



January 17, 2008

**REPORT FOR
Candlewood Suites
Rolla, Missouri
Commercial Building Modeling Energy Engineering Services**

Building Energy Use Comparison

**ASHRAE 90.1 Reference Building Design
vs.
Proposed Energy Efficient Design**

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THIS PRELIMINARY ANALYSIS AND REPORT DOES NOT GUARANTEE CERTIFICATION FOR THE FEDERAL TAX DEDUCTION.

Energy Use Comparison Report

Guaranteed Watt Saver (GWS) is pleased to provide the following report for DOE2.1 Modeling engineering services for the Candlewood Suites Project in Rolla, Missouri.

About GWS

GWS is a professional engineering firm licensed in Oklahoma, Texas, Alabama, Florida, Georgia, Louisiana, Mississippi, New Mexico, North Carolina, South Carolina, Kansas, Colorado, Missouri, Nevada, Illinois, and Wisconsin.

GWS specializes in energy and indoor environmental quality. GWS corporate offices are in Oklahoma City. GWS performs residential and commercial building science consulting, energy engineering and building commissioning. Using our building science expertise, we analyze the interaction among the various materials, products and systems used in building construction, the occupants of the buildings and the environments in which they are located. We evaluate and test designs, installations and equipment to reduce costs, improve indoor environmental quality, and improve occupant comfort.

Scope of the Candlewood Suites Project

The Candlewood Suites in Rolla, Missouri is a three-story 37,000 sq. ft. hotel building. The building is rectangular with approximate dimensions of 244' by 51'. The main entrance is an all-glass sliding door located at the front and center of the building. The main entrance faces south. Entrances are also provided at the sides and the rear of the building. The overall **window-to-wall ratio is limited to 9%** including the entrance doors. Wall construction consists of wood or metal studs with insulation and EIFS exterior. The roof is flat with a slight pitch for drainage. The roof is insulated. The roof covering is single-ply EPDM. The slab floor has rigid edge and perimeter insulation. Figure 1 is a photo of a Candlewood Suites building of the type modeled in this study.

Figure 1



Marlon Peterson of Demilec, LLC and Slone Architects Planners, AIA provided drawings, plans, sketches and builder specifications for a typical Candlewood building design similar to the Rolla, Missouri Hotel. GWS used this information to develop the building model.

Purpose – Energy Savings Tax Deduction

Marlon Peterson requested GWS to model and analyze the effects of building energy savings performance for an energy efficient Proposed Design vs. an ASHRAE 90.1 2001 Reference building. The purpose of the analysis was to develop preliminary design criteria to ensure that the Candlewood Suites Hotel would qualify for the Commercial Building Energy Savings Federal Tax Deduction. This Federal Tax Deduction is defined in the Energy Policy Act of 2005 administered by the US Department of Energy (DOE).

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Building Modeling and Simulation Methodology

The modeling was performed using VisualDOE building simulation software. VisualDOE is packaged with the latest version of DOE2.1E from Lawrence Berkeley National Laboratory. VisualDOE covers all major building systems including lighting, daylighting, HVAC, water heating, and the building envelope. VisualDOE computer software is qualified by the EERE Building Technologies Division of the USDOE and has been tested in a wide variety of commercial building projects. It, therefore, provides a clear and fair assessment of any differences in the energy performances of the ASHRAE Reference and the Proposed Energy Efficient Design for the Candlewood building.

External loads applied in the Candlewood building simulation were taken from hourly weather and solar BIN data typical for the Rolla, MO area. Internal loads consisted of people, equipment and lighting. Air infiltration, ventilation and exhaust conditions were included in the analysis. Occupancy and operation schedules were also applied in the simulation.

The HVAC equipment used in this analysis consists of packaged heat pump room units and packaged heat pump units located on the roof of the building. Electricity powers the heating and cooling. Natural gas provides the water heating for the whole facility. Each zone/unit has its own thermostat.

Comfort condition results are manifested in the DOE2.1 simulation by unmet cooling (under-cooled) and heating (under-heated) hours which occur during the imposed weather and solar conditions for the Rolla area. ASHRAE 90.1 requires that the total unmet hours must be less than 300 per year. In these Candlewood building energy simulation trials, HVAC sizes and CFMs were adjusted to maintain less than 300 unmet hours. The results provide a fair apples-to-apples comparison.

Results

Table 1 shows the results of the DOE2.1 energy savings performance analysis for the ASHRAE Reference Building vs. the Current Building design. Note that in Table 1, the interior lighting systems, heating, cooling, ventilation and hot water systems, and building envelope that are planned to be incorporated into the Current Building design will reduce the total annual energy and power costs by 24% (percent) as compared to the Reference Building that meets the minimum requirements of ASHRAE Standard 90.1-2001.

Table 1 Energy Savings of Current Building Design vs. ASHRAE Reference

CANDLEWOOD SUITES							
Old Wire Outer Road, Rolla, Missouri							
Energy Use Summary (this building uses gas heating)							
	Reference Building Usage			Current Design Building Usage			
Front Azimuth	180 deg.		Average	180 deg.			
	Energy Used	Energy Price	Energy Cost	Energy Used	Energy Price	Energy Cost	
Electricity	kWhr/year	\$/kWhr	\$/year	kWhr/year	\$/kWhr	\$/year	
Lights	138407			108751			
Cooling	157043			169931			
Heating	227293			204244			
Fans	345771			311232			
Hot Water	0			0			
	868514	0.07	\$ 60,795.98	794158	0.07	\$ 55,591.06	
	Energy Used	Energy Price					
Natural Gas	MMBtu/year	\$/MMBtu					
Heating	4291.1	8	\$ 34,328.80	2132.9	8	\$ 17,063.20	
TOTAL ENERGY COST			\$ 95,124.78			\$ 72,654.26	
			Savings,	\$/year	\$	22,470.52	
				%		23.6%	

Although the current design is considerably more energy efficient than the ASHRAE Reference, the Current Building design **will not meet** the requirements for the Commercial Building Energy Savings Federal Tax deduction.

Table 2 shows the results of the DOE2.1 energy savings performance analysis for the ASHRAE Reference Building vs. the design recommended/proposed in this study.

Table 2 Energy Savings of Proposed Building Design vs. ASHRAE Reference

CANDLEWOOD SUITES							
Old Wire Outer Road, Rolla, Missouri							
Energy Use Summary (this building uses gas heating)							
	Reference Building Usage				Proposed Building Usage		
Front Azimuth	180 deg.			Average	180 deg.		
	Energy Used	Energy Price		Energy Cost	Energy Used	Energy Price	Energy Cost
Electricity	kWhr/year	\$/kWhr		\$/year	kWhr/year	\$/kWhr	\$/year
Lights	138407				49443		
Cooling	157043				74073		
Heating	227293				180446		
Fans	345771				166717		
Hot Water	0				0		
	868514	0.07		\$ 60,795.98	470679	0.07	\$ 32,947.53
	Energy Used	Energy Price			Energy Used	Energy Price	
Natural Gas	MMBtu/year	\$/MMBtu			MMBtu/yea	\$/MMBtu	
Heating	4291.1	8		\$ 34,328.80	1176.0	8	\$ 9,408.00
TOTAL ENERGY COST				\$ 95,124.78			\$ 42,355.53
				Savings, \$/year	\$ 52,769.25		
				%	55.5%		

Note that in Table 2, the interior lighting systems, heating, cooling, ventilation and hot water systems, and building envelope that are planned to be incorporated into the building will reduce the total annual energy and power costs with respect to combined usage of the building’s heating, cooling, ventilation, hot water, and interior lighting systems by 50 percent or more as compared to a Reference Building that meets the minimum requirements of ASHRAE Standard 90.1-2001.

Table 3 is a list identifying the components and features of the interior lighting systems, heating, cooling, ventilation, hot water systems, and of the building envelope, that are recommended for achieving the 50% (or more) energy savings.

Table 3

ENERGY EFFICIENCY FEATURES OF THE CANDLEWOOD SUITES BUILDING	
Energy Efficiency Features Recommended for the Candlewood Building	
Lights	1. Lighting Power Density of 0.85 Watts/sq. ft. or less 2. Occupancy sensors for the Conference Rooms 3. CFLs in at least half of the screw-in bulb fixtures
Building Envelope	4. R-41 roof assembly insulation 5. R-20 wall assembly insulation 6. Grade 1 foam installation in roof and walls for near zero infiltration 7. Windows with U = 0.44 and SHGC = 0.35 or better
Heating, Cooling, Ventilation	8. A/C with SEER = 16 or better; Heat pump with COP = 4 or better 9. Consider the use of ground source heat pumps for the common areas
Domestic Hot Water	10. Water Heater(s) with energy factors of 0.96 or better 11. Low flow bathroom and kitchen fixtures resulting in average usage rate of 1.5 gpm or less 12. Consider the use of desuperheat from ground source heat pumps for water heating

Figures 1 & 2 provide a graphical comparison of the energy end uses in the Candlewood Suites building modeled in this study. Note that equipment power density (plug equipment load) does not change between the building models as defined by the Energy Policy Act.

Figures 3 & 4 show graphically the reductions in energy use by the Current Design (24%) and the Proposed Energy Efficient Design (55%) for the Candlewood Suites.

Appendix A lists some further details regarding the building architecture/construction used in the Proposed Energy Efficient Design modeling/simulation.

Figure 1 Candlewood Suites - Reference Building vs. Current Design

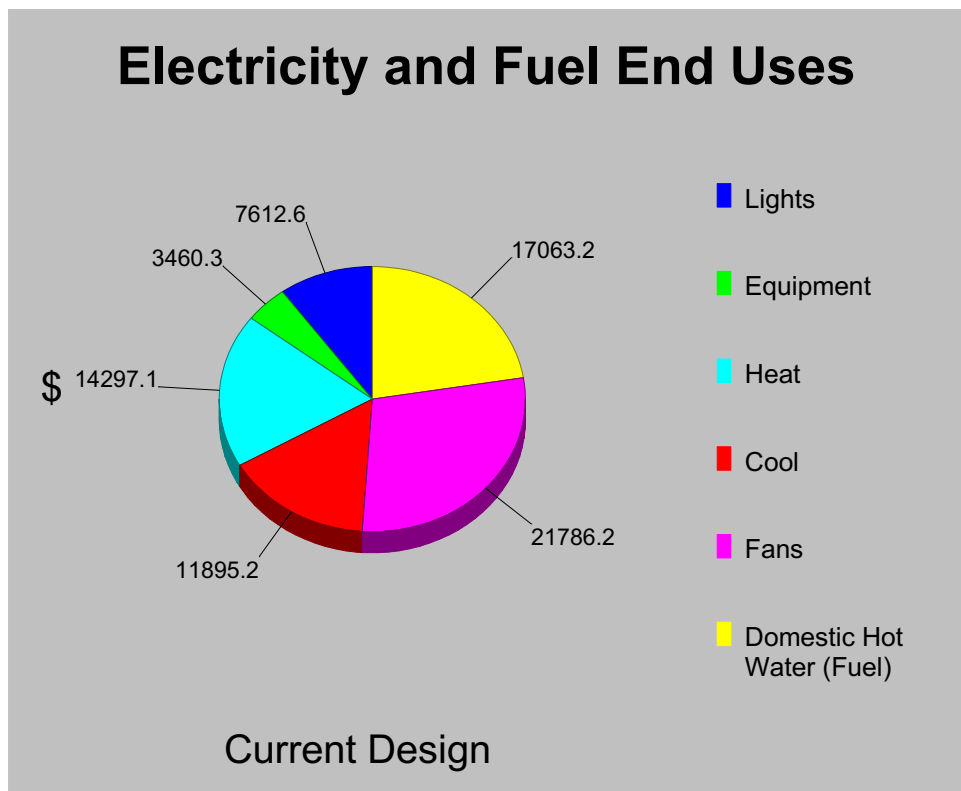
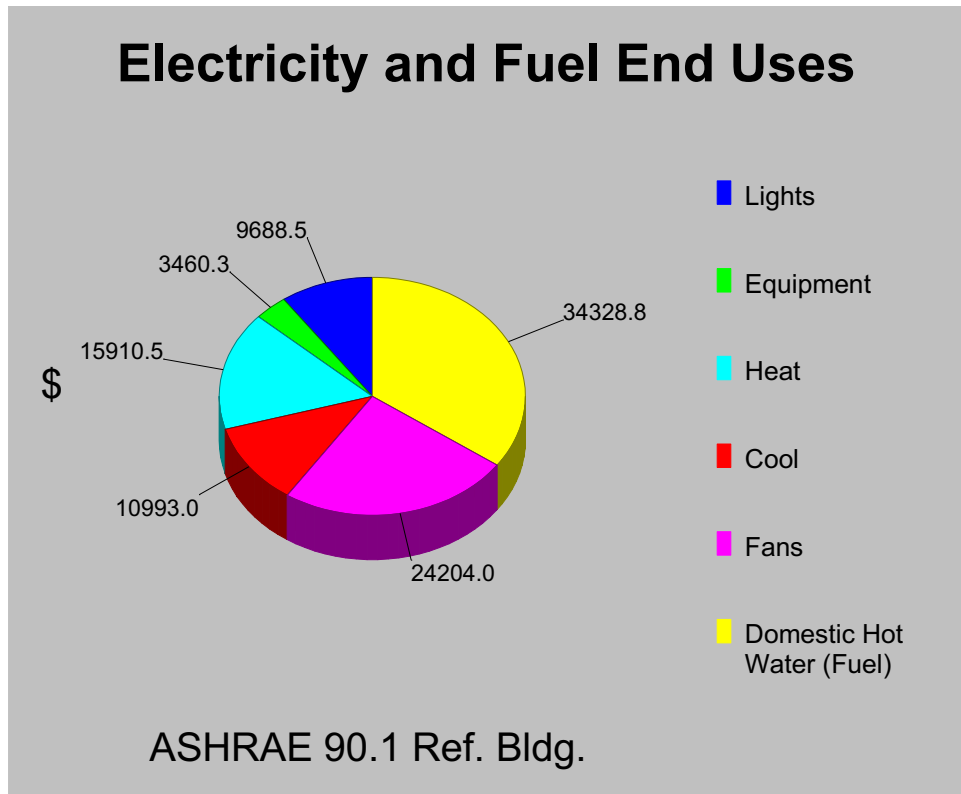


Figure 2 Candlewood Suites - Reference Building vs. Proposed Design

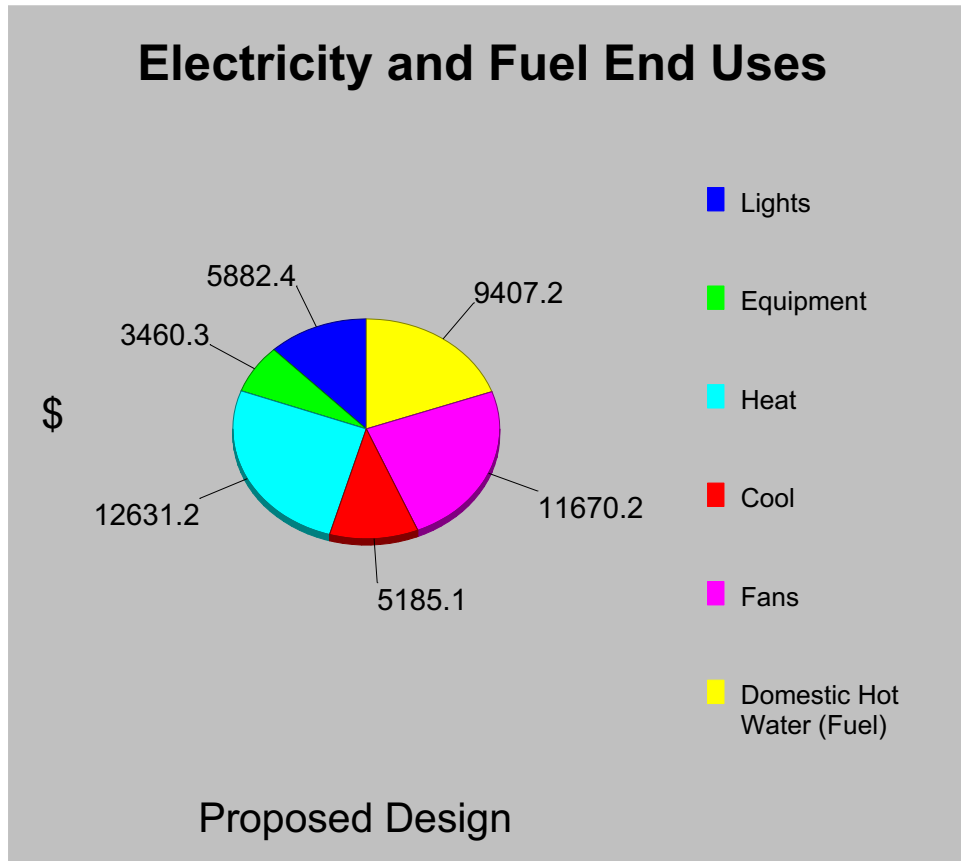
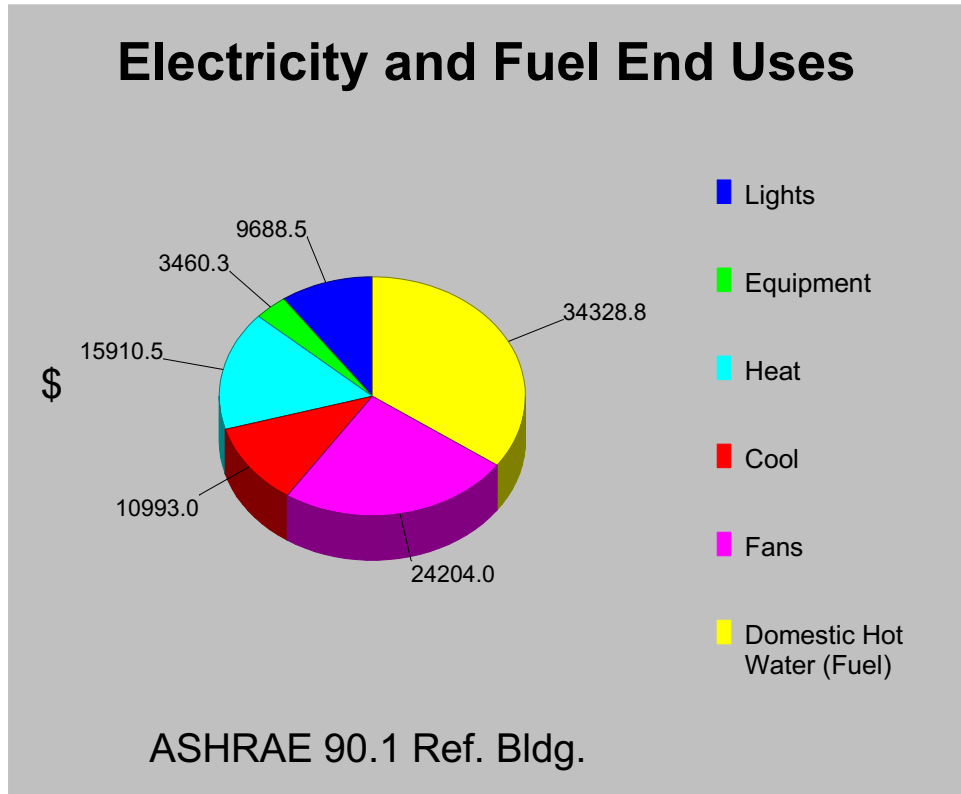


Figure 3 Candlewood Suites - Reference Building vs. Current Design

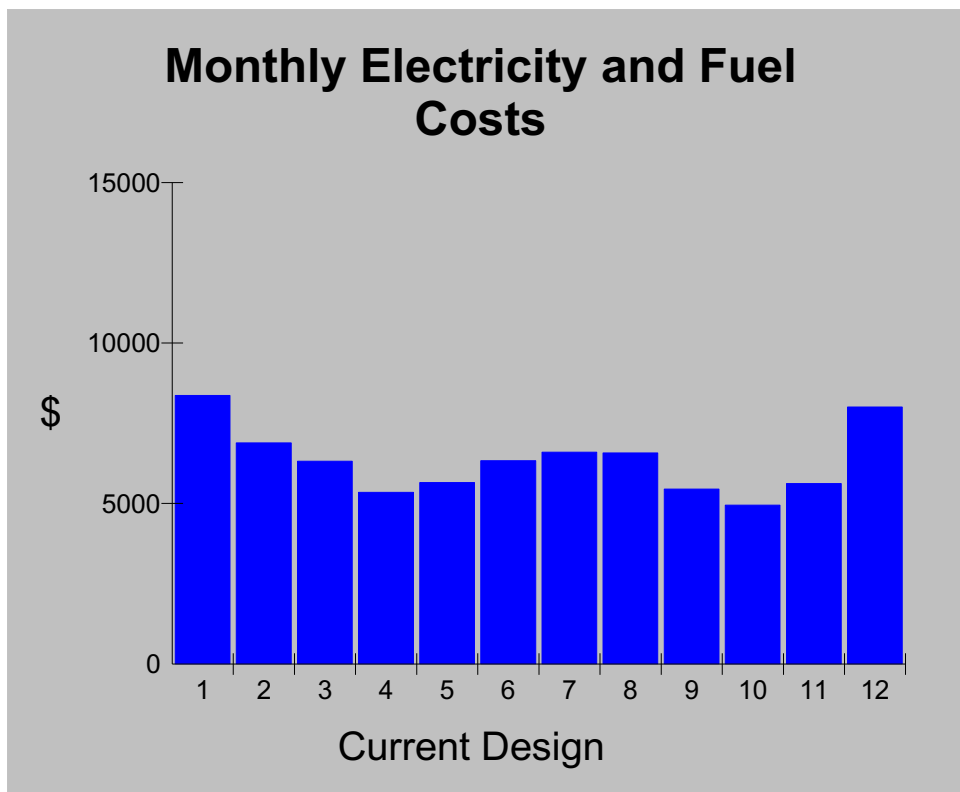
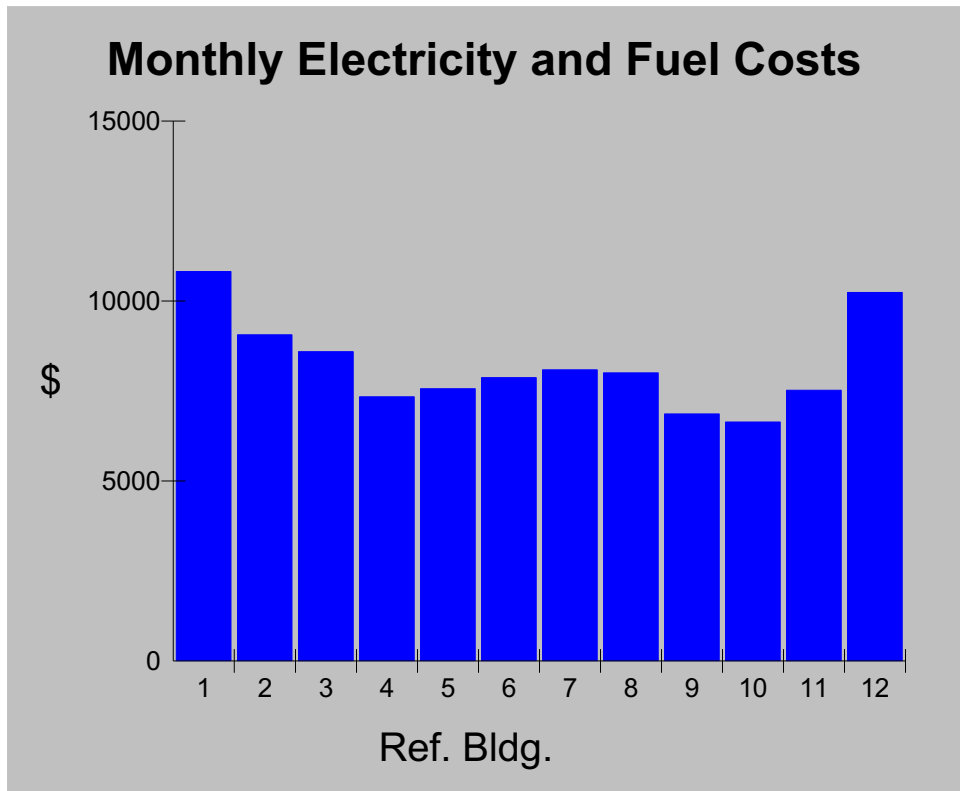
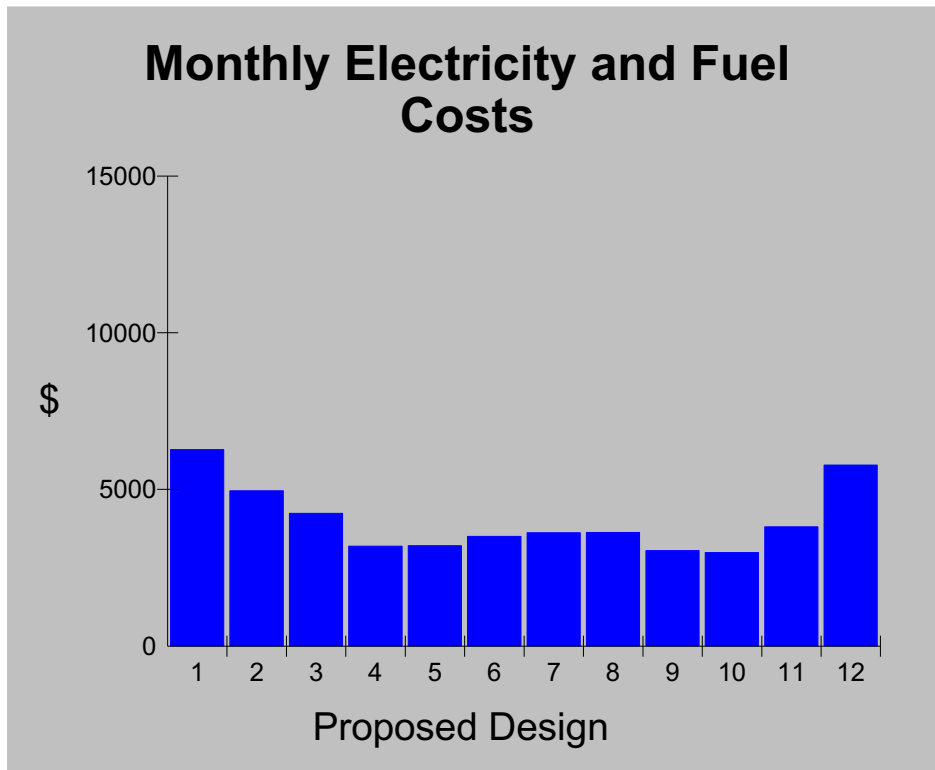
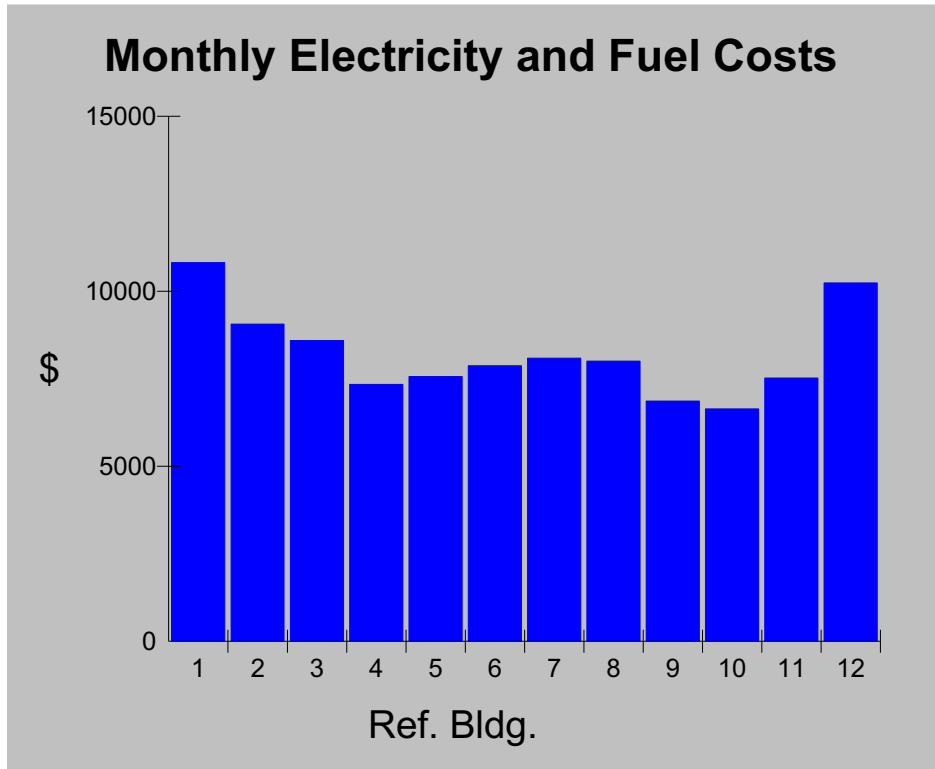


Figure 4 Candlewood Suites - Reference Building vs. Proposed Design



Appendix A (Architectural Parameters for Proposed Design)

Project Information

Name: Candlewood Suites
 Address: Rolla, MO
 Description: Candlewood Suites Test Model
 Analysis done by: Ed Ja @ GWS
 Project File: c:\program files\gdt4\shared\marloncandlewood-1-6-08.gph
 Case Name: Proposed Energy Efficient Design
 Case Description: Proposed Energy Efficient Design using lower capacity HVAC
 Gross Area: 37,332 ft²
 Conditioned Area: 37,332 ft²
 Window-Wall-Ratio: 8.4%
 Skylight-Roof-Ratio: 0.0%
 Number of Blocks: 1
 Note: This report includes floor multipliers

Occupancies Summary

Name	Area (ft ²)	Avg. LPD (W/ft ²)	Avg. EPD (W/ft ²)
Hotel	37,332	0.85	0.5
Building Totals & Averages	37,332	0.85	0.5

Constructions Summary

Name	Net Area (ft ²)	U-Factor (Btu/h-ft ² -°F)	HC (Btu/ft ² -°F)	Absorptance	Type	Category	Layers
Custom Roof, 0.0244, 70%	12,444	0.02	0.93	0.7	Roofs	Light	n.a.
R-7 Mass	12,444	0.13	9.33	0.7	Floors	Light	3
Custom Wall R-20	16,171	0.05	2.45	0.7	Walls	Light	n.a.

Fenestrations Summary

Name	Ucog (Btu/h-ft ² -°F)	SHGC	Tvis	North (ft ²)	East (ft ²)	South (ft ²)	West (ft ²)	Total (ft ²)	No.
4.5x4 G4435	0.440	0.353	0.70	669	51	721	51	1,493	87
Building Totals & Averages	0.440	0.353	0.70	669	51	721	51	1,493	87