Energy and Water Conservation Report Format
Projects Over $10M Construction Cost

Executive Summary

Energy conservation measures (ECMs) were evaluated using ASHRAE 90.1 Appendix G procedures. Appendix G requires estimated savings be compared to a *Baseline Building* that exactly meets ASHRAE 90.1 energy code requirements.

The version of the ASHRAE standard that this project was evaluated against was ASHRAE 90.1-

The estimated total annual cost savings by implementing the recommended ECMs is , which is equivalent to an annual percent savings of compared to a ASHRAE 90.1 *Baseline Building*.

The estimated total annual water savings by implementing the recommended water conservation measures is , which is equivalent to an annual percent savings of compared to a building complying with the Michigan Plumbing Code.

Table 1: Recommended ECMs (ECM Interactions Not Accounted For)

Table 1 lists all the ECMs that are recommended for implementation on this project. It indicates the savings potential for each ECM without regard to the impact ECMs may have upon one another. Because of such "interactions", the actual cost savings for some ECMs will be less than when they are analyzed on a stand-alone basis. For example, the savings from an ECM that reduces lighting energy will be partially offset by increased space heating requirements due to less light energy heating the space. Table 2 accounts for such ECM interactions.

Table 1: Recommended ECMs (ECM interactions not accounted for)

ECM No.	Description	Dollars/Year Savings	First Cost
1c	Increase Wall Insulation to 2.75"	$18,400	$350,000
2b	Improved Window Performance, SHGC = 0.33, U = 0.44	$8,000	$190,000
3	Day Lighting Sensors, Atrium	$12,000	$42,000
4	Desiccant Wheel	$40,000	$200,000
5	Exterior Shades, South Façade	$15,000	$78,000
6	Increase Thermostat Deadband	$7,000	$0
7	Install Free Cooling System	$55,000	$350,000
	Total First Cost:		$1,210,000
	Total Savings (no interactions accounted for):	**$155,400**	

Table 2: Summary ECM Savings (with ECM Interactions)

Table 2 reports the total estimated ECM savings with ECM interactions taken into account. Where combinations of ECMs are listed, it indicates that those ECMs interact with one another and therefore had to be analyzed as a group.

Table 2: Summary ECM Savings (with ECM interactions)

ECM No.	Description	Dollars/Year Savings
Combo 1	Combines ECMs 1c,2b,3,5	$50,300
ECM 4	Desiccant Wheel	$40,000
ECM 6	Increase Thermostat Deadband	$7,000
ECM 7	Install Free Cooling System	$55,000
	Total Savings (interactions accounted for):	**$152,300**

Table 3: Energy Conservation Predicted Results

Table 3 indicates the percent savings for versus a similar building constructed to exactly meet energy code requirements. The estimated annual energy cost for the building without the recommended ECMs is presented first; the energy cost for the same building with the recommended ECMs implemented is presented second.

Table 3: Energy Conservation Predicted Results[1]

Estimated Energy Costs w/o ECMs[2]	Dollars/Year
ASHRAE Base Building	$420,000
Elevators	$15,000
Process Cooling	$12,000
Outdoor Lights	$4,200
Total Energy Cost w/o ECMs:	$451,200
Estimated Annual Energy Cost Avoidance w/ECMs:	**$152,300**
Estimated Percentage Cost Avoidance:	**34%**
Total Estimated First Cost of ECMs:	**$1,210,000**
Over-all Simple Payback (years):	**7.9**

Note 1: Compared to a baseline ASHRAE building using ASHRAE 90.1 Appendix G methodology. Actual energy use and savings may vary due to occupancy levels, occupancy schedules, utility rates, and other factors different than assumed in the analysis.
Note 2: Energy use break-down reported per ASHRAE 90.1 Appendix G requirements.

Table 4: Estimated Annual Savings in Energy Units, per ECM

Table 4 reports the estimated savings in energy units, with ECM interactions taken into account. Where combinations of ECMs are listed, it indicates that those ECMs interact with one another and therefore had to be analyzed as a group.

Table 4: Estimated Annual Savings in Energy Units, per ECM

ECM No.	Description	KWH/Year Savings	Therms/Year Savings
Combo 1	Combines ECMs 1c,2b,3,5		
ECM 4	Desiccant Wheel		
ECM 6	Increase Thermostat Deadband		
ECM 7	Install Free Cooling System		
		Total:	

Table 5: Water Conservation Measures and Predicted Results

Table 5 indicates the water saving measures and resulting percent water savings predicted for this project versus a project constructed to meet building code requirements (building code requirements are based on Energy Policy Act of 1992 fixture performance dictates). The requirement of U-M Design Guideline 3.2 is for designs to provide projects that use 20% less water than projects designed to exactly meet the building code.

Table 5: Water Conservation

Water Conservation Measure	Estimated Annual Savings (Gallons)
Dual Flush Water Closets	7,000
Waterless or 1/8 Gallon Per Flush Urinals	5,000
HVAC Condensate Used For Cooling Tower Make-Up	8,000
2 GPM Shower Heads	12,000
Gray Water Recovery	9,000

Estimated Total Annual Water Savings: **41,000**

Annual Water use w/o Water Conservation Measures: **200,000**

Estimated Percentage Savings: **21%**

Table 6: Summary of ECM Evaluations

Table 6 summarizes every ECM evaluated by the design team for this particular project, along with various ECM financial metrics. For a detailed description and analysis of individual ECMs, please see the Appendices.

Table 6: Summary of ECM Evaluated

ECM No.	Description	First Cost Estimate	Annual Costs Savings	Simple Payback	ROI	Persistence[1] H/M/L	Accepted Yes/No	Comments
1a	Additional 0.75" Wall Insulation	$180,000	$14,000	12.9	7.8%	H	**N**	SD design/estimate included insulation 1" thicker than required by code.
1b	Additional 1" Wall Insulation	$300,000	$16,500	18.2	5.5%	H	**N**	
1c	Additional 1.5" Wall Insulation	$350,000	$18,400	19.0	5.3%	H	**Y**	
2a	Glass SHGC =0.38	$186,000	$7,500	24.8	4.0%	M	**N**	
2b	Glass SHGC =0.33	$190,000	$8,000	23.8	4.2%	M	**Y**	
2c	Argon Filled Triple Glazed Glass SHGC = 0.26	$265,000	$13,400	19.8	5.1%	L	**N**	Seal life guaranteed only 10 years. Slight gray tint.
3	Day Lighting Sensors, Atrium	$42,000	$12,000	3.5	28.6 %	M	**Y**	
4	Desiccant Wheel	$200,000	$40,000	5.0	20.0 %	M	**Y**	
5	Exterior Shades, South Facade	$78,000	$15,000	5.2	19.2 %	H	**Y**	
6	Increase Thermostat Deadband	$0	$7,000	N/A	N/A	L	**Y**	
7	Free Cooling Process Load	$350,000	$55,000	6.4	15.7 %	H	**Y**	
8	Shower Heat Recovery Device	$24,000	$3,000	8.0	12.5 %	L	**N**	Maintenance issues

Note 1: Persistence represents an opinion of the probability that the estimated energy savings will be fully realized.

Useful Information:

KWH: Kilowatt Hours

MBTU: Thousands of British Thermal Units

Therms x 100 = MBTU

KWH x 3.413 = MBTU

Appendix A

Table A1: Energy Cost Assumptions:

Table A1 reports the energy cost assumptions utilized for energy cost calculations.

Table A1: Energy Costs Assumptions

Energy Type	Cost	Comments
Electricity	$0.079 /kwh	DTE Direct Purchase Rate
Natural Gas	$0.842/therm	MichiCon Direct Purchase Rate
District Steam	$1.90/therm	U-M Utility Rate
District Chilled Water	$1.07/therm	U-M Utility Rate

Table A2: Accepted ECMs (no ECM interactions) Additional Information

Table A2 presents the estimated annual cost and energy savings, and the relative contribution each ECM contributed toward total savings. Electrical and gas savings for each ECM have been converted to energy units of MBTU and combined.

Table A2: Accepted ECMs (no ECM interactions) Additional Information

ECM No.	Description	Dollars/Yr Savings	% of Total $ Savings	MBTU/Yr Savings	% of Total MBTU Savings	First Cost
1c	Increase Wall Insulation to 2.75"	$18,400	11.8%	450	16.8%	$350,000
2b	Improved Window Performance, SHGC = 0.33, U = 0.44	$8,000	5.1%	183	6.8%	$190,000
3	Day Lighting Sensors, Atrium	$12,000	7.7%	350	13.1%	$42,000
4	Desiccant Wheel	$40,000	25.7%	600	22.4%	$200,000
5	Exterior Shades, South Façade	$15,000	9.7%	224	8.4%	$78,000
6	Increase Stat Deadband	$7,000	4.5%	170	6.4%	$0
7	Install Free Cooling System	$55,000	35.4%	700	26.1%	$350,000
						$1,210,000
	Total First Cost:					
	Total Cost Savings:	**$155,400**				
	Total Energy Savings:			**2,677**		

Tables A3 and A4:

U-M Design Guideline 3.2 requires that all projects implement certain "mandatory" energy conservation measures, and it requires that other energy conservation measures be "evaluated" for every project. Tables A3 and A4 indicate which of the mandatory and evaluated measures were found applicable to the project.

Table A3: Review of Mandatory Energy Conservation Measures

Mandatory ECM No.	Description	Implemented Yes/No	Comments	ECM Cross Ref.
a	Window Blinds/Shades	Y		ECM 9
b	Occupancy Schedules	Y		
c	Part Load Efficiency	Y		
d	HVAC System Zoning	Y		ECM 8
e	DDC VAV Control	Y		
f	Standalone HVAC Systems	N	No process areas.	
g	Laboratory ECMs	N	Not a lab building.	
h	Building Envelope Thermal Scanning	Y		ECM 4
i	Limit Incandescent Lighting	Y		
j	Lighting and Power Justification	N		

Table A4: Review of Mandatory Energy Evaluations

Mandatory Eval. No.	Description	Implemented Yes/No	Comments	ECM Cross Ref.
a	Additional Below-Grade Insulation			
b	Additional Wall Insulation			
c	Additional Roof Insulation			
d	Improved Glazing (1)			
e	Eliminate Server Rooms			
f	High Efficiency Chiller (1)			
g	Free Cooling			
h	Heat Recovery			
i	Increased Envelope Inspections			
j	Occupancy/Daylight Sensing			
k	High Efficiency Boiler (1)			
l	High Efficiency HVAC Equipment (1)			
m	Variable Volume Kitchen Hoods			

Note 1: Performance/efficiency better than required by code.

Appendix B

ECM No.	Description	First Cost Estimate	Dollars/Year Savings	Simple Payback	MBTU/Year Savings
1a	Additional 0.75" Polystyrene Wall Insulation	$180,000	$14,000	12.9	
1b	Additional 1" Polystyrene Wall Insulation	$300,000	$16,500	18.2	
1c	Additional 1.5" Polystyrene Wall Insulation	$350,000	$18,400	19.0	

Description:

The base building wall insulation requirement, Per ASHRAE 90.7 2013 =

R = 11.9 hr-ft^2-F/Btu

U value = 0.084 Btu/(hr-ft^2-F)

This ECM would increase the insulation thickness as follows:

Increase 1.25" thick insulation to 2.0" Thick

R = 15.87 hr-ft^2-F/Btu

U value = 0.063 Btu/(hr-ft^2-F)

Increase 1.25" thick insulation to 2.25" Thick

R = 17.2 hr-ft^2-F/Btu

U value = 0.058 Btu/(hr-ft^2-F)

Increase 1.25" thick insulation to 2.75" Thick

R = 19.9 hr-ft^2-F/Btu

U value = 0.050 Btu/(hr-ft^2-F)

Construction Costs:

Appendix C: