



Bringing Efficiency to LightSM

Staying Out of the Dark Horticultural Perspective

Energy Codes 2019 – Denver, CO

Who Are You, Anyway?

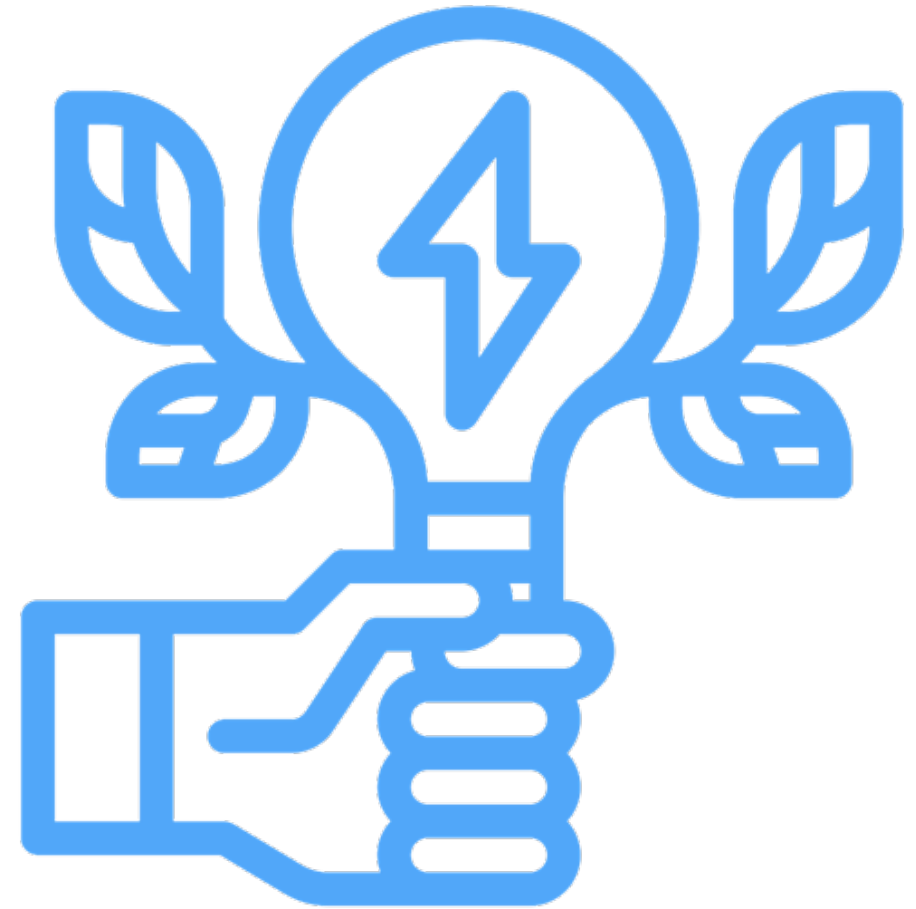
- Proud residents of Medford, MA
- Small nonprofit
 - “20 people with a blog”
- We help utilities show prudence when choosing what to incentivize for efficiency programs
- General lighting, networked lighting controls, and now, horticultural fixtures



Wikipedia

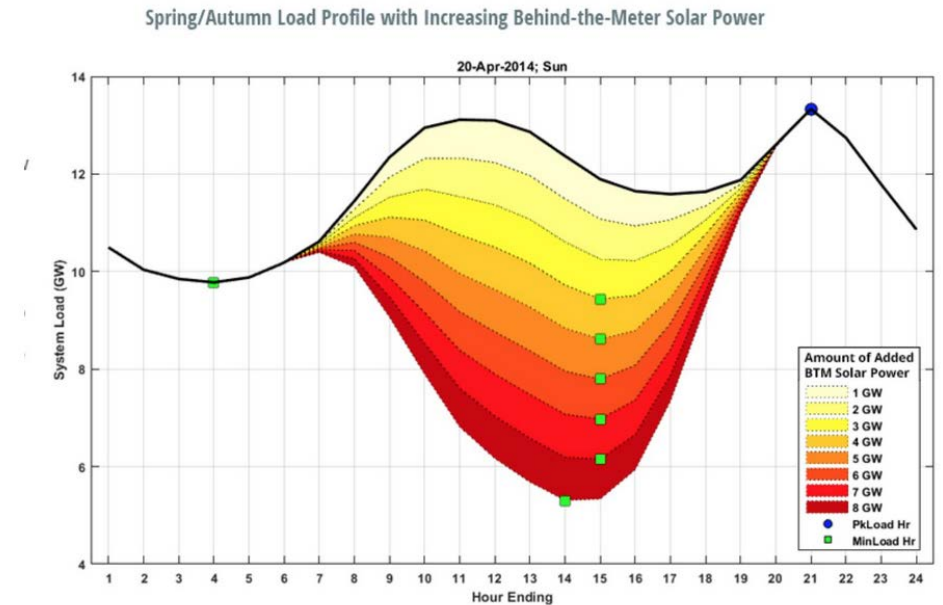
Why Hort Fixtures? Energy!

- Controlled Environment Agriculture (CEA) uses energy, and lighting is a big piece of that
- DLC member utilities need to get a handle on this load
- Industry is in the early stages, with rapid tech and product changes occurring
 - Performance claims have some issues
 - But LED *can* give us at least 40% savings versus baseline



But It's Not Just "Efficiency"!

- Keeping CEA loads small is important, but so is *managing* those loads.
- A single meter could represent 5MW or more – think of the peak / DR implications
 - Generation
 - Transmission
 - Distribution
- Growers are already controls-savvy



Source: ISO New England

ISO New England will hit the 3-gigawatt level by 2019, driving down the minimum load level. (Image credit: ISO-NE)

Greentech Media

But They're Just Light Fixtures, Right?

Hort	Photosynthetically Active Radiation (400-700 nm)
Human-Based	Visible Light (380-770 nm)
Hort	Photosynthetic Photon Flux ($\mu\text{mol/s}$)
Human-Based	Luminous Flux (lumen)
Hort	Spectral Quantum Distribution ($\mu\text{mol/s/nm}$)
Human-Based	Spectral Power Distribution (W/nm)

Hort	Photosynthetic Photon Flux Density ($\mu\text{mol/s/ft}^2, \mu\text{mol/s/m}^2$)
Human-Based	Illuminance ($\text{ft-cd}, \text{lux}$)
Hort	Photosynthetic Photon Intensity Distribution ($\mu\text{mol/s/sr}$)
Human-Based	Luminous Intensity Distribution (lm/sr)
Hort	Photosynthetic Photon Efficacy ($\mu\text{mol/J}$)
Human-Based	Efficacy (lm/W)



Is LED Up To The Job?

- Baseline: most efficient existing product – the 1,000W HPS
- DOE / Navigant study: overnight potential savings of 40% to switch CEA fleet to LED
- A-B studies of HPS-LED in cannabis grow rooms have begun – see SMUD study linked here.
 - “Life . . . finds a way”:
 - Biological systems are chaotic, and it’s difficult to truly isolate a single variable. But, yields have been within normal ranges.
 - Plants aren’t machines – they change their phenotypical expression according to their environment. But with careful monitoring and adjustment, growers are succeeding in the switch to 100% LED.



How Does This Help Today?

- Any listed product will be **at least** 10% more efficient than 1,000 HPS.
- Compare product performance in a standardized format
- Collect third-party-verified performance for better future decisions
- Set an automatic upward efficacy “ratchet” every two years



How Might This Help Tomorrow?

- Publish statistics on market-wide product trends
- Potential “Premium” quality for the top 25% of products
 - Spectral minimums crucial, though
- Different categories
 - Top, intracanopy, supplemental, sole-source, etc.
- Different spectra
 - YPF? PSS?



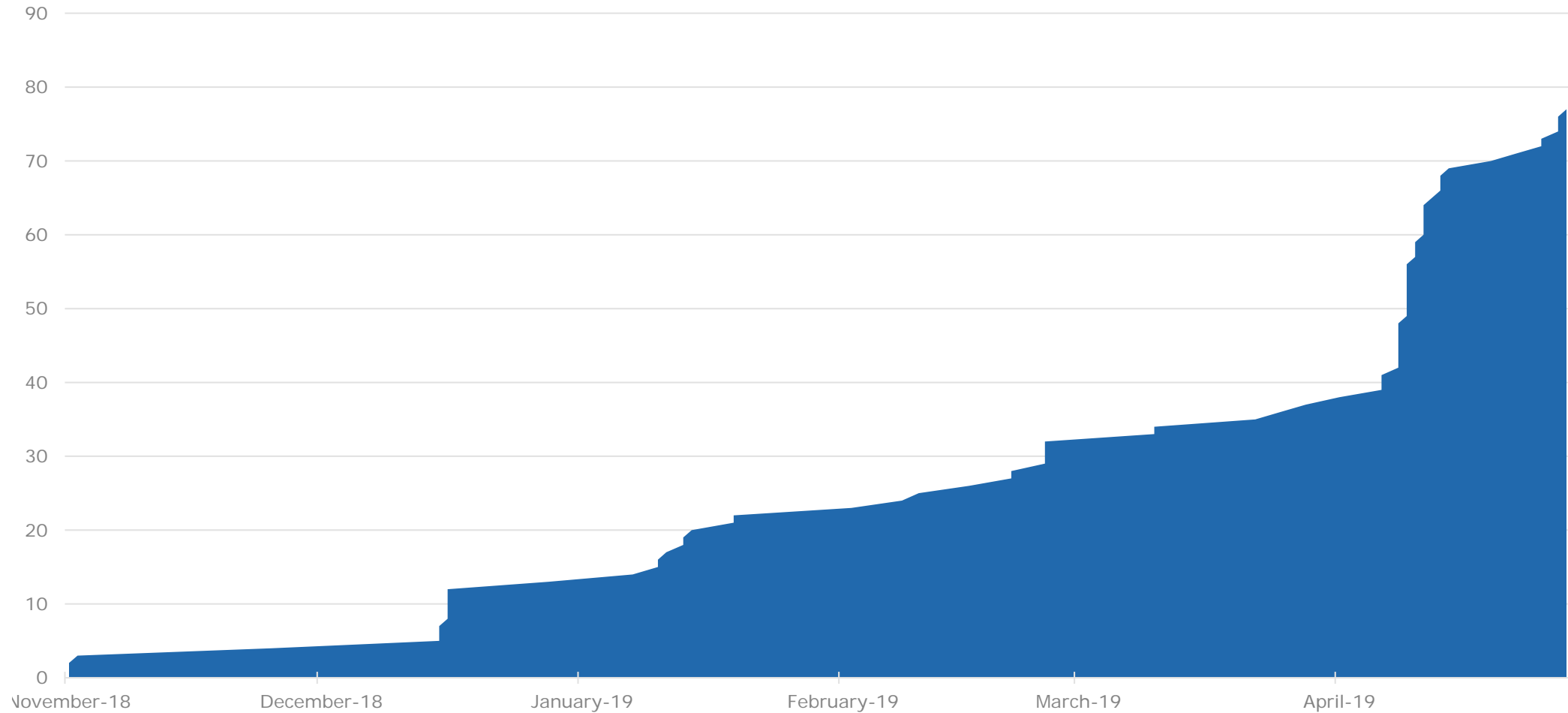
What Don't We Know?

- Is Far Red universally useful to plants? In what amounts / timing / application?
- What role should UV play?
- How does dimming work with plant biology?
- What are the “mixes” of various wavelengths that will be important?
- ???

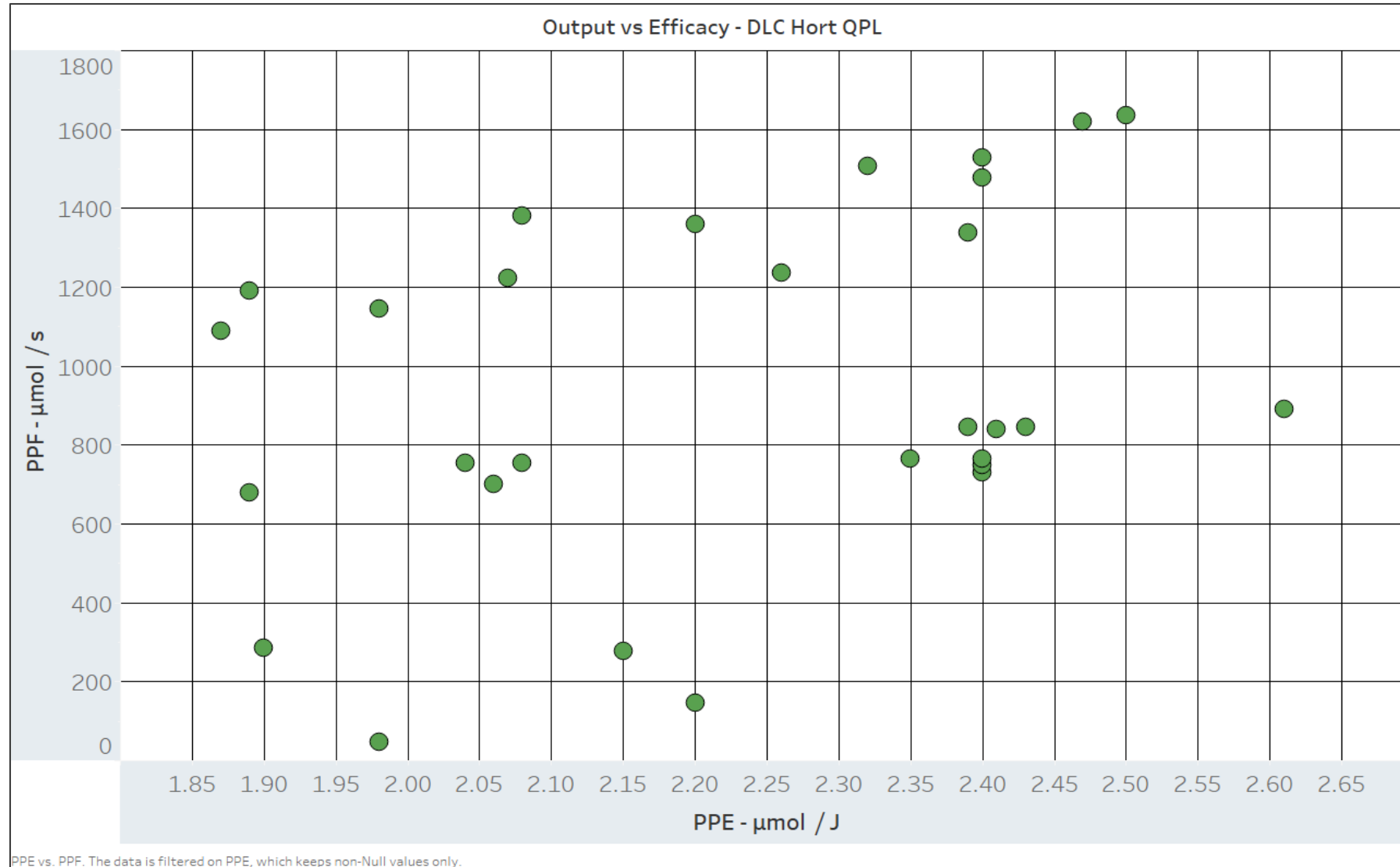


“Where Are My Hort Fixtures?!?!”

Cumulative DLC Hort Applications

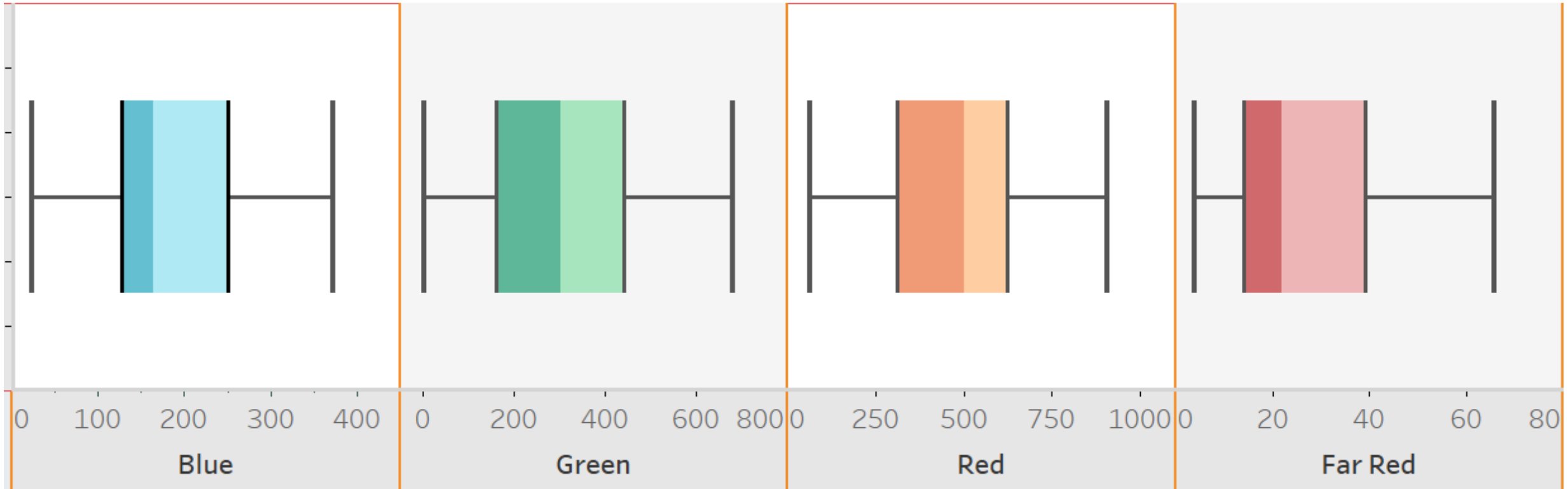


Finding the Flux



Spectrum Stats

Photon Flux, $\mu\text{mol} / \text{s}$



Great, What Do We Do With This?

Appliance



- Fixture conversion of watts to photons
- Doesn't need facility design info – fast and easy to admin
- Potential for overlighting

Outcomes



- What is your crop efficiency in kWh / kg?
- Hardware-, crop-agnostic
- Backward-looking
- Variation across cycles

Blended



- Facility design criteria, in power density
- Hardware-neutral, crop-specific



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Thank you!