Lighting Upgrades for CEF Growth Chamber Efficiency

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INTRODUCTION

The UC Davis Controlled Environment Facility (CEF) houses 165 growth chambers to support plant research. The chambers use High Intensity Discharge (HID) lamps and Fluorescent lamps that use large amounts of electricity as well as cause problems during disposal because they contain mercury. To decrease their energy usage and lifecycle impact, the CEF has asked us to investigate LED technology that could be used to replace the current lights while mitigating impact to ongoing research at the facility.

Growth Chambers:

Growth chambers are highly-controlled indoor plant-growing environments.

They are designed to recreate the ideal plant-growing environmental conditions (light levels, humidity, and temperature) to maximize plant growth.

CONSTRAINTS

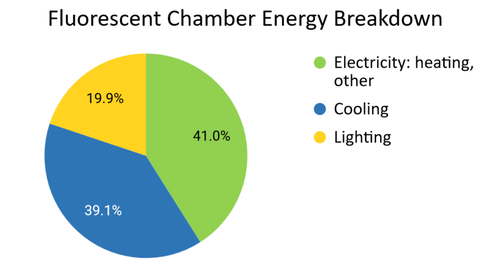
- No impact to ongoing research
  - Spectrum should match the current lamps or be closer to the Sun's spectrum
  - Lumen output should match the current lamps
- Energy use should be lower
- The lamps should have a payback period under 20 years
- Disposal should be non-hazardous waste
- The new lamps must fit in even the smallest chambers

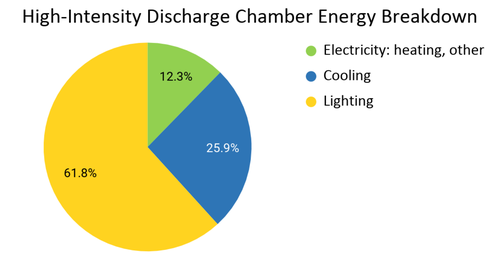
METHODS

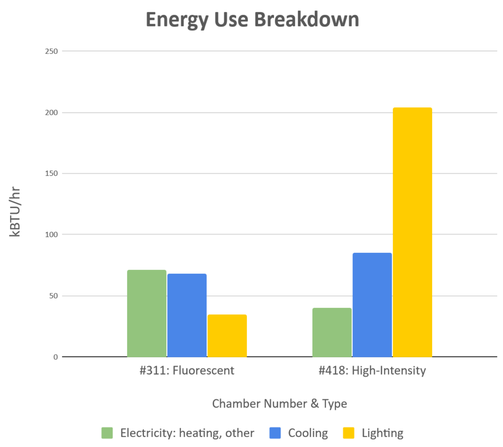
Used the Onset HOBO RX3000 Remote Monitoring Station Data Logger to obtain current data for two chambers, a chamber with Fluorescent lamps and a chamber with HID lamps.

Data for the cooling and electrical systems was logged over a six-day period and used to obtain an energy breakdown for the two chambers.

ENERGY BREAKDOWN



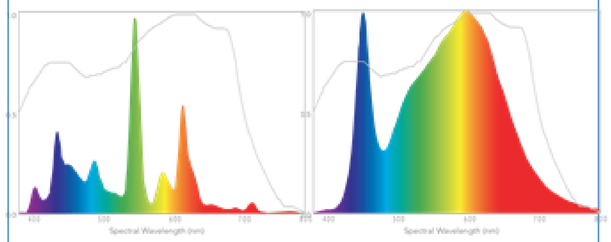


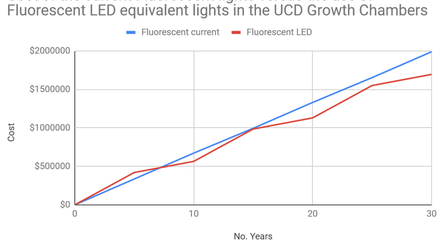


LED UPGRADES

Fluorescent Replacement: FGI Light Bar 185

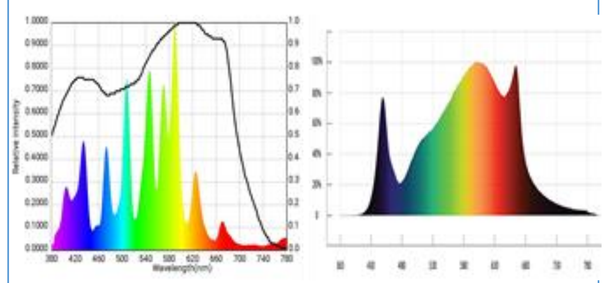
- Watt: 185
- PPF: 487 umol/s
- Lifetime: 9-10x
- Cost: $525

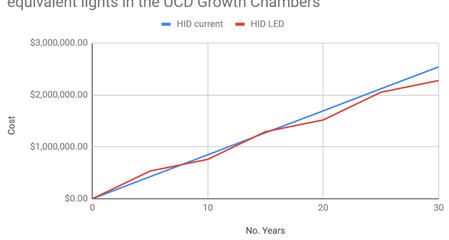




HID Replacement: Fluence VYPR 2p

- Watts:630
- PPF:1700 umol/s
- Lifetime:3.3x
- Cost:$1,300





CONCLUSIONS

Under the current assumptions and data, the LED upgrades would be a good investment for the CEF. The new technology would break even with the current lights after 15 years, even though the initial investment per light is higher.

The new technology will also be able to provide more complete light spectra that more closely matches the Sun and less hazardous waste.

FUTURE WORK

There are a few steps that would further the understanding of the replacement of traditional lighting to LED lighting. First, placing current transformers on all chamber systems for better collection. Then, we would be able to calculate any additional heating costs associated with the lighting replacement.

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