Lighting for Poultry Operations

Introduction

On average, 47% of electrical consumption in poultry operations is attributed to lighting. This equates to about 38,540 kWh for a 50,000 broiler operation.

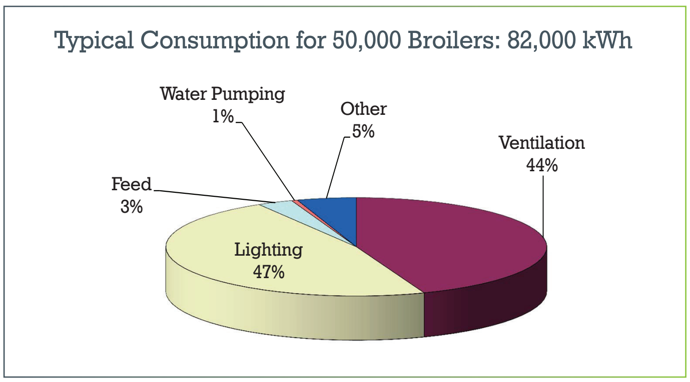

Figure 1. Electricity Usage and Distribution

Assuming the cost of electricity is $0.10 per kWh, this equates to $3,854 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 from $2,312 to $5,781 per year for a 50,000 broiler operation.

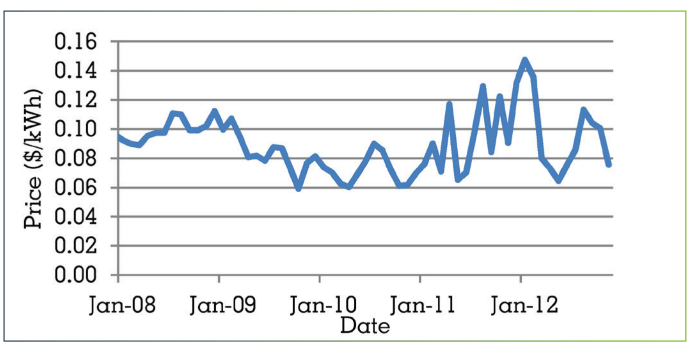

Figure 2. Alberta Price for Electricity from 2008 to 2012
Source: Alberta Agriculture and Rural Development (ARD)

Animal Requirements

Table 1 shows the lighting requirements (light levels and photoperiods) for poultry production 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 and Photoperiods for Poultry Production

Type of poultry	Age (weeks)	Minimum light level (lx)	Photoperiod (hrs/day)
Chickens			
Broilers	0 to 2.5	20 to 30	24
	2.5 to market	5 to 10	24
Breeders	0 to 3	30 to 50	14
	4 to 20	30 to 50	8
	20 to 64	30 to 50	15
Layers	0 to 6	10 to 30	16
	6 to 18	5 to 10	8
	18 to 80	5 to 10	15
Turkeys			
New Hens	0 to 8	30 to 50	8
Grow Out, Hens	8 to market	30 to 50	8
New Toms	0 to 8	30 to 50	16
Grow Out, Toms	8 to market	10 to 30	16
Breeder Hens	0 to 5	20	24
	5 to 8	20	8
	8 to 22	20	8
	22 to 30	20	8
	30 and up	20	13 to 15
Breeder Toms	0 to 5	20	24
	5 to 30	20	13 to 15
	30 and up	20	13 to 15

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

Some stages of growth require high levels of light for an extended period of time. These light levels change for other growth stages. Dimmable bulbs allow for a controlled light level. Dimming a bulb will decrease the power used but the relationship between power used and light output does not correlate for some common bulbs as shown in Figures 3 to 5. The graphs also show the range of light level using household dimmer switches. Traditional incandescents will have better range of light levels than dimmable compact fluorescents and LEDs.

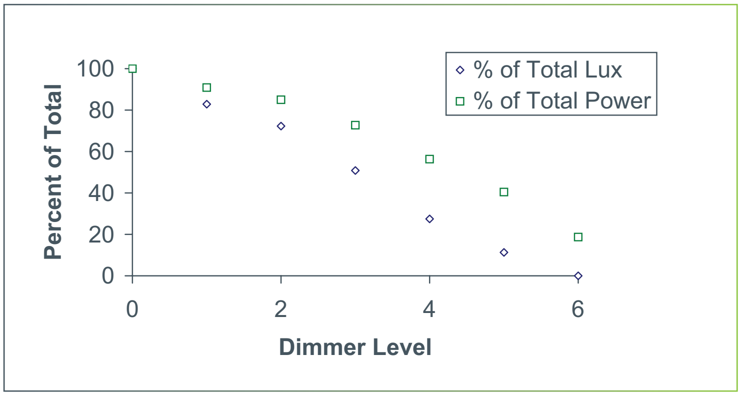

Figure 3. Decrease of Light Output with Power Used; 60 Watt Incandescent

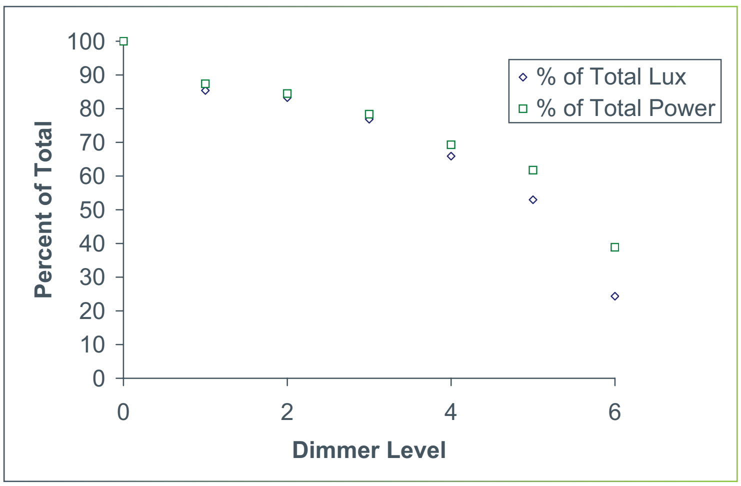

Figure 4. Decrease of Light Output with Power Used; 15 Watt Dimmable Compact Fluorescent

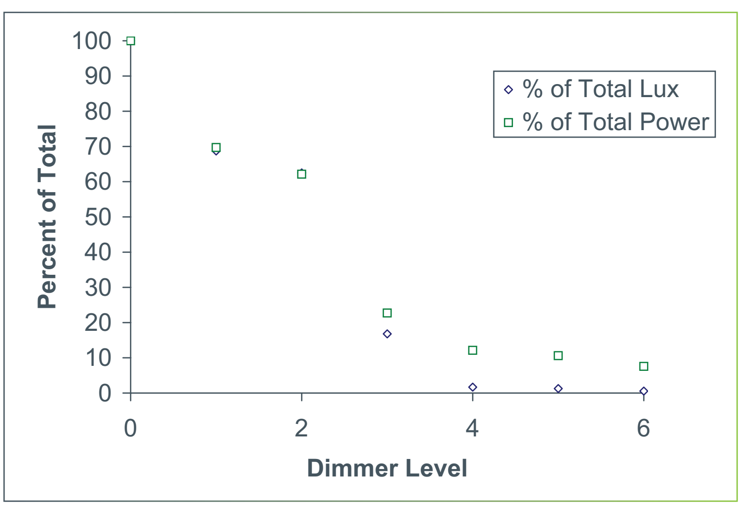

Figure 5. Decrease of Light Output with Power Used; 6 Watt Light Emitting Diode (LED)

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 2009

A Light Program Controller is typically used to set a light level schedule. These controllers can achieve light levels from 1% to 100% and can be programed to simulate dusk and dawn. Typically, they have been used for incandescent or fluorescent lamps. Traditionally, these controllers were not suitable for LED lamps because of the lower current draw but there are controllers available now which have been designed for dimmable LEDs. An alternative is to add a precision dimmer as shown in Figure 6 to the existing controller. This will allow the existing dimmer to dim low current draw lamps such as LEDs to accurate levels.

Figure 6. A PLS-7200 MR3 Precision Dimmer

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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 poultry applications such as incandescent or halogen (Figure 7), high pressure sodium (HPS), fluorescent tubes, and compact fluorescents (CFLs) (Figure 8). Recently, light-emitting diodes (LEDs) (Figure 9) have emerged as an alternative.

Figure 7. Incandescent and Halogen

Figure 8. Compact Fluorescent

Figure 9. Light Emitting Diode (LED)

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

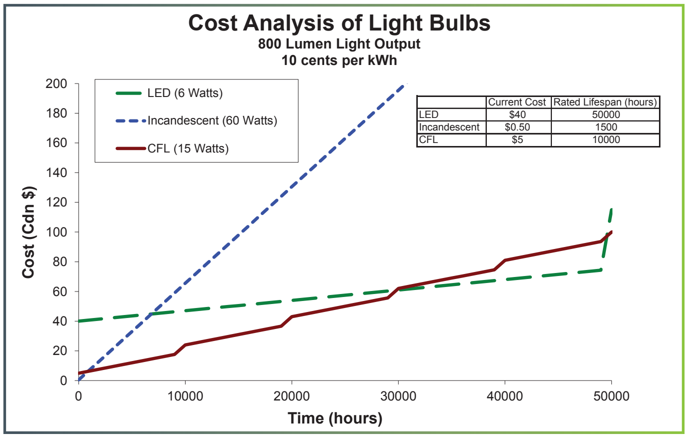

Figure 10. Cost Analysis of Light Bulbs

Shown in Figure 10 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 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. Since LEDs are a relatively new lighting option, the cost is per bulb is decreasing while the efficiency is improving.

Case Study

The lighting in two poultry barns of identical size was monitored for power consumption from 2010 - 2012 by ARD. In one barn, the existing incandescent bulbs were monitored and after one cycle of chickens (approximately 32 days), the bulbs were retrofitted with LED lights which are designed for use in a poultry barn. In the second barn, fluorescent lights were monitored. Over the course of about two years, the barns were monitored using power loggers set up in each barn. Table 4 shows a summary of the lighting technology used, costs, power used, and simple payback periods. LEDs had the largest retrofit cost but the longest life and the operating cost was low because of the low power draw. Retrofitting incandescents with either fluorescents or LEDs had a realistic payback.

Table 4. Lighting Retrofit Case Study

	Incandescent	Fluorescent	LED
Watts	60	32	8
Cost per Bulb	$0.50	$10 ($100 - dimmable ballast)	$60
Life of Bulb (hours)	2,000	20,000 (60,000 for ballast)	40,000
For Entire Barn			
Power Draw (max)	6,300 W	2,200 W	840 W
Total kWh Used per Cycle	2984	845	337
Energy Cost per Cycle	$298.40	$84.50	$33.70
Capital Cost of Bulbs per Cycle	$22.05	$109.20	$132.30
Total Cost per Cycle (capital + energy)	$320	$194	$166
Simple Payback Period (converting from incandescent)	-	31 Cycles	24 Cycles

Summary

There are opportunities for energy savings in a typical poultry 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 50,000 broiler operation is 38,540 kWh using incandescent bulbs. A saving of $2,954 to $3,404 per year can be achieved by switching to compact 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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