Lighting for Dairy Operations

Alberta Government

Introduction

On average 13% of electrical consumption in dairy operations is attributed to lighting (Figure 1). This equates to about 14,430 kWh for a 100 cow dairy.

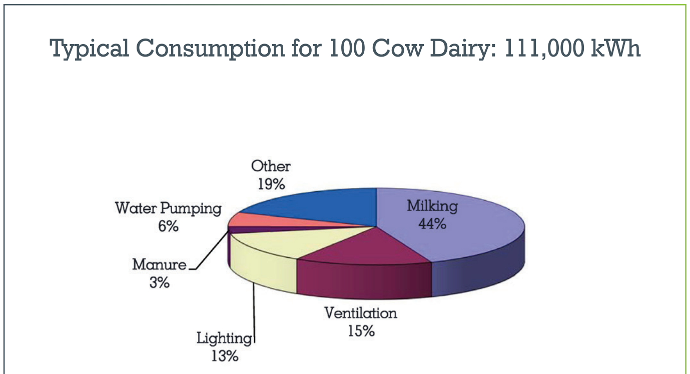

Figure 1. Electricity Usage and Distribution

Assuming the cost of electricity is $0.10 per kWh this equates to $1,443 per year. Electricity prices over the last five years have been unpredictable ranging from $0.06 to $0.15 per kWh (Figure 2). This equates to a range of $866 to $2,165 per year for a 100 cow dairy.

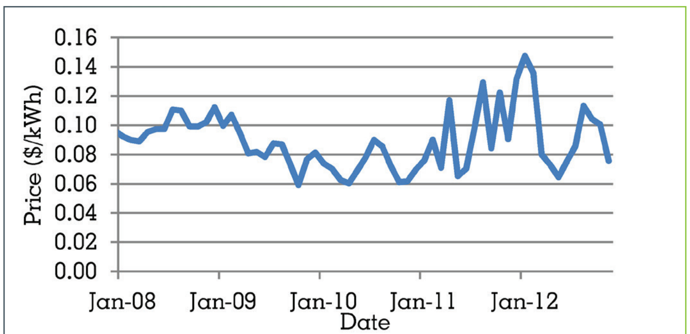

Figure 2. Alberta Price for Electricity from 2008 to 2012
Source: Alberta Agriculture and Rural Development

Animal Requirements

Table 1 shows the lighting requirements for dairy livestock facilities according to the American Society of Agricultural and Biological Engineers (ASABE) standards. There is potential cost savings with energy efficient lighting options.

Table 1. Recommended Light Levels for Dairy Livestock Facilities

Work Area or Task	Illuminance (lx)
Parlour, pit and near udder	500
Parlour, stalls & return lanes	200
Parlour, holding area	100
Milk room, general	200
Milk room, washing	750-1,000
Stall barn, manger alley	100
Stall barn, milking alley	200
Drive-through feed alley	200

Source: ASABE Standard ASAE EP344.3 Jan2005, Lighting Systems for Agricultural Facilities

Technology Basics, Terminology

Table 2. Lighting Terms and Units

Term	Unit	Explanation
Luminous Flux	Lumen	Total light source output in all directions. The flow of light.
Luminous Intensity	Candela	A point source of light shining in a particular direction.
Illuminance	Lux (lumens/m^2) Footcandles (lumen/ft^2)	Density of light falling on a plane surface.
Luminance	Candela/m^2	Density of light reflecting off a plane into our eye.
Colour Rendering Index (CRI)	Scale 50 to 100	Measure of colour accuracy. 50 is a warm white fluorescent and 100 is an incandescent at a particular colour temperature.
Colour Temperature	Kelvin	Measure of warmth or coolness of the colour of light. 7500 K is blue-white and <2000 K is red.

Source: K.Hooper, Lighting Fundamentals Seminar. November 29, 2009

Applicable Technology

Table 3. Comparison of Lamp Types

Comparison of Lamp Types							
Lamp Type	Lumens per Watt	Average Life (hrs)	Colour	CRI	CCT (K)	Instant On	Wattage Range
Incandescent	7 - 20	750 - 1,000	White	100	2,800	Yes	25 - 200
Halogen	12 - 21	2,000 - 6,000	White	100	3,000	Yes	45 - 500
Compact Fluorescent	45 - 55	6,000 - 10,000	White	82	2,700-5,000	Yes*	14 - 29
T-12 Fluorescent	62 - 80	9,000 - 12,000	White	52 - 90	3,000-5,000	Yes*	30 - 75
T-8 Fluorescent	76 - 100	15,000 - 20,000	White	60 - 86	3,000-5,000	Yes*	25 - 59
T-5 Fluorescent	85 - 105	20,000 - 24,000	White	80 - 85	3,000-5,000	Yes*	24 - 80
Induction	80	60,000 - 100,000	White	80	4,000-6,500	Yes*	40 - 400
High Pressure Sodium	66 - 90	24,000	Yellow-orange	22 - 70	1,900-2,100	No	35 - 1,000
Malide Halide	60 - 94	7,500 - 20,000	Bluish	60 - 80	3,000-4,300	No	35 - 1,000
LED	4.5 - 150	30,000 - 100,000	White	70 - 95	2,000-6,500	Yes	2.5 - 100

Source: data adapted from manufacture's literature
**Require varying warm up period*

There are many lighting technologies available on the market suitable for high bay lighting in dairy applications such as high pressure sodium (HPS) (Figure 3) and fluorescent tubes. Recently induction (Figure 4) and light-emitting diodes (LEDs) (Figure 5) have emerged as an alternative.

Figure 3. High Pressure Sodium

Figure 4. Induction

Figure 5. Light Emitting Diode (LED)

Induction lighting typically operates at high colour temperatures, producing a high quality white light. It also has 4 times the operating life compared to a HPS. Some LEDs and fluorescents produce more lumens of light per watt consumed compared to the traditional incandescent and high pressure sodium bulb making them an energy efficient alternative.

A 60 watt incandescent is comparable to a 7 watt LED and 14 watt CFL in light output. Table 3 compares light output ratings for common bulbs. It is also important to consider their performance over time if they are being washed. Most bulbs are not washable with direct water spray because they will deteriorate more quickly than the rated bulb life and in some cases may suffer immediate damage. Waterproof figures are available which protect bulbs from water and moisture.

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The difficulty with LEDs is they have heat dissipation requirements so they should not be mounted in air tight fixtures. This may change in the future with new waterproof fixture designs entering the marketplace.

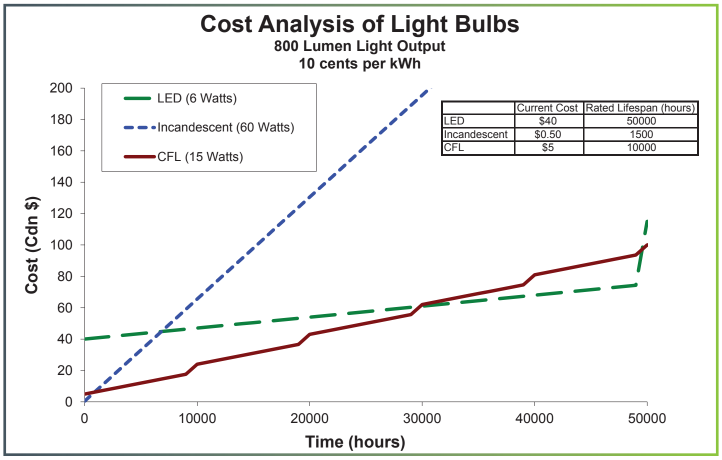

Figure 6. Cost Analysis of Light Bulbs

Shown in Figure 6 is a cost analysis of LEDs and CFLs compared to the standard 60 watt incandescent bulb. With an initial cost of $40 for the LED, the pay back would occur after about 6,000 hours which is less than a year if the bulb is on 24 hours a day. The return on investment for a $5 CFL is 1,000 hours or about a month and a half. The payback is reasonable but there are drawbacks to both bulbs. The CFL is not suitable for use in cold temperatures. The LED must be designed with a good heat sink and should not be used in an air tight fixture in order to achieve its rated life span. Both CFLs and LEDs are available as dimmable bulbs but both cost more and may not dim as well as incandescents when used with household dimmer switches.

Example

Consider a dairy parlor with HPS lamp fixtures rated at 400 watts. With the ballast each fixture draws about 465 watts with an initial rated lumen output of 55,000 and a rated life of 24,000 hours. This can be replaced by a 400 watt induction fixture, a 374 watt 6 lamp T5 fluorescent fixture, or a 258 watt LED fixture. Table 4 shows the comparison of each choice assuming the cost of electricity at $0.10 per kWh and an operating time of 12 hours a day.

Table 4. Lighting Retrofit Example

Fixture	Watts	Life (hours)	Operating Cost 1 year	Operating Cost 5 year
HPS	465	24,000	$ 198.65	$ 1,393.24*
Induction	400	100,000	$ 170.88	$ 854.40
6 Lamp T5	374	10,000	$ 159.77	$ 998.86*
LED	258	60,000	$ 110.22	$ 551.09

**Includes replacement cost*

Newer technology has a higher initial cost and may not be as reliable as well established lighting options. It is important to have a good warranty agreement. Because of the low draw of an LED fixture and the long life of an induction, both are a good choice for high bay dairy barn lighting.

Summary

There are opportunities for energy savings in a typical dairy operation by choosing efficient lighting options. These savings can be achieved by retrofitting inefficient lighting with bulbs having high lumens per watt; such as fluorescents, induction, HPS, metal halide, and LEDs. Other important factors to consider are the life span, colour, and if the lamp is instant on. Fluorescents and LEDs have been leading the market as energy efficient options for many applications.

The typical consumptions of a 100 cow dairy is 14,430 kWh. A saving of $282 and $643 per year can be achieved by switching from HPS to fluorescents and LEDs, respectively. There are greater initial costs associated with choosing energy efficient lighting options but the payback period is realistic and constantly improving.

References

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