

Appendix 5:

Achieving a 25% Reduction in Energy Consumption in Your Office, Assembly & Manufacturing, and Warehouse Space

This appendix includes strategies for achieving 25% energy efficiency beyond the requirements of the State of Wisconsin Energy Code for Office space types. Each strategy is presented with a range of achievable savings, which are based on 10 years of field-verified results and correlated building simulation data. The ranges represent the variability inherent in any complex system. The effectiveness of each strategy in each architectural, mechanical or electrical subsystem can affect the performance and associated savings of other strategies. These dependent relationships coupled with weather and operating variability produce an expected range of savings potentials.

Data from the past seven years suggests that the 25% savings is achievable with no more than a 2 to 3 year payback. Payback ranges are affected by the size of project, specific utility rate structure and first cost. For example, a normal electrical bill for a building that meets the Wisconsin Energy Code is \$1.00/ft² of annual operating costs, the new operating costs would be \$0.75/ft². With these reduced operating costs you can spend 50% more in first-costs and come even in a 2 year payback. This translates into a 50% return on investment.

Office Space

Typical Base Characteristics for Office space:

- 1 story office building
- Glazing 4.5 SF per LF of perimeter wall
- Natural Gas Heating
- DX Rooftop Cooling
- Constant Volume Air distribution

Code-Level Annual Energy Consumption	KBTU/ ft ²	% of Total
Heating	46	42%
Cooling	13	12%
Fan/ Pumps	15	14%
Lighting	20	18%
Equipment	15	14%
Total	108	

Approximate Code Level for this space type:

Targeted energy consumption for this typical scenario is 81 KBTU/ft², which represents a 25% reduction from State of Wisconsin Building Code. The table on the following page identifies strategies that you can employ to assist in achieving the 25% targeted reduction.

Office Space					Savings Potential	
					Low	High
Envelope Strategies						
Glazing Type		U Factor¹	SHGC²	V T³	3%	6%
• Low E Glazing Aluminum Frame		< 0.42	< 0.38	> 0.50		
• Low E Glazing Wood Clad Frame		< 0.32	< 0.38	> 0.50		
Envelope Insulation⁴		R Value			2%	8%
• Wall Insulation Level		> R-16				
• Roof Insulation Level		> R-24				
Lighting Strategies						
Calibrated Daylighting Controls					5%	10%
• Dimming Controls in open office areas						
• Stepped Controls in circulation and lobby spaces						
Lighting Controls					2%	5%
• Strategic Switching in Private Offices						
• Private Office Occupancy Sensor Control						
• Storage Room Occupancy Sensor Control						
• Conference Room Occupancy Sensor Control						
• Toilet Room Occupancy Sensor Control						
Lighting Design		Code W/sf			3%	7%
• Open Office connected (W/ft ²)		< 1.10				
• Private Office connected (W/ft ²)		< 1.30				
• Conference Rooms connected (W/ft ²)		< 1.55				
• Circulation connected (W/ft ²)		< 0.75				
• Toilets connected (W/ft ²)		< 0.75				
• Storage rooms connected (W/ft ²)		< 0.75				
• Mechanical Rooms connected (W/ft ²)		< 0.75				
HVAC Strategies						
Heating/ Cooling/ Motor Efficiency		Improvement Level			2%	3%
• Cooling Efficiency		10 % greater than code level				
• Heating Efficiency		5% greater than code level				
• Motor Efficiencies		Premium Efficiency				
Load Responsive Control					8%	15%
• Variable Air Volume distribution with VFD's of fan motors			• Enthalpy controlled economizer sequence			
Outside Air Control					5%	10%
• CO2 control of outside air volume			• Total Heat Recovery of outside air			

1 Unit U-factor is the U-factor of the glass and frame assembly together. The unit U-factor of the glass and frame assembly is typically higher than the center-of-glass U-factor only. Lower U-factors reduce heat loss.

2 Solar Heat Gain Coefficient (SHGC) is the ratio of the amount of solar radiation transmitted through the glass compared to the amount of exterior radiation incident on the glazing's exterior surface. Lower SHGC values reduce cooling loads.

3 Visible light transmittance (VT) is the ratio of the amount of light radiation transmitted through the glass compared to the amount of light striking the glazing's exterior surface. Higher values provide more daylight.

4 Wall and Roof insulation R-values include the entire opaque wall and roof envelope construction assembly including air films. Wall and Roof insulation R-values include the entire opaque wall and roof envelope construction assembly including air films.

Assembly & Manufacturing Space

Typical Base Characteristics for Assembly & Manufacturing spaces:

- 1 story building
- Natural Gas Heating
- DX Rooftop Cooling
- Constant Volume Air distribution
- Minimal window area

Approximate Code Level for this space type:

Code-Level Annual Energy Consumption	KBTU/ ft2	% of Total
Heating	48	38%
Cooling	15	11%
Fan/ Pumps	12	9%
Lighting	32	24%
Process Equipment Load*	24	18%
Total	131	

* Estimated at 2 Watts/ft2

Targeted energy consumption for this scenario is 98 KBTU/ft2, which represents a 25% reduction from State of Wisconsin Building Code. The table below identifies strategies that you can employ to assist in achieving the 25% targeted reduction.

Assembly/Manufacturing Space							Savings Potential	
							Low	High
Envelope Strategies								
Add skylights and Daylight Controls				U Factor	SHGC	V T	8%	16%
• Diffuse 4x8 skylights from 2-4% of roof area				< 0.65	< 0.55	> 0.65		
• Add stepped daylight controls to turn off 50%-65% of electric lamps during daytime hours								
Envelope Insulation				R Value			1%	4%
• Wall Insulation Level				> R-16				
• Roof Insulation Level				> R-24				
Lighting Strategies								
Lighting Controls							1%	3%
• Assembly area dual-level switching								
• Storage Room Occupancy Sensor Control								
• Toilet Room Occupancy Sensor Control								
Lighting Design				Code W/ft²			3%	8%
• Assembly Area – Pulse Start Metal Halide Lamps				< 1.5				
• Assembly Area – T5 High Output Lamps				< 1.2				
HVAC Strategies								
Heating/ Cooling/ Motor Efficiency				Improvement Level			2%	3%
• Cooling Efficiency				10 % greater than code level				
• Heating Efficiency				5% greater than code level				
• Motor Efficiencies				Premium Efficiency				
Load Responsive Control							6%	15%
• Variable Air Volume distribution with VFD's of fan motors								
• Enthalpy controlled economizer sequence								
Outside Air Control							8%	15%
• CO2 control of outside air volume								
• Total Heat Recovery of outside air								

Warehouse Space

Typical Base Characteristics for Warehouse space:

- 1 story building
- Natural Gas Heating
- Constant Volume Air distribution
- No Cooling
- Minimal window area

Code-Level Annual Energy Consumption	KBTU/ ft2	% of Total
Heating	34	59%
Cooling	0	0%
Fan/ Pumps	6	10%
Lighting	12	21%
Equipment	6	10%
Total	58	

Approximate Code Level for this space type:

Targeted energy consumption for this scenario is 43 KBTU/ft², which represents a 25% reduction from State of Wisconsin Building Code. The table below identifies strategies that you can employ to assist in achieving the 25% targeted reduction.

Warehouse Space						Savings Potential		
						Low	High	
Envelope Strategies								
Add skylights and Daylight Controls				U Factor	SHGC	V T	10%	18%
• Diffuse 4x8 skylights from 2-4% of roof area				< 0.65	< 0.55	> 0.65		
• Add stepped daylight controls to turn off 50%-65% of electric lamps during daytime hours								
Envelope Insulation				R Value			1%	4%
• Wall Insulation Level				> R-16				
• Roof Insulation Level				> R-24				
Lighting Strategies								
Calibrated Daylighting Controls						5%	10%	
• Dimming Controls in open office areas								
• Stepped Controls in circulation and lobby areas								
Lighting Controls						2%	4%	
• Warehouse aisle Occupancy Sensor Control								
• Storage Room Occupancy Sensor Control								
• Toilet Room Occupancy Sensor Control								
Lighting Design				Code W/ft²			3%	7%
• Warehouse Area – Pulse Start Metal Halide Lamps				< 1.0				
• Warehouse Area – T5 High Output Lamps				< 0.8				
HVAC Strategies								
Heating/ Cooling/ Motor Efficiency				Improvement Level			2%	3%
• Heating Efficiency				5% greater than code level				
• Motor Efficiencies				Premium Efficiency				