SASKATCHEWAN ENERGY MANAGEMENT TASK FORCES

TECHNOLOGY INFORMATION SHEET

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COMBINING EFFICIENT LIGHTING TECHNOLOGIES

1. How Far Can We Go?

Combining high efficiency lamps and ballasts with lighting controls and effective matching of light levels to tasks can save well over 50% of lighting electricity use. In high usage areas, with good daylighting potential, the savings can be over 75%. These savings also produce a "bonus" in reduced cooling loads, sometimes allowing the building to downsize its HVAC equipment as well.

How do we know which combination of technologies to use, and what are the financial returns?

While there is no substitute for a local audit of lighting equipment and needs, the following examples provide an illustration of the savings and returns[1] associated with applying greater and greater efficient lighting retrofits to a typical office space. For all calculations included in these examples (and presented in the attached table), it is assumed that lighting is required for 4000 hours per year, and there is some perimeter window space and a usage pattern which varies throughout the day so that occupancy sensors can be effective. Annual savings only include direct electricity savings. No indirect savings from cooling or maintenance are included. Costs and savings for other facilities will vary if conditions are different.

2. Retrofit Packages

A comparison of the features, performance and costs of four retrofit packages is shown in the attached table.

The **Existing system** is the standard fixture found in most offices, and consists of a four lamp fixture with 4 F40 florescent lamps and 2 x 2 lamp electromagnetic ballast, white reflector, and opaque diffuser. A typical (overlit) lighting intensity of 900 lux is assumed.

In **Upgrade 1**, only the lamps and ballasts are replaced, using 4 T8 (32 watt) fluorescent lamps to replace the F40s, and a 4 lamp electronic ballast to replace the two electromagnetic ones. The white reflector and diffuser are retained. Electricity savings of 40% are achieved with a 53% Internal Rate of Return (IRR)[2] based on a ten year investment..

[1] Financial returns are estimated assuming an electricity cost of 3.34 cents per kWh and $13.01 per kVA (SaskPower's 1996 rates)

[2] For a complete definition of *Internal Rate of Return* and other investment criteria see the EMTF publication, *A Guide to the Selection of Energy Efficient Technologies*.

In **Upgrade 2**, the overall lighting level from the fixture is reduced to match the office task optimum level of 600 lux. Specular aluminum reflectors and a clear acrylic lens replace the white reflector and diffuser, and two T8 fluorescent lamps and a 2-lamp electronic ballast are able to meet the new lighting level requirements. A 68% electricity savings is achieved with an IRR of 55%.

In **Upgrade 3**, occupancy sensors that reduce lighting time requirements to 2500 hours per year are installed. Electricity savings rise to 73%, and an IRR of 45%.

Upgrade 4 is the same as Upgrade 3, but with photocell light sensors connected to a dimmable 2-lamp electronic ballast, which reduces the artificial lighting requirements in fixtures near windows for a significant period of the day, equivalent to 1800 hours at 600 lux. Savings increase to 76%, with an IRR of 35%.

3. Conclusions

The most important conclusions to draw from this comparison of retrofits are as follows:

- **The Value of Packaged Retrofits**

The largest electrical savings come from packaging or "bundling" a number of efficient lighting technologies and measures together. Total costs are reduced because reinstallation and rewiring is eliminated, and the higher cost of some measures can be absorbed by lower cost ones.

When lighting measures are implemented in packages, the returns on the investment can be much greater than if the measures are implemented one at a time. In fact, by "cream skimming" the low cost measures that have small savings, the cost and economics of more efficient technologies are put further out of reach. For example, considering capital costs only, Upgrade 1 would save $35 per fixture compared to Upgrade 2. But when a investment analysis is conducted, it is obvious by all measures that the more costly of the two options produces a greater return for the money invested.

If a company is considering environmental criteria as well as financial, Upgrades 3 and 4 have significant reductions in energy consumption and are worthy investments. It is important to note that other effects such as increasing energy prices and reduction in maintenance costs have not been factored into this analysis. Both of those will favor the higher priced options (less bulbs and ballasts to replace).

- **Go the Whole Way if You Can**

The longer lives of efficient lighting packages - extended even more with control systems - means that building owners will receive savings long after the energy management program is completed for the entire life of the equipment. Appropriate financing will allow you to pay for these packages over a short period, therefore there are no real financial barriers to "going the whole way" (see *Financing Options Technology Information Sheet*).

- **The Importance of Retrofit Planning**

If measures have to be carried out in sequence, then make sure that nothing is done in one operation that will jeopardize the second. For example, if occupancy sensors and photocell dimming are to be added later, make sure dimmable electronic ballasts are installed in fixtures near windows. If reflectors are to be added later, make sure 2 lamp electronic ballasts are used in each fixture, *etc.*

- **Bonus Savings and Peak Demand Reduction**

Heat given off by lighting represents about 40% of the cooling load in most commercial buildings. An 85% reduction in lighting electricity, therefore, reduces the cooling load by a third, saving additional electricity and lowering the cost of replacement cooling systems. This will be very useful to building owners, as they are required to change over to more expensive non-CFC cooling systems.

Efficient lighting will also reduce monthly demand charges. At 60 watts/fixture for upgrades 2, 3 and 4, down from 186 watts, monthly peak electricity demand from lighting is reduced by two thirds. Peak demand for cooling will also be reduced.

- **Lower Maintenance Requirements and Waste Management Problems**

Efficient lighting involves fewer lamps and ballasts, and the lamps last longer (particularly if control systems are used). This will lower staff time for change out, and lower the volume of old ballasts and lamps to be removed and disposed of. A proactive replacement program for old ballasts containing PCBs can be coordinated with an efficient lighting retrofit.

See also: *A Guide to the Selection of Energy Efficient Technologies.*

Comparison of Fluorescent Light Fixture Performances and Costs

	Existing	Upgrade 1	Upgrade 2	Upgrade 3	Upgrade 4
Lamp Type	4 x F40T12 Fluorescent	4 x F32T8 Fluorescent	2 X F32T8 Fluorescent	2 X F32T8 Fluorescent	2 X F32T8 Fluorescent
Ballast(s)	2 x 2 lamp Electro-Magnetic	1 x 4 lamp Electronic	1 x 2 lamp Electronic	1 x 2 lamp Electronic	1 x 2 lamp Electronic (dimmable)
Reflector	White	White	Specular Reflector	Specular Reflector	Specular Reflector
Controls	Central Switching	Central Switching	Central Switching	Occupancy Sensors	Occupancy + Daylighting
Light Level (lumens/m2)	900	900	600	600	600
Lamp Efficacy (lumens/watt)	66	102	92	92	92
Power Input (watts/fixture)	186	112[3]	60[3]	60[3]	60[3]
Hours of Use (hours/year)	4000	4000	4000	2500	1800
Annual Electricity (kWh/yr. per fixture)	744	448	240	150	108
Annual Energy Costs at 3.34¢/kWh	$24.85	$14.96	$8.02	$5.01	$3.61
Annual Demand Costs $13.01/kVA[4]	$29.04	$17.49	$9.37	$9.37	$9.37
Total Annual Electricity Costs	$53.89	$32.45	$17.38	$14.38	$12.97
Total Annual Savings in Electricity Costs	- -	$21.44	$36.50	$39.51	$40.91
Percentage Savings in Electricity Costs	- -	40%	68%	73%	76%
Fixture Cost[5]	$40	$80	$105	$125	$150
Simple Payback (years)	- -	1.9	1.8	2.2	2.7
Net Present Value (k=16%, t=10yrs)	- -	$55	$96	$89	$74
Internal Rate of Return (t=10 yr.)	- -	53%	55%	45%	35%
Return on Investment (t=10 years)	- -	44%	46%	36%	27%

[3] Electronic ballasts operate fluorescent lamps at a higher efficiency; *i.e.* the power consumed by the lamp is reduced by 10% from the rated wattage.

[4] It assumed that all light fixtures are operating during each monthly peak demand.

[5] Fixture costs may vary from those quoted. Rates of return calculations will change as capital costs increase or decrease.