16 Payback With Lighting

Reducing lighting load pays back twofold. Not only is there less energy required for lighting, but it also reduces demand on the chiller due to reduced load. Table 15.3.4 shows that lighting power density reduces to .5W/sf. With 24,000 SF of open office in the building, the following table projects yearly energy savings.

Table 16.1. Yearly Lighting Energy and Cost Savings

	Density	Power	Energy Use	Energy Savings	Cost Savings
	W/SF	kW	kWh/yr	kWh	
Original	1.02	24.43	76,232		
Redesign	0.5	**11.98**	37,369	**38,863**	**$3,109.08**

Energy and power savings provide two more opportunities to lower payback. First, 12 kW reduced lighting power is 12 kW of demand load the chiller does not need to cool. To convert kW to tons:

1 kW = 3413 BTU/hr (16.1)

1 ton = 12,000 BTU/hr (16.2)

1 kW = 0.2844 tons

11.98 kW = **3.41 tons**

This 3.41 tons is a direct reduction of chiller demand load. As previously stated in Section 14.1, each ton of load reduction reduces chiller cost by $1000[c]. Tambient lighting saves **$3410** in reduced chiller size.

Finally, 38,860kWh saves in yearly operating costs for the chiller. However, to calculate electrical usage, one must account for COP of the chiller. COP is a ratio of cooling energy/electrical energy input. This means the higher a chiller's COP, the less electrical energy needed to produce the desired cooling. From Appendix G, the chiller's EER (energy efficiency ratio) is 21.

COP = EER/3.412 (16.3)

COP = 21/3.412 = 6.15

So, electrical energy needed to produce required cooling:

$Q_{electric} = Q_{load}/COP$ (16.4)

$Q_{electric} = 38863kWh/6.15 = 6319kWh$

At a utility rate of $0.08/kWh:

Savings = 6319*.08 = **$506/year**

All together, Tambient lighting saves $3410 in first cost and $3615 in yearly savings.

The following table shows the new payback, with Tambient lighting included. The new lighting system reduces payback period to only 18 years, making the redesign much more promising.

Table 16.2. Overall Redesign Payback

	Yearly Energy Savings	Yearly Cost Savings	First Cost Deficit	Payback
Mechanical Redesign	51,230 kWh	$4,100	$143,300	35.0 years
Redesign with Tambient	96,410 kWh	$7,715	$139,890	**18.1 years**
***67% Finished**	64,595 kWh	$5,170	$66,104	**12.8 years**

67% finished assumes that 1/3 of the office space in the building will not be in use. This reduces yearly energy usage, and thus savings, by 33%.*

17 Conclusion

Designers at McKinstry had three main objectives: sustainability, comfort and economy. The redesign presented in this thesis provides all three. By saving energy every year for the lifespan of the building, any reduction in energy helps the building become more sustainable. Also, the sustainable elements of the original design were all kept in place. The ground source water loop, as well as the rainwater harvesting, were undisturbed by the redesign. In addition DOAS provides a more comfortable environment.

The large first cost increase for the redesign may not seem very economical. However, as stated in Section 14.2, current construction leaves 1/3rd of the office space unfinished. This reduces initial added first cost from $143,000 down to $69,500. Also with Tambient lighting providing a reasonable payback at 18 years (with 100% construction), the redesign is economical for McKinstry.

The redesign ensures occupant comfort. By eliminating the VAV system and providing 100% outdoor air, the DOAS system ensures that all spaces receive adequate ventilation air. In addition, DOAS provides better control of air humidity. Proper ventilation is a definite plus for occupant comfort. Radiant panels provide a draft free source of heating and cooling. DOAS does not recirculate any air. If any contaminant is present in any area of the space, it will not redistribute throughout the building.

Finally, Tambient lighting gives a better aesthetic to the office space by eliminating clutter from the ceiling space and making the office look more open. An appealing looking space is comforting to occupants.