|  |  |  |
| --- | --- | --- |
|  | | |
| **Memo to:** |  |  |
| Willdan’s study authors (Jeff Hirsch, James J. Hirsch and Associates, Kevin Madison, PNNL, and Felix Monterroso, Willdan)  TRC’s study authors (Susanne Lehre, Glen LaPalme, Andrew Gustafson, TRC)  PG&E  SCE  SDG&E | **From:** | Custom Project Review (CPR) team |
| **Date:** | June 20, 2023 |
|  | **Prep. By:** | Sepideh Shahinfard, Quantum Energy Analytics  Rashid Mir, CPUC |
|  | | |

**CPUC Staff Response to the Cannabis Lighting Standard Practice Studies Performed by Willdan and TRC**

The CPUC has approved the following standard practice and minimum measure PPE (Photosynthetic Photon Efficacy) values, referred to as efficacy, for cannabis lighting projects based on the grow type. These values have undergone a rigorous approval process, which involved extensive discussions with stakeholders. Two proposals, submitted by the Willdan team and TRC, were thoroughly reviewed and considered during this process. As a result, the following approved values are now established as the official guidelines for all cannabis lighting projects. These guidelines reflect the collective input and expertise of stakeholders involved in the review process.**[[1]](#footnote-1)**

Table 1 Standard Practice and Measure Eligibility Requirements for Indoor Single Layer Operation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Standard Practice | | | | Measure |
| Year | LED Fraction | Non-LED Efficacy (µmol/J) | LED Efficacy (µmol/J) | Standard Practice Efficacy (µmol/J) | Minimum LED Efficacy  (µmol/J) |
| 2023 | 75% | 1.9 | 2.48 | 2.34 | 2.76 |
| 2024 | 87.5% | 1.9 | 2.52 | 2.44 | 2.86 |
| 2025 | 100% | 2.3 | 2.56 | 2.56 | 2.96 |

Table 2 Standard Practice and Measure Eligibility Requirements for Greenhouse Operation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Standard Practice | | | | Measure |
| Year | LED Fraction | Non-LED Efficacy (µmol/J) | LED Efficacy (µmol/J) | Standard Practice Efficacy (µmol/J) | Minimum LED Efficacy  (µmol/J) |
| 2023 | 75% | 1.7 | 2.48 | 2.29 | 2.76 |
| 2024 | 87.5% | 1.7 | 2.52 | 2.42 | 2.86 |
| 2025 | 100% | 2.3 | 2.56 | 2.56 | 2.96 |

Table 3 Standard Practice and Measure Eligibility Requirements for Stacked Operation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Standard Practice | | | | Measure |
| Year | LED Fraction | Non-LED Efficacy (µmol/J) | LED Efficacy (µmol/J) | Standard Practice Efficacy (µmol/J)) | Minimum LED Efficacy  (µmol/J) |
| 2023 | 100% | N/A | 2.48 | 2.48 | 2.76 |
| 2024 | 100% | N/A | 2.52 | 2.52 | 2.86 |
| 2025 | 100% | N/A | 2.56 | 2.56 | 2.96 |

We also approve an annual improvement rate of 0.04 µmol/J for standard practice efficacy and an annual improvement rate of 0.10 µmol/J for minimum measure efficacy.

These results, derived from market data, are intended to serve as standard practice requirements for all 2023 cannabis lighting projects. 2024 and later projects shall use the above listed values until an update is produced and approved as noted below. These values are required to be utilized as outlined in the Standard Practice Baseline Selection Guidance specified in Attachment A of CPUC Resolution E-4939 quoted below (with emphasis added).

*“Step 1. Consider and apply any applicable and current CPUC published Standard Practice documents relevant to the anticipated functional, technical, and economic needs of the customer, building, or process. Such documents, which may include ISP study reports, DEER baseline values, or* ***CPUC-issued memoranda*** *or dispositions, will be publicly available on a single website with a date of issuance, applicability, and effective dates [endnote 3].* ***If applicable baseline information within these documents is found, apply it and stop here****.”*

The PAs are required to update these values annually. The next update should be submitted for review by CPUC staff no later than June 30th, 2024. However, recognizing that market changes may occur, and these results were developed using 2022 data, an earlier update may be submitted by November 2023 if there is compelling evidence of significant shifts in the market, as demonstrated by updated survey and product data. This earlier update is optional and provides flexibility for the PAs to respond to emerging trends or changes in the industry. The methodology for future updates should remain consistent unless revisions to the methodology have been approved by CPUC before commencing the update work.

It is important to emphasize that market survey data collected by the Cannabis Business Times (CBT) since 2016[[2]](#footnote-2) [[3]](#footnote-3) [[4]](#footnote-4) [[5]](#footnote-5) clearly indicates LEDs have become the dominant technology, with 70% of current cannabis growers of all types and sizes utilizing LEDs in their existing installations. Additionally, the analysis of the trends in CBT data over the past several years indicates that newly installed projects must have an even higher level of LEDs than the existing installations else the increasing trend would not have occurred. As clarified in Resolution E-4939[[6]](#footnote-6) when a technology becomes predominant, the CPUC mandates its adoption as the standard practice. However, utilization of a mixed baseline, as proposed here, is allowed when there is no predominant technology but rather more than one commonly used technology.

Given the significant share of installed LEDs and the consistent upward trend in LED adoption over the past seven years, it is clear that new installations, which the CPUC considers when determining standard practice, will include a considerably higher proportion of LEDs. This would effectively establish LEDs as the standard practice in subsequent years to 2023, and specifically that is directed for 2025. Additionally, as directed in Resolution E-4939[[7]](#footnote-7) Accelerated Replacement (AR) projects shall use the above directed values for the standard practice starting at the end of remaining useful life.

The standard practice values approved by CPUC staff listed above are based on a technology mix that includes non-LED technologies. These assumptions have deliberately been made lenient to exercise caution. However, we request Program Administrators (PAs) to take into account the market trends and the increasing adoption of LEDs when designing and implementing programs for this industry. For example, we note that the forthcoming Codes and Standards Enhancement (CASE) Initiative report for Controlled Environment Horticulture, scheduled for the 2025 Title 24, proposes a minimum efficacy value that would exclude non-LED technologies from the mix. The CASE report proposal suggests that LEDs may already be standard practice and that non-LED technologies should not be allowed by code in new installation within the next two years. However, CPUC staff feels that use of a mixed baseline for 2023 and 2024 is warranted for now during this “transitional” period.

We appreciate the efforts made by all stakeholders in identifying valuable market data sources and conducting comprehensive analyses to ensure accurate standard practice results.

# Background

CPUC staff has issued a number of dispositions for PG&E’s cannabis lighting projects in the past few years. These dispositions—including the most recent dispositions issued in June-July of 2022 for projects proposed under Willdan California Design Assistance (CEDA) and TRC Agricultural Energy Savings Action Plan (AESAP) programs—raised concerns about a number of issues. Disposition issues included program influence, cost savings calculations, energy savings calculations (including standard practice issues and other assumptions/algorithms used in the Grow Green Calculator), measure life, service level equivalency, and HVAC interactive savings.

In response to these dispositions and other ongoing statewide lighting efforts, the Willdan team and TRC provided two separate standard practice studies for cannabis lighting projects. This memo summarizes our feedback for these studies. Other issues including cost calculations, service level adjustment, HVAC savings, program influence and Grow Green Calculator assumptions and algorithms are not discussed here and remain open.

According to the CPUC Decision 12-05-015 at 351 (emphasis added):

*“For purposes of establishing a baseline for energy savings, we interpret the standard practice case* ***as a choice that represents the typical equipment or commonly-used practice, not necessarily predominantly used practice****. We understand that the range of common practices may vary depending on many industry- and/or region-specific factors and that, as with other parameters, experts may provide a range of opinions on the interpretation of evidence for standard practice choice.* ***Here again, we expect CPUC staff to use its ex ante review process to establish guidelines on how to determine a standard practice baseline****.”*

Consistent with this long-term CPUC policy, Resolution E-4939 at 17 states that:

*“h.) Consistent with existing policy,[[8]](#footnote-8) when Step 2[[9]](#footnote-9) of the adopted baseline selection process yields more than two feasible options, the most commonly implemented feasible option shall be used as the baseline. In cases where there is more than one commonly implemented feasible option, an appropriate composite of the commonly implemented feasible options shall be used for the baseline determination. The various options can be weighted using available data such as sales fraction data or the relative cost of the options, or by the relative energy consumption of the options. A rationally developed and well documented assessment of the available data should be used to determine a reasonable baseline in these cases. For example, in the case of lighting measures there are usually numerous options with varying prices and efficiency levels available in the marketplace. Sales data obtained from lighting manufacturers and/or other industry sources can been used to weight the options to determine a composite baseline. When there is significant price differential between the proposed measure and the rest of the market, a sales weighted average of the lower cost measures may be appropriate to determine the baseline.”*

Additionally, as directed in Resolution E-4939[[10]](#footnote-10) below, the baseline considerations for projects claiming AR must consider alternative values for the standard practice for the second period:

*“i.) In an Accelerated Replacement project or measure case the standard practice baseline assignment shall appropriately consider the practices expected for a normal replacement at the end of its Remaining Useful Life (RUL).”*

In our review of PG&E cannabis lighting projects, it was discovered that a baseline of 100% HID (High Intensity Discharge) lighting (with various types and efficacies) was utilized without conducting the necessary standard practice research. We have repeatedly requested PG&E to conduct this research in multiple meetings and discussions over the past few years. Recently, two program implementers have submitted separate studies to address this specific concern:

1. The Willdan team adapted the statewide general lighting standard practice methodology approved by CPUC staff to establish proposed standard practice efficacies for cannabis lighting. Willdan, PAs, and CPUC staff have collaborated over the past two years in developing a statewide standard practice methodology for general lighting (non-cannabis). Willdan has conducted two standard practice studies for general lighting, which have been extensively discussed within the statewide lighting group. These studies were approved by CPUC staff and are currently incorporated into the statewide custom lighting tool, known as the Modified Lighting Calculator (MLC). The Willdan team followed the same methodology to determine their proposed standard practice efficacies and eligibility criteria for cannabis lighting, taking into account additional considerations for the cannabis grow market. The study relied on market data collected by CBT to establish the standard practice technology mix. The Willdan team also addressed other concerns raised in CPUC staff dispositions, including measure cost and measure life. This study was submitted for CPUC staff review through the ongoing statewide lighting working group led by SDG&E in December 2022. In response to our initial feedback memo issued on April 26, 2023, the Willdan team submitted a revised study on May 11, 2023.
2. TRC conducted a secondary review of previous cannabis lighting studies but also used the 2022 survey data collected by CBT. Their conclusion was that LED is the standard practice technology for most grow stages, except for the single layer flowering stage, where double-ended HPS (high pressure sodium) is considered the standard practice technology. Standard practice efficacy values were determined using various data sources, including public test data for LEDs and HIDs, DesignLights Consortium (DLC) data, and 2022 survey data from CBT. TRC study did not discuss measure cost and measure life. This study was submitted for CPUC staff review by PG&E in February 2023.

After thoroughly reviewing both studies and their results, we found that Willdan's study methodology and results align with the statewide approach used for other lighting projects. However, we updated Willdan’s result to include a lower non-LED efficacy (1.7 µmol/J) for greenhouse projects based on the 2022 Title 24 minimum requirements for greenhouses. Willdan proposed typical double ended HPS fixtures as the predominant non-LED technology and used the 2022 Title 24 minimum efficacy requirements (1.9 µmol/J) for fully enclosed grow facilities.

# Willdan Standard Practice Analysis

Following the approach used for MLC, the Willdan team analyzed the 2022 DLC data to estimate the LED standard practice and minimum eligibility performance in terms of PPE. In addition, the Willdan team estimated the anticipated annual improvements to the standard practice to be applicable to AR projects for the second baseline period. A key difference between this analysis and the approach used for general lighting is that LED technology is not assumed to be the standard practice. Thus, the Willdan team estimated an appropriate composite of the feasible technologies commonly implemented by using the CBT “historical” survey data referenced earlier. Table 4 shows Willdan proposal for standard practice and measure eligibility requirements for all stages of cannabis grow including propagation, vegetation, and flowering.

Table 4 Willdan Proposed Standard Practice and Measure Eligibility Requirements

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Standard Practice | | | | Measure |
| Year | LED Fraction | Non-LED Efficacy (µmol/J) | LED Efficacy (µmol/J) | Weighted Efficacy (µmol/J) | Minimum LED Efficacy (µmol/J) |
| 2023 | 75% | 1.9 | 2.48 | 2.34 | 2.76 |
| 2024 | 87.5% | 1.9 | 2.52 | 2.44 | 2.86 |
| 2025 | 100% | 1.9 | 2.56 | 2.56 | 2.96 |

Willdan suggested an annual improvement rate of 0.04 µmol/J for LED standard practice efficacy. Similar to MLC, the eligibility for measures is set at the 75th percentile of DLC-listed products, with an annual improvement rate of 0.10 µmol/J for efficacy. For multi-level and stacked grow architectures, Willdan proposed a standard practice of 100% LED with an efficacy in the column “LED Efficacy.” Values in the “Weighted Efficacy” column are for single level architectures only.

While we generally agree with the Willdan team’s approach and appreciate the use of a similar approach to the statewide lighting approach for cannabis lighting, we identified two issues in this analysis. The first issue regarding errors in reported survey results from CBT has already been addressed in a revised study submitted by Willdan. The other issue is related to the assumption that LED fraction in the market must reach 100% for LEDs to be considered standard practice. In practice, it is not necessary to wait for market saturation to reach 90-100% before declaring a technology as standard practice. Typically, a 70% share of "new installations" is sufficient to establish a technology as standard practice. As noted in previous quotations of CPUC Decision and Resolution language, when a technology becomes predominant, the CPUC mandates its adoption as the standard practice. Given the current 70% share of installed LEDs and the consistent upward trend in LED adoption over the past seven years, it is evident that new installations should prioritize a significantly higher proportion of LEDs to align with the prevailing market trend. Therefore, it can be argued that LEDs have already been established as the standard practice. We think these standard practice values presented by Willdan, which incorporate a technology mix including non-LED technologies, may be overly generous.

# TRC Standard Practice Analysis

The TRC proposal relied on literature review as well as interviews with stakeholders (e.g., vendors, manufacturers, industry experts, etc.) and concluded that LED is the standard practice technology for most grow stages, with the exception of the single layer flowering stage with double-ended HPS as the standard practice technology. It should be noted that the flowering activity areas are the predominant area as well as electric consumption determinator of cannabis grow facilities, thus often the primary driver of usage and savings. Although the study concluded that double-ended HPS is the standard practice technology for the single layer flowering stage, the study still used a mixed-technology efficacy that included LEDs, HPSs, CMHs (ceramic metal halide), Fluorescent, and others for the flowering stage. Data sources used to calculate the standard practice efficacy included publicly available test data for LEDs and HIDs, DLC data, and the survey data from CBT. Table 5 shows the final proposal from this study.

Table 5 TRC Proposed Standard Practice and Measure Eligibility Requirements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Standard Practice | | | Measure |
| Stage/ Architecture | LED Fraction | Weighted Efficacy by Technology Mix (µmol/J) | Proposed Standard Practice Efficacy (µmol/J) | Minimum LED Efficacy (µmol/J) |
| Propagation | 41.7% | 1.57 | 2.20 | 2.44 |
| Vegetative | 37.9% | 1.65 | 2.20 | 2.44 |
| Flowering | 49.4% | 1.85 | 1.85 | 2.44 |

For stacked operations, TRC proposed a 100% LED standard practice baseline with an efficacy of 2.2 µmol/J.

While we appreciate the TRC team's efforts to establish standard practice values for cannabis lighting, we have identified several issues with their study. We will focus on the flowering stage, but it's important to note that these issues apply to the TRC team's analysis for all grow stages.

The TRC team’s analysis calculated the baseline efficacy for single layer flowering to be a mixed technology baseline with an efficacy of 1.85 µmol/J. This value was calculated assuming the standard practice baseline consists of 49.4% LEDs (with an average efficacy of 2.2 µmol/J), 39% DE HPS (with an average efficacy of 1.67 µmol/J), 2.6% of CMH (with average efficacy of 1.43 µmol/J), 9.1% of fluorescent lighting (with an average efficacy of 0.92 µmol/J), and 5.2% of other lighting (with an average efficacy of 3.6 µmol/J). We have several concerns about these assumptions:

* The CBT survey data utilized in the TRC proposal to determine the technology mix reveals a significantly higher saturation of LEDs. According to this data, the existing installations indicate a LED saturation rate of approximately 75%. However, it's important to note that CPUC defines standard practice based on new installations rather than the cumulative adoption indicated by the saturation rates of previously installed technology. Given the current installations already comprise 75% LEDs and there has been a consistent upward trend in LED installations over the past seven years, it is reasonable to expect that new and retrofitted projects will have an even higher proportion of LEDs to align with the prevailing market shift towards LED technology. Contrary to this expectation, TRC assumed a lower LED fraction and derated the current LED installations asserting that the survey data includes 30% vertical operations with 100% LEDs thus reducing the LED content of the balance of operations. Considering that 75% of installed cases are LEDs (accounting for the 30% vertical operations with 100% LEDs), it can be inferred that the remaining non-vertical operations should have an even higher penetration of LEDs to keep up with the upward trend. Therefore, the TRC's derating approach is not justified or supported by the complete data including trending over the multi-year CBT research periods.
* Another issue with TRC analysis is that the non-LED technologies considered have PPEs that are lower than the minimum requirement set by 2022 Title 24 (i.e., 1.7 µmol/J for greenhouses and 1.9 µmol/J for fully enclosed operations). It is essential to assign all non-LED technologies a PPE that meets at least the minimum compliance level outlined in Title 24.
* Furthermore, there are inaccuracies in the calculation of LED efficacy at 2.2 µmol/J, as TRC included a list of non-DLC fixtures in the analysis that are not valid choices for standard practice. Here are some specific examples:
* Some of the LEDs included in the list have lower efficacy than the minimum requirements set by the DLC and 2022 Title 24, and even lower efficacies than HID lighting. It is not appropriate to include these low-performance fixtures in the standard practice efficacy analysis as they do not meet the necessary standards.
* Certain LEDs included in the list are older, less efficient versions of products that are already represented in the DLC data, such as the Mars Hydro FC-3000. It is not appropriate to include outdated and less efficient versions of products in the standard practice analysis when the current DLC-certified products are available and adequately represented in the DLC data.
* Some LEDs included in the list, like the Lumigrow Pro 650e LED, are no longer available in the market as they utilize older chips that have been discontinued. It is not appropriate to include fixtures that can no longer be manufactured in the standard practice analysis as they are not representative of the current market offerings.

These issues compromise the accuracy and reliability of the LED efficacy calculation proposed by the TRC team. For these reasons we disagree with inclusion of the non-DLC products in the LED efficacy analysis.

* The study made an assumption that different standard practice technologies are used based on the grow stage. However, this assumption is not suitable when considering LED lighting systems. Unlike HIDs, which traditionally use MH lighting for initial growth phases and HPS lighting for more mature plants, LEDs are adjustable and can provide optimum light in various spectrum ranges for different stages of growth. This means that growers can use LED lighting systems throughout the plant's growth cycle, eliminating the need for multiple systems. Additionally, the assumption of multiple systems for different grow stages is inappropriate because most non-LED technologies included in TRC analysis are not allowed by the 2022 Title 24 requirements, which mandate the same efficacy values for all grow areas. Therefore, we find this conclusion to be invalid.
* The study does not discuss or evaluate annual incremental efficacy improvements, which is a requirement for AR projects according to CPUC policy. This issue has been extensively discussed in lighting early opinions and statewide lighting working groups with PG&E and other stakeholders.
* The study did not address the distinction between the standard practice efficacy that should be established based on future installations compared to in-situ or cumulative adoption indicated by saturation rates of previously installed technology by performing a trend analysis on CBT data. The study conclusions are based on a snapshot of the CBT data in 2022 and does not include a trend analysis to estimate future LED installations. This lack of trend analysis is also valid for the 100% LED assumption made for the stacked operation.

# List of Attachements

* 
* Willdan proposal

   

* TRC proposal

 

1. Please refer to the attached Excel file, "CannabisLightin\_StandardPractice\_FinalApprovedValues\_20230620.xlsx," for details and referenced sources. [↑](#footnote-ref-1)
2. “State of the Cannabis Lighting Market” Cannabis Business Times, November 2019 [↑](#footnote-ref-2)
3. “State of the Cannabis Lighting Market” Cannabis Business Times, November 2020 [↑](#footnote-ref-3)
4. “State of the Cannabis Lighting Market” Cannabis Business Times, November 2021 [↑](#footnote-ref-4)
5. “State of the Cannabis Lighting Market” Cannabis Business Times, October 2022 [↑](#footnote-ref-5)
6. Resolution E-4939 at 17 [↑](#footnote-ref-6)
7. Resolution E-4939 at 53 [↑](#footnote-ref-7)
8. D.12-05-015 at 351 (quoted above) [↑](#footnote-ref-8)
9. See “Step 2” of Section 3. Selection Process of Attachment A to this Resolution [↑](#footnote-ref-9)
10. Resolution E-4939 at 18 [↑](#footnote-ref-10)