

Magnolia HVAC Upgrade Project Report
USF H&RE Facilities Management and
Operations

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Abstract

The existing HVAC equipment for all seven Magnolia student apartment buildings are reaching 15 years of service. Without the USF campus hot and chilled water loops, the equipment is a system of roof-top compressors circulating refrigerant to air handling units for each 4-bedroom apartment residence but accessed from the corridors for servicing. The replacement is required but the proposal is to install more efficient equipment (SEER 16 instead of the required SEER 14) and controls compatible with the Metasys system and individual apartment thermostats. SEER values represent the efficiency of a HVAC system, a higher number represents a higher efficiency.

The majority of the energy used by the Magnolia buildings is in the form of space cooling and maintenance, therefore any gain in efficiency in the HVAC system will result in large energy savings and greenhouse reductions. Housing & Residential Education sees this as an opportunity for energy cost savings and to be in alignment with the university goals of energy savings and a reduced carbon footprint. With the new equipment installed and the controls for operating and monitoring we expect a further reduction in operating costs of around 18%.

Introduction

In the Summer of 2017, all the buildings were renovated with new insulated roofs and new insulated exterior wall assemblies which immediately reduced cooling and heating costs, even with the inefficient aging HVAC equipment as illustrated in figure 1. This upgrade improved the building envelope and provided the groundwork necessary for upgrading the HVAC equipment.

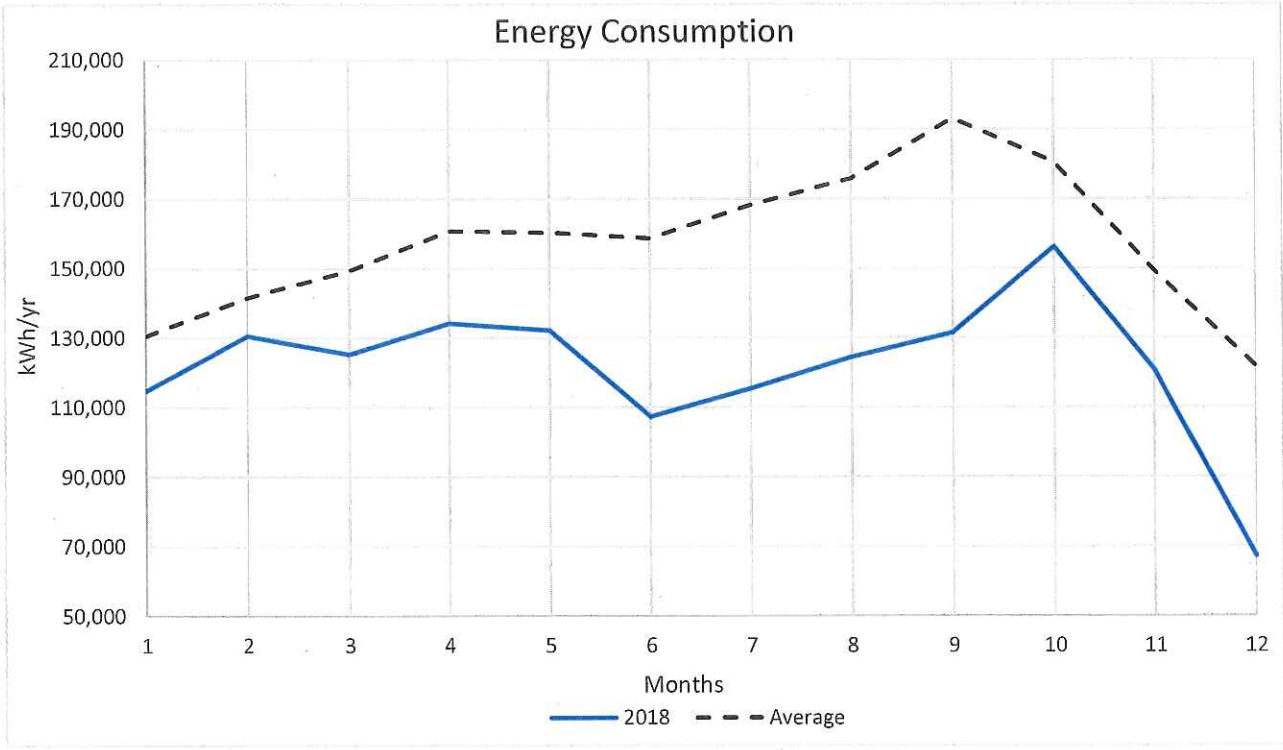


Figure 1. Figure shows the combined energy consumption of all buildings in 2018 after the envelope improvements versus the previous years' average (2006-2016)

The next part of this ongoing process is the replacement of the aging HVAC system with higher efficiency equipment as well as the much-needed addition of controls. The controls will allow remote thermostat setpoint changes and the real-time monitoring of equipment to diagnose problems or potential failures. This will not only reduce equipment downtime, but will also greatly extend the life of the HVAC equipment and the maintenance of it's current efficiency level.

Energy Calculations

The buildings were simulated by a consulting engineering group, CEA. Magnolia consists of 7 residential buildings (MAA, MAB, MAC, MAD, MAE, MAF, MAG) therefore

each building was simulated with the controls and upgraded HVAC system and the energy consumption tabulated for each on a separate page, see Appendix A (each page shows the respective energy calculation for each building and the highlighted portions show building name and energy consumption). This simulation data was used in calculating the potential energy savings and the resulting carbon dioxide reductions as summarized in Table I. All comparisons were done using simulated data to enable accurate projections of savings.

Table I. Summarized data for the energy simulations from Appendix A of existing equipment versus SEER 16 upgrade with controls

Simulated Energy Consumption Comparison			
		Alt-2	Alt-3
		Existing Equipment	SEER 16 Equipment
		(kWh/yr)×10⁻³	
Buildings	MAA	170.3	138
	MAB	169.2	137.4
	MAC	230.5	189.4
	MAD	250.6	206.2
	MAE	248.9	205.2
	MAF	217.7	179.8
	MAG	110.1	91.9
Energy	Total Usage (kWh/yr)	1,397,300	1,147,900
	Annual Energy Savings vs Existing (kWh)		249,400
	Savings (%/yr)		17.85
Cost	Electricity Cost	\$ 125,757.00	\$ 103,311.00
	Annual Cost Savings vs Existing		\$ 22,446.00
Sustainability	Annual GHGR (CO ₂ metric tons)		176
	Annual GHGR (gal gas)		19,841

Results

As demonstrated by the simulated data there will be almost an 18% decrease in the amount of energy consumed. Figure 2 shows the energy reduction of the buildings through the years. The simulations show USF Housing and Residential Education’s commitment to reduce energy consumption and promote sustainability.

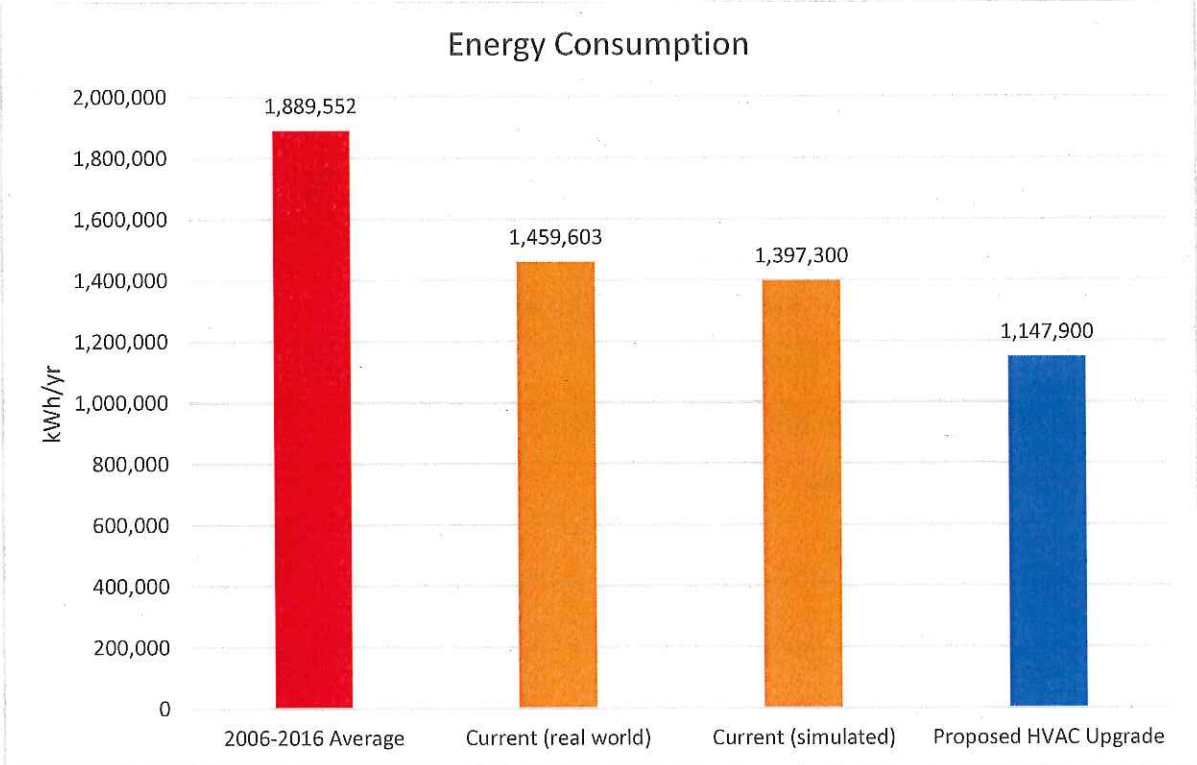


Figure 2. Figure shows the energy reduction achieved by the Magnolia buildings over time.

Project Cost

The majority of the project will be funded by USF H&RE as demonstrated in Table II. The break down of the SGEF request is shown in Table III.

Table II. Project cost

Item	Cost
HVAC Equipment	\$ 1,659,260.17
Controls	\$ 396,507.00
Student Engagement	\$ 1,500.00
Project Grand Total	\$ 2,057,267.71
Matching Funds	\$ 1,784,414.21
SGEF Request	\$ 272,853.50

Table III. SGEF request breakdown

Item	Cost
Difference between SEER16 and SEER14	\$ 73,100.00
Student Engagement	\$ 1,500.00
Half of the controls	\$ 198,253.50
SGEF Total	\$ 272,853.50

Conclusions

The project will lead to a savings of 249,400 kWh/yr. In terms of sustainability this will lead to a reduction of 176 MT/yr of CO₂. This project will not only have benefits for the environment and subsequent student life, but will also continue USF's commitment to be at the forefront of suitability.

Appendix A

Magnolia A

Energy Cost Budget / PRM Summary

By Consulting Engineering Associates, Inc.

Alt-2 represents the aging/existing equipment on the building currently

Alt-3 represents the SEER 16 HVAC system upgrade proposal

Alt-1 represents a SEER 14 replacement

Project Name: Magnolia Apartments MAA-0072 HVAC Repl	Date: February 13, 2019
City: Tampa, Florida	Weather Data: Tampa, Florida

Note: The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

		* Alt-2 Existing			Alt-1 Renovation			Alt-3 Higher EFF Renovation		
		Energy 10 ^{^3} kWh/yr	Proposed /Base %	Peak kW	Energy 10 ^{^3} kWh/yr	Proposed /Base %	Peak kW	Energy 10 ^{^3} kWh/yr	Proposed /Base %	Peak kW
Lighting - Conditioned	Electricity	16.6	9.8	8	16.6	100.0	8	16.6	100.0	8
Space Heating	Electricity	3.5	2.1	6	3.0	85.4	5	1.9	53.0	3
Space Cooling	Electricity	89.3	52.4	25	64.0	71.7	23	59.9	67.1	21
Heat Rejection	Electricity	7.1	4.2	2	6.0	84.0	3	5.9	82.5	3
Fans - Conditioned	Electricity	19.5	11.4	2	19.5	100.0	2	19.5	100.0	2
Receptacles - Conditioned	Electricity	34.2	20.1	8	34.2	100.0	8	34.2	100.0	8
Total Building Consumption		170.3			143.3			138.0		

		* Alt-2 Existing	Alt-1 Renovation	Alt-3 Higher EFF Renovation
Total	Number of hours heating load not met	0	0	0
	Number of hours cooling load not met	0	0	0

		* Alt-2 Existing		Alt-1 Renovation		Alt-3 Higher EFF Renovation	
		Energy 10 ^{^3} kWh/yr	Cost/yr \$/yr	Energy 10 ^{^3} kWh/yr	Cost/yr \$/yr	Energy 10 ^{^3} kWh/yr	Cost/yr \$/yr
Electricity		170.3	15,324	143.3	12,901	138.0	12,421
Total		170	15,324	143	12,901	138	12,421

Magnolia B

Energy Cost Budget / PRM Summary

By Consulting Engineering Associates, Inc.

Project Name: Magnolia Apartments MAB-0073 HVAC REPL	Date: February 13, 2019
City: Tampa, Florida	Weather Data: Tampa, Florida

Note: The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

		* Alt-2 Existing			Alt-1 Renovation			Alt-3 Higher EFF Renovation		
		Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW	Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW	Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW
Lighting - Conditioned	Electricity	16.6	9.8	8	16.6	100.0	8	16.6	100.0	8
Space Heating	Electricity	3.6	2.1	6	3.0	85.4	5	1.9	53.0	3
Space Cooling	Electricity	88.2	52.1	27	63.3	71.8	24	59.3	67.2	22
Heat Rejection	Electricity	7.1	4.2	2	6.0	84.0	3	5.9	82.6	3
Fans - Conditioned	Electricity	19.5	11.5	2	19.5	100.0	2	19.5	100.0	2
Receptacles - Conditioned	Electricity	34.2	20.2	8	34.2	100.0	8	34.2	100.0	8
Total Building Consumption		169.2			142.7			137.4		

		* Alt-2 Existing	Alt-1 Renovation	Alt-3 Higher EFF Renovation
Total	Number of hours heating load not met	0	0	0
	Number of hours cooling load not met	0	0	0

		* Alt-2 Existing		Alt-1 Renovation		Alt-3 Higher EFF Renovation	
		Energy 10 ³ kWh/yr	Cost/yr \$/yr	Energy 10 ³ kWh/yr	Cost/yr \$/yr	Energy 10 ³ kWh/yr	Cost/yr \$/yr
Electricity		169.2	15,231	142.7	12,839	137.4	12,362
Total		169	15,231	143	12,839	137	12,362

Magnolia C

Energy Cost Budget / PRM Summary

By Consulting Engineering Associates, Inc.

Project Name: Magnolia Apartments MAC-0106 HVAC Repl	Date: February 13, 2019
City: Tampa, Florida	Weather Data: Tampa, Florida

Note: The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

		* Alt-2 Existing			Alt-1 Renovation			Alt-3 Higher EFF Renovation		
		Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW	Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW	Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW
Lighting - Conditioned	Electricity	32.3	14.0	11	32.3	100.0	11	32.3	100.0	11
Space Heating	Electricity	5.2	2.2	10	4.4	85.5	8	2.8	53.3	5
Space Cooling	Electricity	111.2	48.2	36	79.3	71.3	29	74.1	66.6	27
Heat Rejection	Electricity	9.4	4.1	3	7.9	84.4	4	7.8	83.0	4
Fans - Conditioned	Electricity	29.1	12.6	3	29.1	100.0	3	29.1	100.0	3
Receptacles - Conditioned	Electricity	43.4	18.8	11	43.4	100.0	11	43.4	100.0	11
Total Building Consumption		230.5			196.4			189.4		

		* Alt-2 Existing	Alt-1 Renovation	Alt-3 Higher EFF Renovation
Total	Number of hours heating load not met	0	0	0
	Number of hours cooling load not met	0	0	0

		* Alt-2 Existing		Alt-1 Renovation		Alt-3 Higher EFF Renovation	
		Energy 10 ³ kWh/yr	Cost/yr \$/yr	Energy 10 ³ kWh/yr	Cost/yr \$/yr	Energy 10 ³ kWh/yr	Cost/yr \$/yr
Electricity		230.5	20,749	196.4	17,680	189.4	17,047
Total		231	20,749	196	17,680	189	17,047

Magnolia D

Energy Cost Budget / PRM Summary

By Consulting Engineering Associates, Inc.

Project Name: Magnolia Apartments MAD-0107 HVAC Repl	Date: February 13, 2019
City: Tampa, Florida	Weather Data: Tampa, Florida

Note: The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

		* Alt-2 Existing			Alt-1 Renovation			Alt-3 Higher EFF Renovation		
		Energy 10 ^{^3} kWh/yr	Proposed / Base %	Peak kW	Energy 10 ^{^3} kWh/yr	Proposed / Base %	Peak kW	Energy 10 ^{^3} kWh/yr	Proposed / Base %	Peak kW
Lighting - Conditioned	Electricity	33.3	13.3	11	33.3	100.0	11	33.3	100.0	11
Space Heating	Electricity	4.5	1.8	9	3.8	85.5	8	2.4	53.2	5
Space Cooling	Electricity	124.4	49.6	36	90.0	72.3	31	83.8	67.3	29
Heat Rejection	Electricity	10.4	4.2	3	8.9	85.2	4	8.7	83.7	4
Fans - Conditioned	Electricity	30.8	12.3	4	30.8	100.0	4	30.8	100.0	4
Receptacles - Conditioned	Electricity	47.2	18.8	12	47.2	100.0	12	47.2	100.0	12
Total Building Consumption		250.6			214.0			206.2		

		* Alt-2 Existing	Alt-1 Renovation	Alt-3 Higher EFF Renovation
Total	Number of hours heating load not met	0	0	0
	Number of hours cooling load not met	0	0	0

		* Alt-2 Existing		Alt-1 Renovation		Alt-3 Higher EFF Renovation	
		Energy 10 ^{^3} kWh/yr	Cost/yr \$/yr	Energy 10 ^{^3} kWh/yr	Cost/yr \$/yr	Energy 10 ^{^3} kWh/yr	Cost/yr \$/yr
Electricity		250.6	22,558	214.0	19,262	206.2	18,559
Total		251	22,558	214	19,262	206	18,559

Magnolia E

Energy Cost Budget / PRM Summary

By Consulting Engineering Associates, Inc.

Project Name: Magnolia Apartments MAE-0108 HVAC Repl	Date: February 13, 2019
City: Tampa, Florida	Weather Data: Tampa, Florida

Note: The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

		* Alt-2 Existing			Alt-1 Renovation			Alt-3 Higher EFF Renovation		
		Energy 10 ^{^3} kWh/yr	Proposed / Base %	Peak kW	Energy 10 ^{^3} kWh/yr	Proposed / Base %	Peak kW	Energy 10 ^{^3} kWh/yr	Proposed / Base %	Peak kW
Lighting - Conditioned	Electricity	33.3	13.4	11	33.3	100.0	11	33.3	100.0	11
Space Heating	Electricity	4.5	1.8	9	3.8	85.5	8	2.4	53.2	5
Space Cooling	Electricity	122.7	49.3	37	88.9	72.4	32	82.8	67.4	29
Heat Rejection	Electricity	10.3	4.2	3	8.8	85.2	4	8.7	83.7	4
Fans - Conditioned	Electricity	30.8	12.4	4	30.8	100.0	4	30.8	100.0	4
Receptacles - Conditioned	Electricity	47.2	19.0	12	47.2	100.0	12	47.2	100.0	12
Total Building Consumption		248.9			212.9			205.2		

		* Alt-2 Existing			Alt-1 Renovation			Alt-3 Higher EFF Renovation		
		Energy 10 ^{^3} kWh/yr	Cost/yr \$/yr	Peak kW	Energy 10 ^{^3} kWh/yr	Cost/yr \$/yr	Peak kW	Energy 10 ^{^3} kWh/yr	Cost/yr \$/yr	Peak kW
Total	Number of hours heating load not met	0			0			0		
	Number of hours cooling load not met	0			0			0		

		* Alt-2 Existing			Alt-1 Renovation			Alt-3 Higher EFF Renovation		
		Energy 10 ^{^3} kWh/yr	Cost/yr \$/yr	Peak kW	Energy 10 ^{^3} kWh/yr	Cost/yr \$/yr	Peak kW	Energy 10 ^{^3} kWh/yr	Cost/yr \$/yr	Peak kW
Electricity		248.9	22,403		212.9	19,160		205.2	18,465	
Total		249	22,403		213	19,160		205	18,465	

Magnolia F

Energy Cost Budget / PRM Summary

By Consulting Engineering Associates, Inc.

Project Name: Magnolia Apartments MAF-0109 HVAC Repl	Date: February 13, 2019
City: Tampa, Florida	Weather Data: Tampa, Florida

Note: The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

		* Alt-2 Existing			Alt-1 Renovation			Alt-3 Higher EFF Renovation		
		Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW	Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW	Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW
Lighting - Conditioned	Electricity	30.3	13.9	10	30.3	100.0	10	30.3	100.0	10
Space Heating	Electricity	4.4	2.0	9	3.7	85.5	7	2.3	53.2	5
Space Cooling	Electricity	104.5	48.0	33	75.3	72.1	28	70.1	67.1	26
Heat Rejection	Electricity	8.8	4.1	3	7.5	84.9	4	7.4	83.4	4
Fans - Conditioned	Electricity	29.2	13.4	3	29.2	100.0	3	29.2	100.0	3
Receptacles - Conditioned	Electricity	40.6	18.6	10	40.6	100.0	10	40.6	100.0	10
Total Building Consumption		217.7			186.5			179.8		

		* Alt-2 Existing	Alt-1 Renovation	Alt-3 Higher EFF Renovation
Total	Number of hours heating load not met	0	0	0
	Number of hours cooling load not met	0	0	0

		* Alt-2 Existing		Alt-1 Renovation		Alt-3 Higher EFF Renovation	
		Energy 10 ³ kWh/yr	Cost/yr \$/yr	Energy 10 ³ kWh/yr	Cost/yr \$/yr	Energy 10 ³ kWh/yr	Cost/yr \$/yr
Electricity		217.7	19,589	186.5	16,787	179.8	16,185
Total		218	19,589	187	16,787	180	16,185

Magnolia G

Energy Cost Budget / PRM Summary

By Consulting Engineering Associates, Inc.

Project Name: Magnolia Apartmets MAG-0110 HVAC Repl	Date: February 13, 2019
City: Tampa, Florida	Weather Data: Tampa, Florida

Note: The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

		* Alt-2 Existing			Alt-1 Renovation			Alt-3 Higher EFF Renovation		
		Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW	Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW	Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW
Lighting - Conditioned	Electricity	14.7	13.3	5	14.7	100.0	5	14.7	100.0	5
Space Heating	Electricity	2.8	2.5	5	2.8	100.0	5	1.8	63.6	3
Space Cooling	Electricity	54.7	49.7	17	39.7	72.6	14	38.3	69.9	13
Heat Rejection	Electricity	4.6	4.1	1	3.9	84.5	2	3.8	83.7	2
Fans - Conditioned	Electricity	13.7	12.5	2	13.7	100.0	2	13.7	100.0	2
Receptacles - Conditioned	Electricity	19.6	17.8	5	19.6	100.0	5	19.6	100.0	5
Total Building Consumption		110.1			94.4			91.9		

		* Alt-2 Existing	Alt-1 Renovation	Alt-3 Higher EFF Renovation
Total	Number of hours heating load not met	0	0	0
	Number of hours cooling load not met	0	0	0

		* Alt-2 Existing		Alt-1 Renovation		Alt-3 Higher EFF Renovation	
		Energy 10 ³ kWh/yr	Cost/yr \$/yr	Energy 10 ³ kWh/yr	Cost/yr \$/yr	Energy 10 ³ kWh/yr	Cost/yr \$/yr
Electricity		110.1	9,906	94.4	8,494	91.9	8,267
Total		110	9,906	94	8,494	92	8,267