Lighting for Swine Operations

Alberta Government

Introduction

On average, 17% of electrical consumption in swine operations is attributed to lighting (Figure 1). This equates to about 19,550 kWh for a 500 sow farrow-to-wean operation.

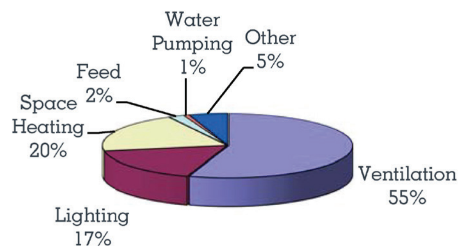

Figure 1. Electricity Usage and Distribution

Assuming the cost of electricity is $0.10 per kWh, this equates to $1,955 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 $1,173 to $2,933 per year for a 500 sow farrow-to-wean operation.

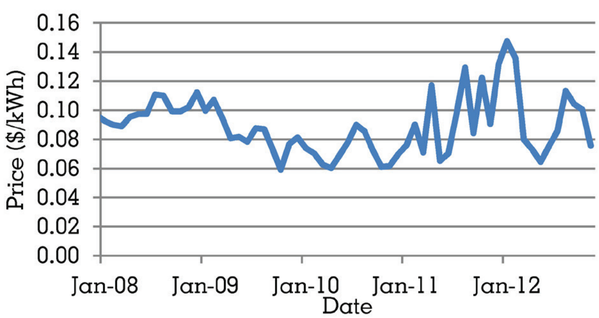

Figure 2. Alberta Price for Electricity from 2008 to 2012
Source: Alberta Agriculture and Rural Development

Animal Requirements

Table 1 shows the lighting requirements for swine housing according to the American Society of Agricultural and Biological Engineers (ASABE) standards. Some stages require high light levels for extended periods of time. There is potential cost savings with energy efficient lighting options.

Table 1. Recommended Light Levels and Photoperiods for Swine Housing

Type of housing	Illuminance (lx)	Photoperiod (hrs/day)
Breeding/gilts	>100	14-16
Gestation	>50	14-16
Farrowing	50 - 100	8
Nursery	50	8
Grower-finisher	50	8

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

Technology

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 Manufacturer's Literature

* Requires varying warm up period

There are many lighting technologies available on the market suitable for swine applications such as incandescent (Figure 3), high pressure sodium (HPS), fluorescent tubes, and compact fluorescents (CFLs) (Figure 4). Recently, light-emitting diodes (LEDs) have emerged as an alternative (Figure 5).

Figure 1. Incandescent and Halogen

Figure 2. Compact Fluorescent

Figure 3. Light Emitting Diode (LED)

LEDs and fluorescents produce more lumens of light per watt compared to the traditional incandescent and high pressure sodium bulbs 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 fixtures are available which protect bulbs from water and moisture. 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.

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 payback 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 1000 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.

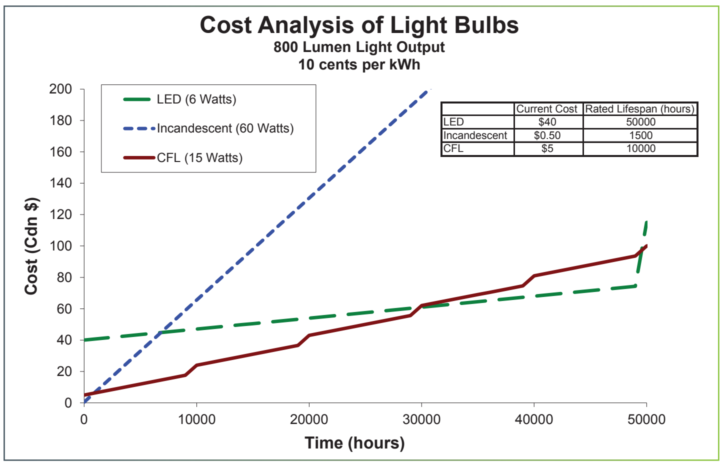

Figure 6. Cost Analysis of Light Bulbs

Example

Consider a 1,000 head finisher barn with 975 m^2 of barn space and 8 foot ceilings. ASABE states a minimum of 50 lux is required for at least 8 hours per day. Using 50 lux and 975 m^2, a total of 48,750 lumens is required to light the barn. This would equate to 61 bulbs which produce 800 lumens each. Table 4 shows the energy used and cost associated per year for each bulb choice. Clearly, the more energy efficient options, LEDs and fluorescents, cost significantly less than incandescents with LEDs having the lowest operating cost per year.

Summary

There are opportunities for energy savings in a typical swine 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 consumption of a 500 sow farrow-to-wean operation is 19,550 kWh using incandescent bulbs. A saving of $1,500 and $1,727 per year can be achieved by switching to CFLs 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

Alberta Agriculture and Rural Development, 2007. OnFarm Energy Audit Report

ASABE Standard ASAE EP344.3, Jan 2005, Lighting Systems for Agricultural Facilities

Design Recycle Inc. January 2010 www.designrecycleinc.com

Hooper, K, Lighting Fundamentals Seminar, November 29, 2009

Lighting Research Centre, January 2010, www.lrc.rpi.edu

Table 4. Lighting Retrofit Example

Bulb	Watts per Bulb	Lumens per Watt	Total Watts Used	Energy (kWh) per Year (6.5 crops)	Total Operating Cost per Year (10c/kWh)
Incandescent	60	13	3,660	10,687	$1,068.70
Fluorescent	14	57	854	2,493	$249.30
LED	7	114	427	1,247	$124.68