Air Conditioning The Indoor Growing Environment

1. What The Heck?

Don't we just need to know what the best LED light is? That's what everyone else talks about. Be patient, we'll get to LED lighting in our lighting discussion to follow.….

THE most important thing you can know about indoors growing is that no matter what lights you use, they will add SO much heat to the building that you'll need a big A/C unit just to keep the temperature down to a reasonable level! A lot of people, because they are doing small scale indoors growing, don't even have a clue about this; because even though the lights are putting out heat, they're only growing eight or ten square feet; nothing to worry about. We're talking about indoors grows of 5-10,000 square feet and larger. Let's explain why heat is such a concern in these larger grows:

2. Some Basic Rules Of Physics

No electric light converts all the electricity you feed into it into light for your plants. Some of the electricity comes out in the form of light, and some radiates out as heat. This is called "waste heat", because it is simply a waste of your money. Even worse, it heats up the inside of your growing area so that you need to spend even more money buying and running a large A/C unit to keep the temperature down in the comfort range for plants and people.

Even though LED's don't put out **much** heat, they **do** put out heat; even the best ones; the 44% efficient ones. In an enclosed space, such as an indoors aquaponics farm, that heat will build up until it's 100 degrees, 105 degrees, then 110 and 120, and so on. It will probably stop around 130 degrees F. But that's way too hot for people, and will fry all your vegetables!

To get a sense of this, imagine you're inside a nice cool, 75-degree house in Phoenix, Arizona, in the middle of a 115-degree July day outside, and the air conditioning breaks. That house will get up into the 130-140 degree range within a few hours. So will your indoors farm, until you do something about it. And the best thing to do is to get the most efficient LED's on the market, then put in the right size air conditioning unit to handle the waste heat from those lights.

The biggest surprise is that unless you're in Alaska, Northern Canada, or Mongolia, you'll still need to run that A/C unit in the wintertime! Even the best lights put out so much heat that they'll heat your grow space up into the 90's and 100's or higher, even if it's in the 40's outside. And if you have to run your A/C during the wintertime to keep an indoors grow cool, imagine how much you'll have to run it in the summertime!

3. Electrical Cost And Heat Reduction

Maybe you've heard: "flourescent lights are efficient and hardly give out any heat". That's true, compared to standard incandescent lights, which put out 96% of their electrical consumption as waste heat; that doesn't mean flourescents don't give out any. A "High Output" T5 flourescent light puts out 13% of the incoming electricity as light, and 87% as waste heat. And the only thing you can do with waste heat is purchase and run a big A/C unit.

But the answer to that problem must be LED lights, right? They're even more efficient than flourescents, so won't they solve this problem? Let's look at the numbers for LED's: the best LED lights are 44% efficient, and give out 56% waste heat; but many are down around the 12% efficiency level, and give out 88% waste heat. Take a look at these numbers with our spreadsheet "Air Conditioning Estimate Spreadsheet" to see what we're talking about. A spreadsheet is really the only tool to understand the interplay of 6 to 10 variables in a mathematical equation, which is what figuring out how much air conditioning you need is.

4. **"I already have a warehouse or building with A/C"**

Even if you have an existing warehouse or storage building that "already has" A/C, it's totally undersized for handling the additional waste heat that the tens of thousands of watts of light you'll use will generate. You will probably need to upgrade it, or add an additional A/C system to handle the additional heat load that the lights impose on it. You may also need to install an additional "electrical service", for powering both the lights and the air conditioning. Although you may be able to bring in some outside cold air in the wintertime to help with cooling, there are limits on this that are best explained by your mechanical engineer; he's the guy who designs the air conditioning and ventilation system for your indoors farm. That's WAY beyond the scope of this manual!

Needing A/C for an indoors grow is a fact. And it's not an obvious one, unless you're a mechanical engineer (that's an air conditioning engineer). So if you have any doubts about this, or are simply hoping your indoor grow will work, consult an engineer. Take them the specifications of the lights you plan to use, how many of them, and how big the space you're putting them in is. Even if you like to believe in fairies at the bottom of the garden, talking to a mechanical engineer about how much A/C unit you need to buy, and how much electricity will be required to run it, will get you back into reality quickly.

Don't go ahead with your indoors grow, without consulting your electrician and a local mechanical engineer. They will tell you if 3-phase service is available at your location, and probably advise you to put in a **single** 208Y/120V 3-phase service in the size the engineer recommends. You'll be able to run **all** your single-phase 120 volt AC lighting, aquaponic equipment, and other A/C equipment off this. A 3-phase air conditioning unit will use less electricity, and cost much less to run than single-phase A/C equipment, as will your aquaponics blowers and water pumps, because anything with a motor that you can run off 3-phase power saves you about 12% on your electric bill.

IMPORTANT! There is a bright side! Because you decide when to turn the lights on, you can run the lights at night (rather than during the day). This will leverage the nighttime cool and cost you less to run the A/C than running it during the daytime. And you and your employees can work a normal shift during the daytime to do your harvesting, seeding, and cleanup operation.

Now, isn't that naturally-lit aquaponic operation in a greenhouse starting to look more attractive?

5. **How much electricity do the lights and the A/C use?**

Let's start with the lights: we'll compare a "top-end" 44% efficient 100-watt LED to an "average" inexpensive 100-watt LED that is 15% efficient. The top-end LED is 44% efficient, so that means it puts out **44 watts of light and 56 watts of waste heat.** That's pretty good!

Now let's look at the average LED, which also uses 100 watts of power. It only puts out 15 watts of light, **so you need to buy three of them to put out the same amount of light**

as the 44% efficient, top-end LED puts out. This should be your first warning that something's wrong: your "inexpensive light" just got a lot more expensive when you have to buy three of them!

Unfortunately, that's not all the damage: because your light is only 15% efficient, it also puts out more waste heat: 85% waste heat, in fact, or 85 watts of waste heat. Right? **Wrong!** Because you needed to buy three of them to equal the output of the efficient light, you've got 85 watts times 3, or 255 watts total waste heat!

Let's compare power consumption now:

1. Our 44% efficient, 100-watt LED uses 100 watts of power, and puts out 44 watts of light and 56 watts of waste heat.
2. Our THREE 15% efficient, 100-watt LED's use 300 watts of power, and put out 255 watts of waste heat.

That's not all; we forgot to check out the PAR light output of the cheap lights! (What?).

PAR LIGHT:

In addition, these inexpensive lights do not put out as much PAR light as the top-end LED's do. What's PAR light? PAR stands for Photosynthetically Active Light; that's the light that the plants **actually use to grow with**. You can't see it, but the plants sure know when it's there and when it isn't.

In addition to putting out less light, the inexpensive LED's also put out less PAR light, **so you really need FOUR of them to equal the amount of usable light that one 44% efficient LED puts out.** They don't look so inexpensive now, do they, if you have to buy four times as many!

Our Final Waste Heat calculation:

One of these 15% efficient LED's puts out 85% waste heat, or 85 watts of waste heat. Because you have four of these lights, you put out 340 watts of waste heat (4 X 85 watts = 340w). This is 6 times the waste heat that the "expensive" 44% efficient LED put out. **This means you need an air conditioning unit 6 times bigger than the one you'd buy if you'd bought the 44% efficient LED lights!**

By choosing your lights based on price rather than efficiency, you have to buy four times as many inexpensive, inefficient lights; and that's expensive! Because those inefficient lights put out 6 times as much waste heat, you'll also have to buy an A/C unit 6 times bigger, and spend 6 times as much paying for electricity to run it, **FOREVER!**

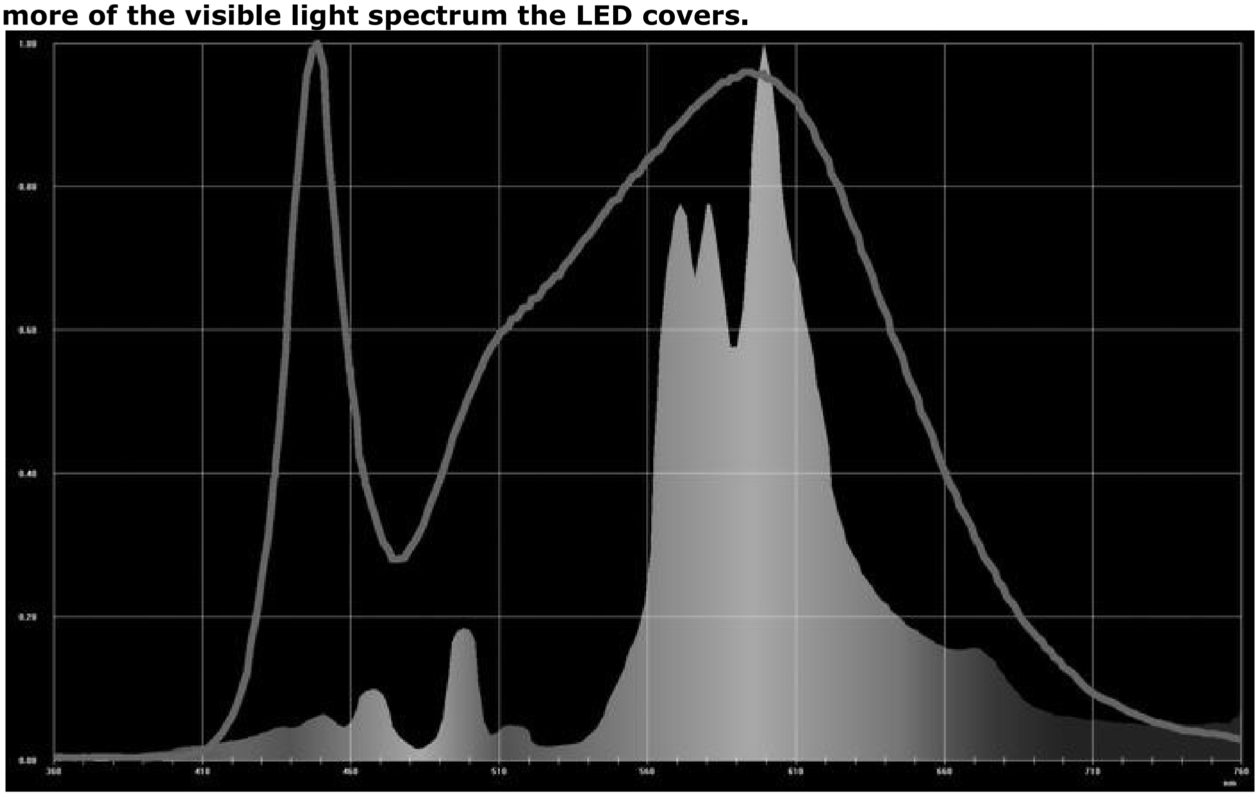
Our final total cost calculation for using 15% efficient LED lights:

That's not the end of the story: our original 100-watt LED, at 44% efficiency, only puts out 56 watts of waste heat. The wattage required to run the air conditioning unit you need to get rid of that is 56 watts X 0.3015, or 16.88 watts. **Your total electricity requirement** to run one 44% efficient 100-watt light **and** to get rid of the waste heat from it is **116.88 watts**. We put that in bold so it's easy to remember.

Our original "inexpensive" 100-watt LED, at 15% efficiency, puts out 85 watts of waste heat. But you needed four of them, remember, to give your plants the same amount of usable light that the single 44% efficient 100-watt LED puts out. Four of them use a total of 400 watts of electricity.

Four of them also give you a total of 340 watts of waste heat to get rid of. The wattage required to run the air conditioning unit you need to get rid of that is 340 watts X 0.3015, or 102.51 watts. **Your total electricity requirement** to run four 15% efficient 100-watt light and to get rid of the waste heat from them is **442.51 watts** (400 watts to run them, plus 102.51 watts to run the A/C to get rid of the waste heat). **That is almost four times as much electricity in total!** We put that in bold so it's easy to remember.

(Below) The spectrum (line) of a 44% efficient LED compared to the industry-standard for the last 30 years, High-Pressure Sodium (shading). Note how much more of the visible light spectrum the LED covers.



Here's the bottom line: if you get 15% efficient LED's, you need to buy four times as many light fixtures, get an A/C unit six times as big, and pay for four times as much electricity forever, as if you'd bought 44% efficient LED's. There's really no choice for an intelligent person to make; get the 44% efficient LED'S!

Does that mean that if I buy 44% efficient LED's, my indoors aquaponic farm will be sure to make money? It's too early to tell; because we've just scratched the surface of the issues you'll have to deal with.

The Relative Efficiency of Different Types Of Lights:

1. THE BEST CHOICE: the high-efficiency, high-output LED'S flourescent lights that are made by Nick Brumm, the owner of Nextlight Systems. Nick's lights use Samsung high-output LED's (they're the best), are 44% efficient, and only generate 56% waste heat. **They also mimic the "spectrum" of natural sunlight almost perfectly**, so they are

50% to 100% more efficient at delivering PAR light that the plants can actually use. What's PAR?

PAR stands for Photosynthetically Active Radiation, and is the only accurate way to compare two or more lights to each other. Lumens, the measure most lighting manufacturers use to rate their lights, are meaningless unless combined with a PAR light rating; the amount of lumens a light puts out doesn't tell you anything about how much usable light the plant is getting.

Nick's lights use a high-quality LED chip manufactured with the best dye on the market, so they emit very small amounts of waste heat; as a result, they DON'T need to be water-cooled like some other "vertical farming LED's" do!

Although the people who sell those water-cooled lights will try to tell you that the water-cooling is a "feature" and a benefit, water cooling an inefficient LED uses just as much electricity as an air conditioner would to cool the air, if the same lights had no water cooling. The whole "water-cooled" thing is just a head fake to keep you from seeing the real problem: these LED's are inefficient, and you're going to have to spend a ton of money getting rid of the waste heat from them.

You can email Nick at nick@nextlightsystems.com , and help convince him you are an emerging market for his products. Just say: "We're building an indoors farm, and we'd like you to price some efficient lights for us". These are the **perfect** lights for an indoors farm, and will save you tens to hundreds of thousands of dollars on electrical costs for lighting your farm and for air conditioning to get rid of the waste heat.

The more lights he sells, the more the price for those lights is going to come down. They also offer a "lease to own" program, so you don't have to purchase the lights outright, with a big upfront cost. You can see their current product line at http://getnextlight.com/nextlight/.

2. AN EXPENSIVE AND INEFFICIENT ALTERNATIVE: The "other" LED's on the market are less efficient than this; they only convert 9-20% of the electricity into light, and convert 80-91% into heat. You need two to five times as many lights, which means you will be using two to five times as much electricity for the lights. And, as we've learned in this series, you will ALSO have to install an air conditioning unit TWO TO SIX TIMES AS BIG as the one requires by the lights described in #1 above.

3. An even more expensive and inefficient alternative: Flourescents: Flourescents are not much good. Even high-efficiency, high-output flourescent lights like the T5HO's are only about 13% efficient in converting electrical energy into light to your plants. The other 87% of the electricity is emitted by the lights and their "ballasts" as waste heat into your growing area.

That doesn't sound too bad until you understand that a flourescent uses approximately **twice** as much electricity as even a 13% efficient LED, so it puts out twice as much waste heat for the same amount of light. If you go back to #2, and do some simple math, you'll realize that flourescents will use four to ten times as much electricity for both lighting and getting rid of the waste heat, as do 44% efficient LED's.

4. Other types of lights: sodium vapor, halogen, mercury vapor, all use a LOT of electricity for the amount of light they put out, and put out an incredible amount of heat compared to even flourescents. They are what you'd use if you owned the electric company, the air conditioning company, and the company that makes these lights.

Take a look at these numbers with our spreadsheet "Air Conditioning Estimate Spreadsheet" to see what we're talking about.