -	$ (2,000.00)	$ 40,000.00	$ -	$ -
CEP - State FY2010-12309 usage	$ 207.93	$ 704.60	$ 66,711.92	$ 6,127.43	$ 12,307.12	$ 1,278.21	$ 1,545.02	$ 49,915.62	$ 1,001.18	$ 67,736.21	$ 6,266.40	$ 68,238.36	$ 282,040.00
CEP - State FY2010-12309 balance	$ 248,832.07	$ 248,127.47	$ 181,415.55	$ 175,288.12	$ 162,981.00	$ 161,702.79	$ 159,337.77	$ 105,242.15	$ 104,240.97	$ 31,058.18	$ 64,791.78	$ 13,020.94	$ -
CEP - Local FY2010-17767Transfers	$ -	$ -	$ -	$ -	$ 189,312.06	$ -	$ -	$ -	$ -	$ -	$ -	$ 23,000.00	$ -
CEP - Local FY2010-17767 usage	$ 2,984.71	$ 5,074.08	$ 9,578.11	$ -	$ (17,011.06)	$ 2,753.06	$ 4,314.76	$ 3,583.63	$ 3,507.99	$ 4,137.20	$ 3,459.43	$ 17,865.54	$ 23,000.00
CEP - Local FY2010-17767 bal.	$ (174,659.87)	$ (179,733.95)	$ (189,312.06)	$ (189,312.06)	$ 17,011.06	$ 14,258.00	$ 9,943.24	$ 6,359.61	$ 2,851.62	$ (1,285.58)	$ (4,745.01)	$ 389.45	$ -
UTH FY2010-13627 Transfers for month	$ -	$ -	$ -	$ -	$ (189,312.06)	$ -	#REF!	#REF!	#REF!	#REF!	#REF!	$ (23,000.00)	#REF!
UTH FY2010-13627 usage for month	$ 469,042.93	$ 75,412.14	$ 40,706.82	$ 243.58	$ 1,116.92	$ -	$ 13,241.79	$ -	$ -	$ -	$ -	$ 60,430.77	$ 660,194.95
UTH FY2010-13627 received for month	$ 95,980.58	$ 15,002.16	$ 66,018.50	$ 443,161.79	$ 58,942.34	$ 58,550.93	$ 129,325.23	$ 107,426.79	$ 81,207.79	$ 126,314.66	$ 159,396.65	$ 292,624.54	$ 1,633,951.96
UTH FY2010-13627 month end Bal.	$ 165,606.16	$ 105,196.18	$ 130,507.86	$ 573,426.07	$ 441,939.43	$ 500,490.36	$ 616,573.80	$ 724,000.59	$ 805,208.38	$ 931,523.04	$ 1,090,919.69	$ 1,300,113.46	
Steam leaving pressure (psig)	130	130	130	130	130	130	130	130	130	130	130	130	130
Atmospheric pressure (patm)	11.34	11.34	11.34	11.34	11.34	11.34	11.34	11.34	11.34	11.34	11.34	11.34	11.34
Temperature condensate (F)	160	160	160	160	160	160	160	160	160	160	160	160	160
Temperature boiler feed water (F)	207.5	207.5	207.5	207.5	207.5	207.5	207.5	207.5	207.5	207.5	207.5	207.5	207.5
Temperature boiler steam (F)	348.5	348.5	348.5	348.5	348.5	348.5	348.5	348.5	348.5	348.5	348.5	348.5	348.5
Enthalpy boiler condensate, sat liquid (Btu/lb)	128	128	128	128	128	128	128	128	128	128	128	128	128
Enthalpy boiler feed water, sat liquid (Btu/lb)	173	173	173	173	173	173	173	173	173	173	173	173	173
Enthalpy boiler leaving steam, sat vapor (Btu/lb)	1193.1	1193.1	1193.1	1193.1	1193.1	1193.1	1193.1	1193.1	1193.1	1193.1	1193.1	1193.1	1193.1
Steam Production (lb/month)	13,842,000	6,798,000	22,764,000	34,932,000	40,224,000	50,745,000	51,265,000	42,330,000	42,085,000	36,305,000	24,113,000	17,176,000	382,579,000
Qout (MMBtu steam)	14,743	7,241	24,246	37,206	42,843	54,048	54,602	45,086	44,825	38,668	25,683	18,294	407,485
Qin (MMBtu coal)	15,458.95	9,255.11	39,052.01	45,212.09	58,742.07	67,325.52	69,436.79	62,228.99	56,309.73	53,851.07	24,519.05	22,086.30	523,477.68
Plant efficiency	95.4%	78.2%	62.1%	82.3%	72.9%	80.3%	78.6%	72.5%	79.6%	71.8%	104.7%	82.8%	77.8%

Data provided to [redacted] from thrid party consultant 08/2010