DLC Horticultural Lighting Resources:

# Horticultural Lighting & Application Design

## Considerations for applying LED-based horticultural light fixtures

While each horticultural lighting design application is unique, there are topics that should always be considered before purchasing and installing LED-based light fixtures in a horticultural facility. This document is meant to help the reader understand some of the most crucial factors in horticultural lighting application design, and point the way to outside experts who can provide insight into an appropriate whole-facility design.

## Facility parameters

When considering a new or retrofit lighting installation, growing facility parameters must be considered. One is the facility height, which must accommodate the maximum plant height, the height of the selected lighting fixtures, and the additional distance between the fixture and plant canopy. These variables combine with fixture-specific optical and output parameters to dictate the achievable photosynthetic photon flux density (PPFD), the engine for plant growth, at varying heights throughout the growing area. Another important facility parameter is the Heating, Ventilation, and Air Conditioning (HVAC) system, which needs to accommodate the heat generated by the lighting installation while meeting overall temperature, humidity, and sanitation needs.

## Plant requirements

Plant requirements are equally as important as the facility parameters. While each application will have its own specific requirements, there are general plant requirements that should be considered. These include the Daily Light Integral (DLI) for the specific horticultural application (daily and seasonal requirements), the required intensity of the photosynthetically active radiation (PAR) light emitted by the light fixture, and canopy height and required DLI for all plant growth states. Also, the preferred lighting interval (and even tolerance of interruption of said interval) for each of these stages should be considered and should align with the operating hours of the growing facility.

It is important to remember that not every fixture produces the same quality or quantity of light. Not every fixture is equally suitable for every application, and many LED-based products have not been developed to act as one-to-one replacements of legacy fixtures. Consider PPFD, PAR, DLI and other plant/application-specific lighting requirements (including spectral content) to ensure the best design is implemented.

## Installation comparison

After defining specific facility parameters and plant requirements, compare designs to better ensure the optimal application-specific solution. Baseline comparison values should include:

- Confirmation that design alternatives deliver the same needed DLI to the crop
- Confirmation that design alternatives remain within the crop's needed uniformity of light intensity

Once the baseline comparison has been established and the requirements have been determined, various points may be directly compared. These may include cost of operation, cost of installation, cost of total energy usage, expected effects on HVAC or building construction requirements, and labor savings, among others.

## Additional benefits and potential drawbacks

In retrofit installations, the switch to LED-based horticultural light fixtures will most likely change the use of the HVAC system in the growing facility. In areas with a cooling-dominated climate, this can be beneficial. But in areas with a mixed or heating-dominant climate, the reduced waste heat of LED-based fixtures must be considered as part of the overall facility energy balance, since it is possible that extra energy will need to be delivered to meet the facility's heating needs.

Basic or networked control for horticultural lighting facilities is in its infancy, and there are promising studies that show the potential to tune crops by modulating their light supply. *How* controls are used is being studied, with investigators examining how various wavelength and dimming regimes may help or hinder a crop. Finally, controls can add a valuable grid-support function that uses the high power density of horticultural facilities: if a crop can tolerate interruption to its DLI, a facility could be a useful candidate (and receive income) from participation in utility demand response programs.

## Would you like to know more?

This document is intended to introduce concepts at a basic level. For more detailed information, please refer to the standards and/or research bodies listed below:

- The American Society of Agricultural and Biological Engineers (ASABE)
- Greenhouse Lighting and Systems Engineering (GLASE)
- The Illuminating Engineering Society (IES)
- Lighting Enabled Systems & Applications (LESA)
- The Lighting Research Center (LRC)
- The Resource Innovation Institute (RII)

Each of these entities has been instrumental in the development of the DLC horticultural lighting requirements, and the DLC looks forward to continued cooperation with all in maximizing the horticultural sector's energy efficiency and productivity.