LED Grow Light Savings

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1 Introduction

In order to enable crop growth year round, indoor growing facilities are expanding throughout the world. Choice of proper lighting is essential to efficient crop growth. In addition, other system enhancements, such as automatic control of light timing, temperature maintenance and plant coverage, make the process more cost effective. Different crops require a variety of light wavelengths, color temperatures and intensities at various times in their growth cycle. Independent of these differences, we can estimate the advantages of using the appropriate LEDs for each type of growth, since they are available in a complete spectrum of colors and can be configured to satisfy the requirements for intensities. Most indoor crop growing facilities presently use either high-intensity sodium (or equivalent) lights (HPS), compact fluorescent lamps (CFLs), Metal Halide (HID) or light emitting diode lamps (LEDs). The purpose of this document is to present estimated cost savings of LEDs over a wide spectrum of grow lights.

2 Assumptions and Calculations

To fully understand the cost savings of LEDs over other types of lights, it is useful to list the advantages of using them for grow lighting. Comparison will be made of HPS, CFL, HID, Incandescent and LED type lighting for growing crops. Some of the advantages of LEDs over other lighting types include:

1. LEDs consume less energy for the necessary intensities required for plant growth. For these calculations, we use an average efficiency of 45 lumens per Watt for LEDs, 45 lumens per Watt for CFLs and 15 lumens per Watt for HPS lamps. Although HID lamps sometimes have better lumens per Watt ratings, the amounts of usable light for crops they deliver are more than 30% less than LEDs.
Ref: http://howtogrowmarijuana.com/compact-fluorescent-cfl-grow-lights/ and references therein.

2. LEDs have a much longer lifetime than CFLs and HPS lamps, which is anywhere from a factor of $2.5 - 5.0$ times. This advantage alone covers most of the cost differences for the initial installation of each type over the long run. Since costs of equivalent LED systems are constantly decreasing, this cost savings can be realized even sooner than before.

3. There is virtually no warm up time required for LEDs to reach full intensity, so this in turn saves on energy consumption (in kWh).

4. Since LEDs take up less space than HPS or CFL lights, they save in costs of constructing mechanical enclosures and are more shock resistant than other lights. This saves in both immediate costs and long term maintenance expenses.

5. In addition to the space savings, since LEDs have focused light (available in many angles) there are no external reflectors required in the enclosure. This also reduces the necessary space and initial system cost.

6. LEDs run cool, so no external temperature adjustment is necessary. This reduces the required size of the enclosure and its associated costs.

7. Unlike HPS lamps, no ballast is required for constant power consumption, saving on initial costs and space.

8. Combining many of these items, the current and heat management is efficient over even the larger areas required for some crops. This also saves on energy consumption.

The total estimate in savings includes energy costs, initial system and installation expenses. The savings are relatively independent of the wattage and the color temperatures of the lights. Thus, we assume that we are calculating the energy consumption (in kWh) for a one year period at twelve hours per day running. This amount can be scaled up or down for those crops requiring more or less light exposure. The energy costs are estimated for a 9000 lumens light on for twelve hours per day. This is meant to be an average, not a particular lamp for a given crop. Other assumptions made for the cost chart are:

1. The emphasis is on actual light received by the plant (in Lux), which is accounted for by including an efficiency factor for each type of light.

2. The calculations are done for 9000 lumens, which is a mid-range for different plants. To adjust the energy cost in the top line, just multiply by the ratio of the desired lighting and the 9000 lumens.

3. The amount of lighting used is based on 12-hour days for one year (4380 hours).

4. The cost per kWh is based on the Illinois average or about $0.10.

5. The lumens per Watt are taken from advertised lighting of that type for the equivalent light output of 9000 lumens.

6. Since LEDs require no additional temperature control circuits, no reflectors and no power ballast, these costs were added to the types of light that require them.

7. The circuitry required for LED operation is simpler than the other types, so the enclosures will be correspondingly smaller and less expensive.

Table 1: LED Light savings calculations

Cost Item	LED cost	CFL cost	HPS cost	HID cost	INCAND cost
Energy cost per year	$88	$88	$263	$131	$876
Temperature control	$0	$50	$150	$150	$150
Reflectors	$0	$50	$50	$50	$50
Ballast	$0	$30	$30	$30	$30
Enclosure/electronics	$1250	$1500	$1500	$1500	$1500
Electrical circuits	$1250	$1250	$1250	$1250	$1250
Total first year	$2588	$2968	$3243	$3111	$3856*

* This total does not include the replacement of bulbs, about four times per year.

2.1 Chart Notes

The chart indicates the amount of energy used based upon energy costs. Costs for the lights themselves vary widely by crop and are not included here. An additional factor in favor of LEDs is that several colors can be combined into one fixture for those crops that require multiple colors for different stages of growth. This could result in two to four times the cost for other types of lights over LEDs. This factor alone makes the LED choice favorable for those crop growers. In addition, the following comparisons can be made.

CFL vs. LED: Although the energy costs are similar for CFLs and LEDs, the savings are realized in external requirements outlined in numbers 4 through 7 in addition to the lifetime of $50,000$ versus $20,000-30,000$ hours average. CFLs typically have only one-fifth to two-fifths the lifetime of LEDs. An additional important factor is that CFLs contain mercury, which presents an environmental problem.

HPS vs. LED: HPS lamps have the highest requirement for temperature control, power and focussing requirements. Both the lumens per Watt ratings and the amount of light actually reaching the plants is far superior for LEDs. Thus, the HPS lamps are the most expensive to operate, outside of incandescents.

HID vs. LED: Although HID lights often have slightly better lumens per Watt ratings, the actual energy costs are greater due to the increased cost to deliver the proper amount of light for efficient crop growth. This is due to the light from HID lamps not being focused, so that some is lost into heat, in spite of reflectors. The necessity for reflectors adds to the auxiliary costs and only brings the energy efficiency somewhat less than LEDs. See the link http://albenergysolutions.com/switch-from-metal-halide-to-led-lighting/ for more information. Enclosure and electronics costs are estimates, based upon retail marketing quotes and could vary, depending on the amount of auxiliary parts needed. These costs do not include the lights themselves, but most auxiliary costs. Note that crop growers that use HPS lights for the flowering and budding stages must, in general, use HID lamps for the blue spectrum vegetative growth. This would require two separate lighting systems. Using full spectrum HID lamps for the entire growth cycle fixes this problem, but HID lamps are only guaranteed for $20,000$ hours while LEDs usually last between $50,000$ and $100,000$ hours.

Metal halide lamps start out with fairly high lumen output, but depreciate in output quite quickly. In fact, the lighting output begins to decline just as soon as you turn on the power to the new bulb. When it gets to 40% of its rated life, the metal halide has lost somewhere in the range of 30-40% of light output, and as low as 40% of its initial lumens by the end of lamp life. By contrast, LED sources fade very slowly over time. Well- designed LED lighting fixtures can retain 70% of their initial output up to $100,000$ hours, depending on operating conditions and other factors. At 12 hours per day of continuous use, such fixtures can deliver useful light for ten to twenty years or longer. See http://albenergysolutions.com/switch-from-metal-halide-to-led-lighting/ for further details on LED advantages over metal halide lamps.

INCAND vs. LED: Not only are the energy equivalents and lumens per Watt much more advantageous for LEDs, the replacement costs for incandescents are much larger over the long term. LED lamps can have over 50 times the lifetime of incandescents. Since this amounts to lifetimes of $1000-1200$ hours, the incandescents would have to be replaced $4-5$ times per year, while the LEDs can last $10-20$ years. See http://www.designrecycleinc.com/led comp chart.html for further details.

3 Final Thoughts

The savings for grow lights just in the first year are substantial. In subsequent years, the longer lifetime of LEDs and energy costs will add up significantly. Thus, although the payoff for LEDs may vary, depending on the initial costs for a particular crop, they will in short term pay for themselves. Note that these calculations are only for one fixture and must be multiplied by the number of fixtures required for a particular facility. This can be a substantial cost savings. Thus, the overall cost for an LED system is less than any of the other type of lights for crop growth.

Not included in these estimates are cost savings realized by any additional features provided with a lighting system, such as automatic on/off control and intensity monitoring that would contribute to the efficiency of growers lighting needs. Growers can enjoy greater crop yields in less time, while producing higher quality crops.