

A photograph of a modern glass building at night. The building's facade is composed of large glass panels reflecting the sky. The interior lights are on, and the OSRAM logo is prominently displayed on the glass in large, illuminated orange letters. The sky is a deep blue, and the building's structure is visible through the glass.

OSRAM

Horticulture Lighting

OS GL NAFTA
Light is **OSRAM**

OSRAM
Opto Semiconductors

Contemporary megatrends are inherently changing the world's food system



Growing Population

- **>9bn people** by 2050
- **70%** increase in food production needed
- **70%** of population in cities
- **60** Mega-Cities with >3m people



Scarce Natural Resources

- **80%** of arable land already in use
- **70%** of fresh water used for food production
- **65%** of water lost due to evaporation or runoff
- **30%** of fossil fuels used by the food sector



Changing Consumer Preferences

- **2.500 km** from field to fork
- **50%** of planted crops not harvested
- **14%** of food contaminated with pesticides
- **0,1%** of used pesticides reach the target pest

“We need more food, harvested close to urban areas, grown in a more efficient and sustainable manner, producing healthier and more nutritious crops all year-round!”

Horticulture is a rapidly growing market and OSRAM is leading it!

Market Drivers

Urbanization



Liberalization



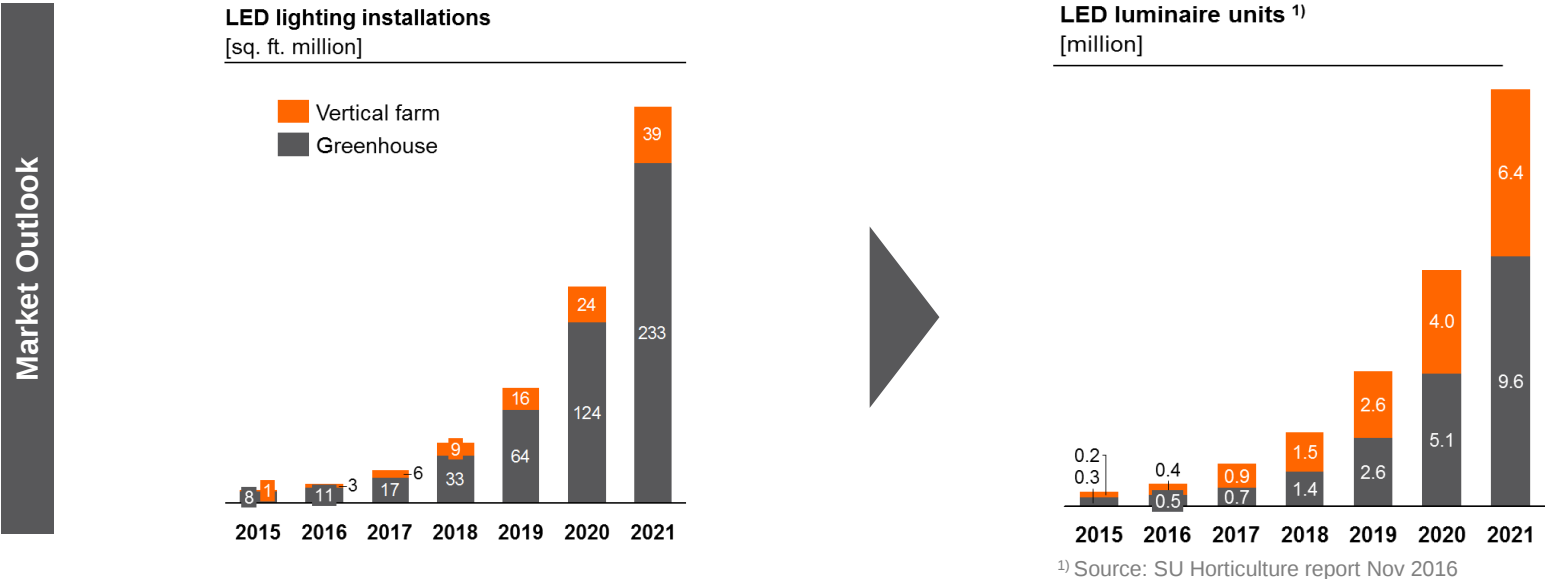
Technology Changes



Growing Population



It is estimated that by 2030 we will need to see at least a 50% increase in food productivity.

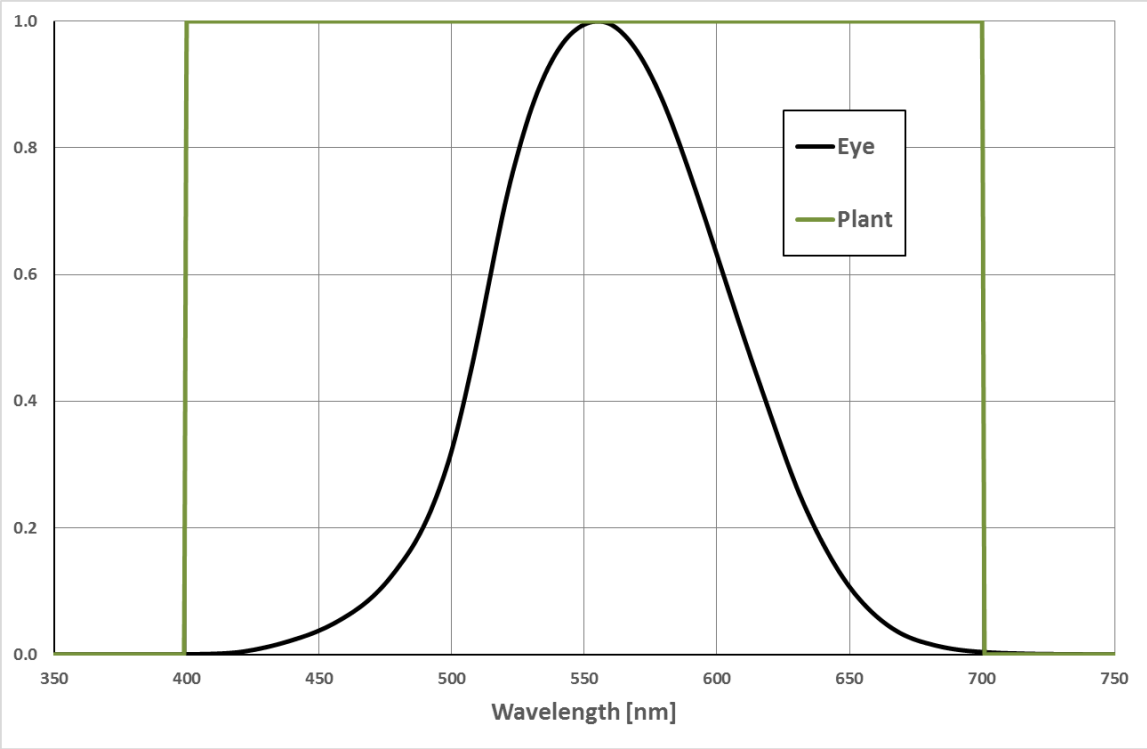


Osram Opto Semiconductors is the **Global Market Leader** with a total market share of >50 % in Horticulture LEDs

Plants process light inherently different to humans



“The light source needs to be optimized in order to serve the specific requirements of the plant”



	Human Eye	Plant
Light Quantity	Lumen [lm]	Micromol per second [μmol/s]
Efficacy	Lumen per Watt [lm/W]	Micromol per Joule [μmol/J]

Photosynthetic efficiency is mainly driven by chlorophyll a and b



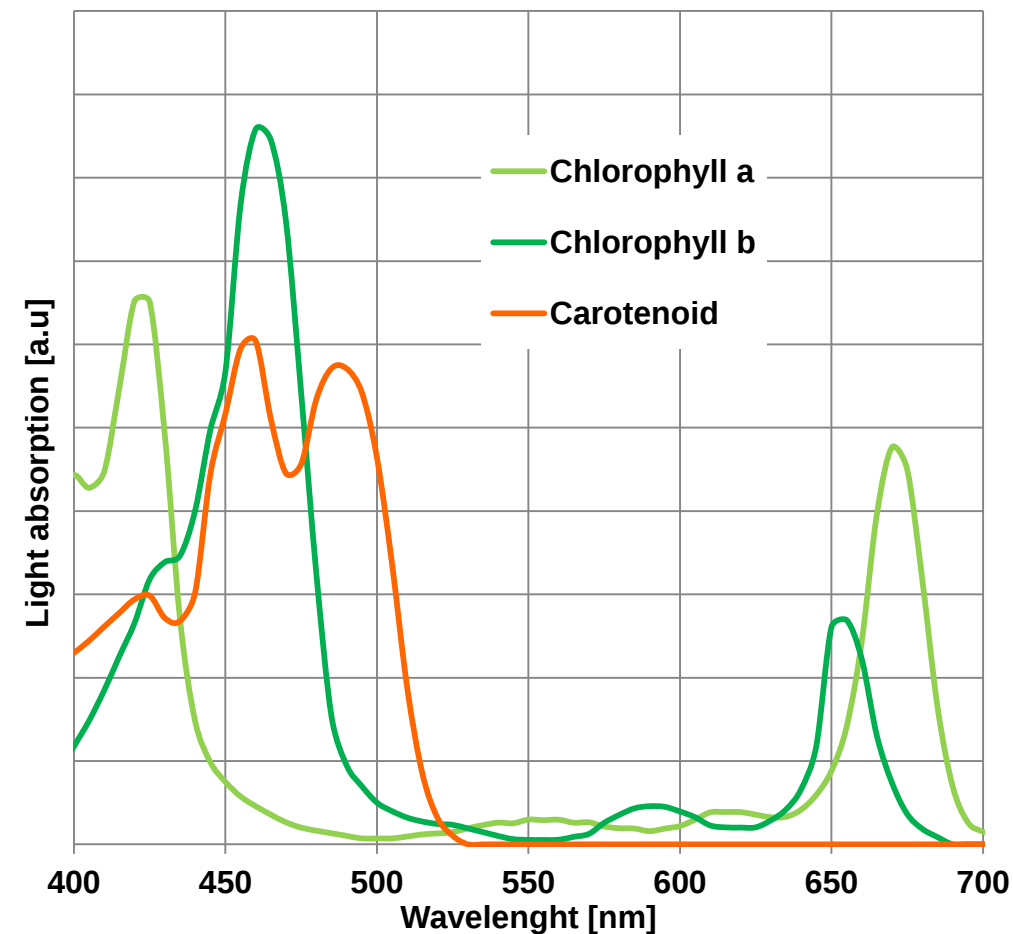
Chlorophyll a & b

Mainly responsible for the photosynthesis and responsible for the definition of the area for the photosynthetically active radiation PAR.



Carotenoid

Further photosynthetic pigments also known as antenna pigments like carotenoids β -carotene, zeaxanthin, lycopene and lutein etc

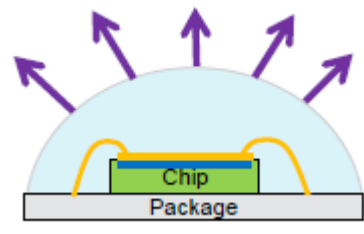


In order to generate light from LEDs, two different approaches are possible



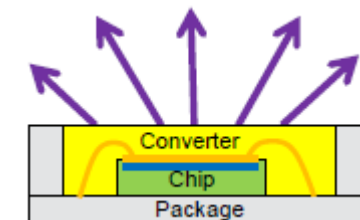
Directly emitting LED

Electrons are converted into photons of desired wavelength. The wavelength depends on the material systems and the epitaxy layer.

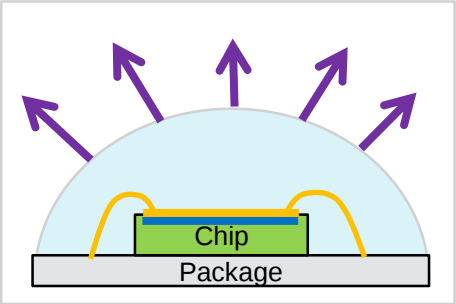
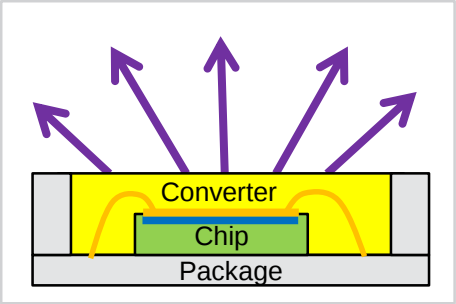
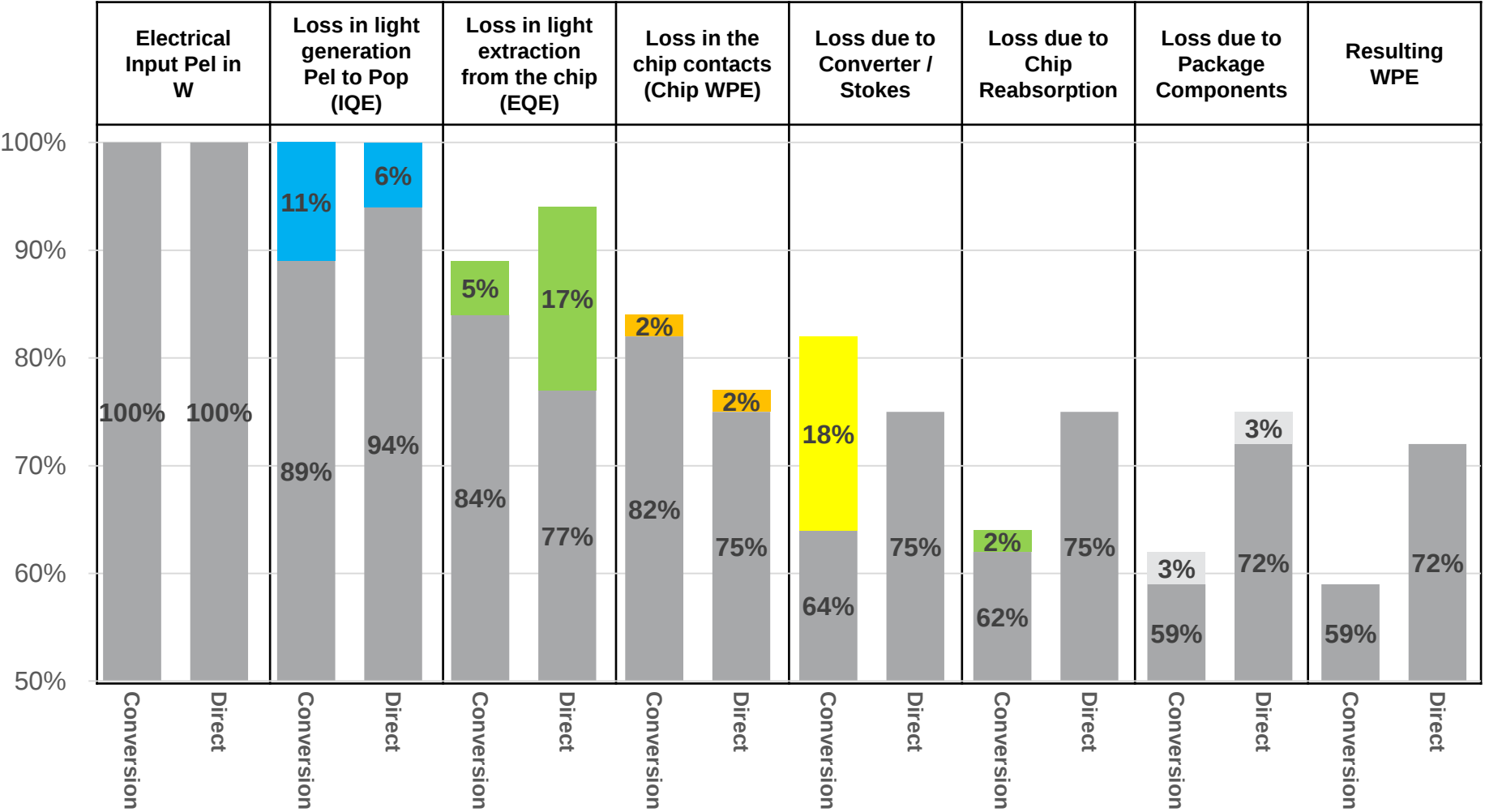


Phosphor converted LED

Light is generated from the LED directly (most of the time blue at 450nm). A part or all of the blue light is then converted into different wavelengths corresponding to colors like green, yellow and red.



Directly emitting LEDs have a superior efficacy compared to phosphor converted LEDs



The closer the proximity between luminaire and plant, the higher are the benefits of LEDs!

Top Lighting

High Efficacy and lifetime of LEDs enables considerable energy savings and thus economic benefits as well as environmental sustainability!



Inter Lighting

LEDs, as a low-temperature emitting light source, can be placed among the plants and apply the light directly to the vegetation!



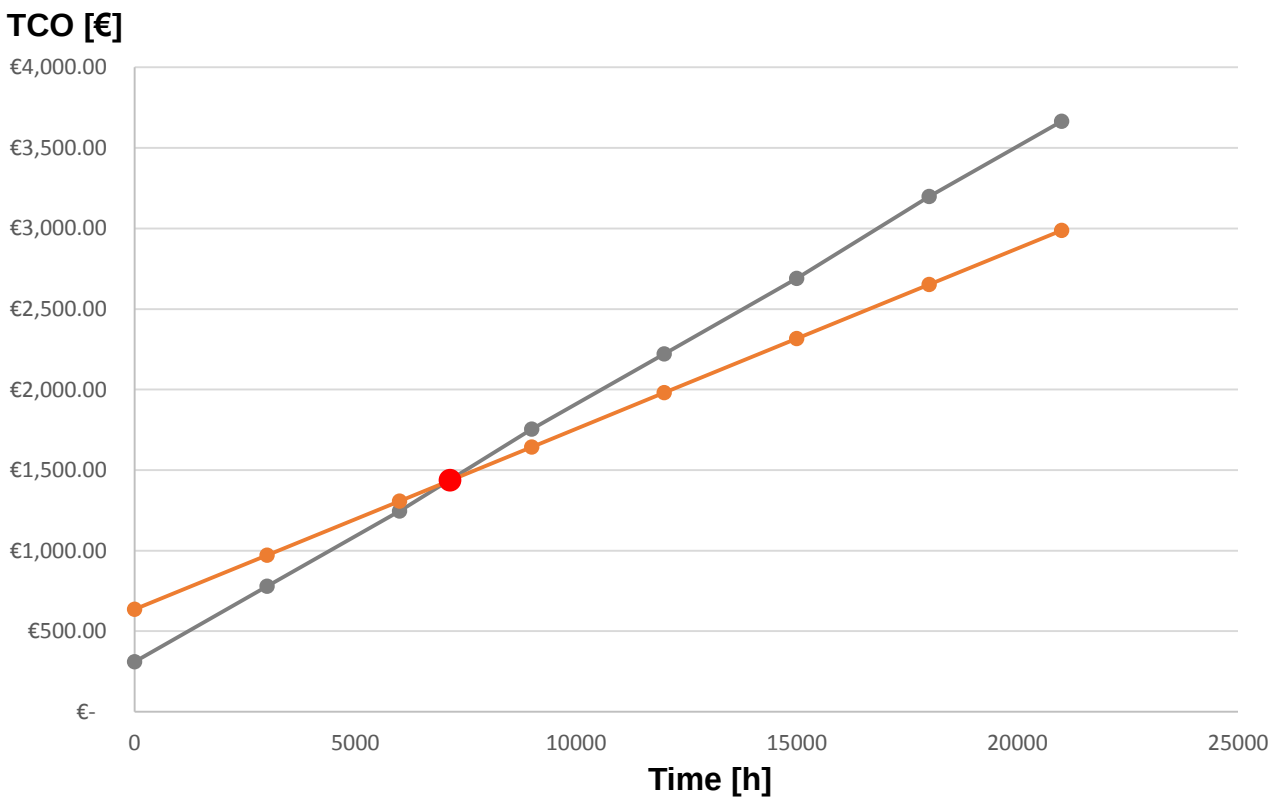
Vertical Farming

LEDs provide full control under sole-source lighting conditions by providing a full and tunable light spectrum!



Total Cost of Owner Ship Analyze

LED vs HPS



➡ **LED luminaires already pay off after 2 years vs HPS***

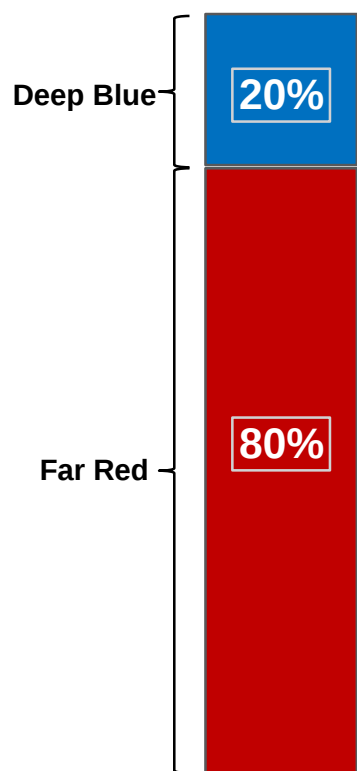
*Considering: Engery Price = 0,156 €/KWh; 90% elec. & 90 opt. Efficiency; Using Oslon Square HR & DP @typ values @700 mA; Considering best in class HPS efficiency

Further benefits of LEDs

	HPS	LED
Spectrum	Single Spectrum	Multiple Spectra
Chemicals	Hazardous	Harmless
Cooling	Ventilation required	Active or passive cooling
Proximity	Large distance to plant	Close distance to plant

A homogenous distribution of light is paramount to achieve superior results

Colour Split



By mixing high-power and mid-power LEDs light homogeneity is optimized



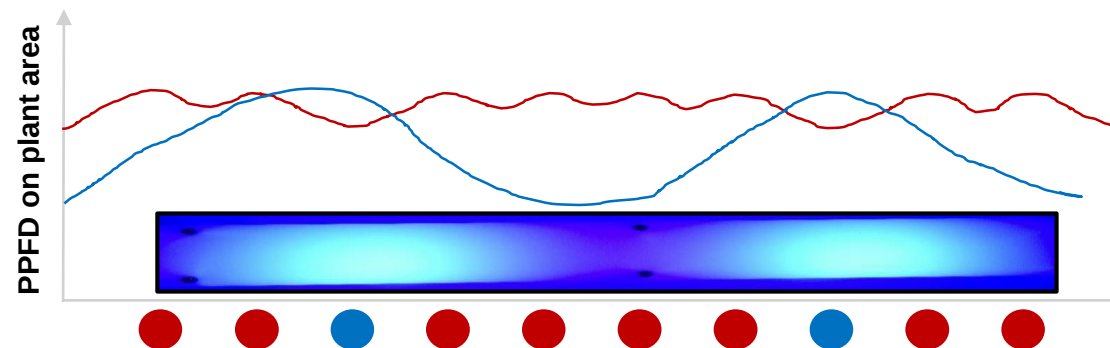
- Uneven blue distribution
- Sub-optimal red distribution



OSLON SSL
Hyper Red



OSLON SSL
Deep Blue



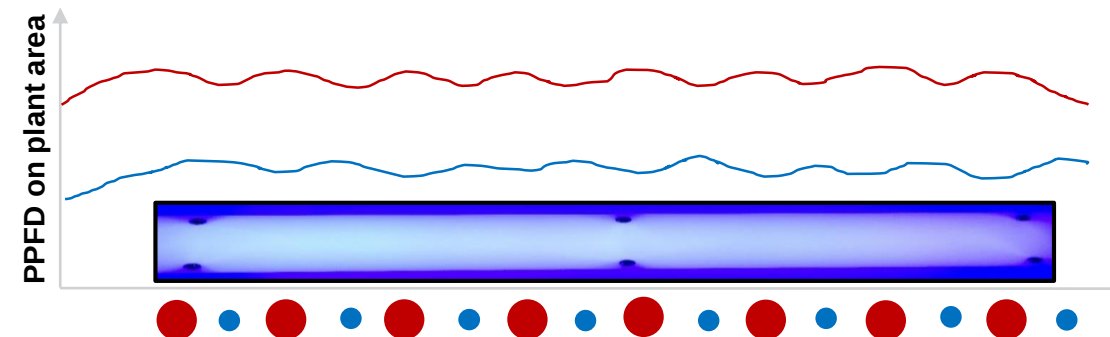
- Perfect blue distribution
- Perfect red distribution



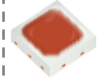
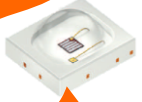
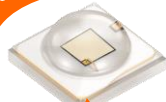
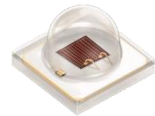
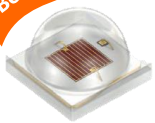
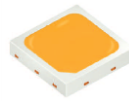
OSLON SSL
Hyper Red



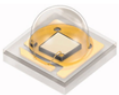
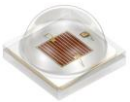
OSCONIQ P 2226
Deep Blue



Horticulture Portfolio

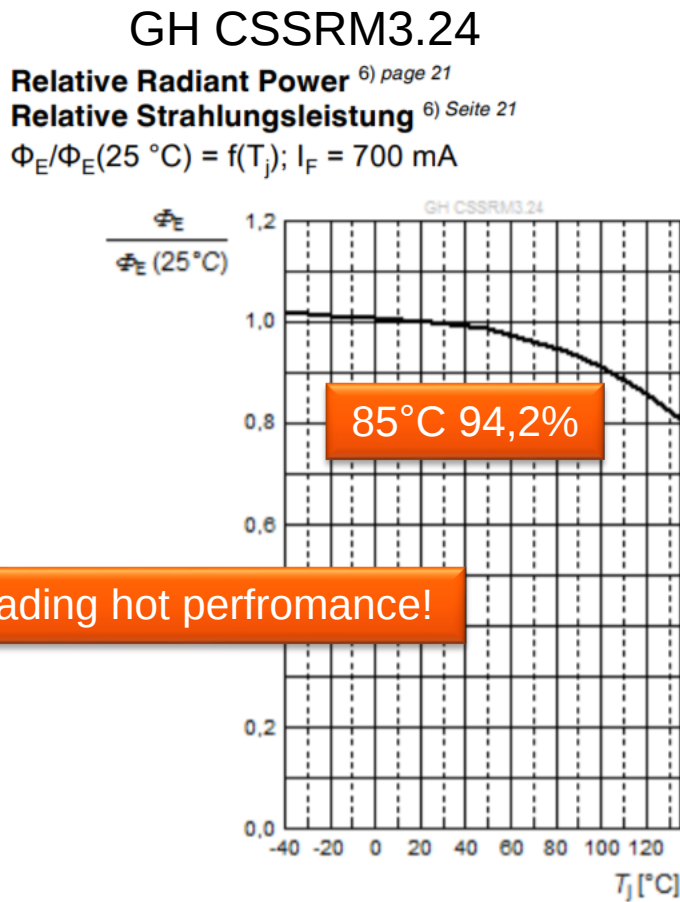
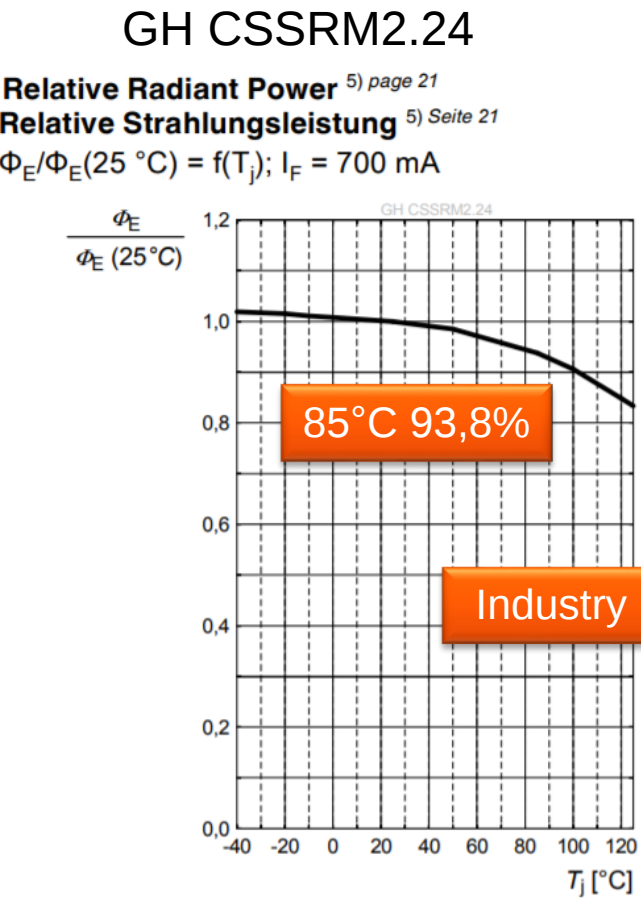
	Deep Blue 455 nm	Hyper Red 660nm	Far Red 730nm	Purple 450 + 660 nm
Consumer	 Duris S 5 - GD PSLM31.14 180 mW (0,67 µmol/s) [@100 mA, 2.9 V] 62 % typ. radiant efficiency (2,34 µmol/J)			 Duris S 5 GP PSLR31.13 1,48 µmol/s [@150 mA, 6 V] 1,65 µmol/J
Professional	Best in Class!  OSCONIQ P 2226 GD DASPA2.14 185 mW (0,7 µmol/s) [@100 mA, 2.9 V] 64 % typ. radiant efficiency (2,4 µmol/J)	Best in Class!  OSCONIQ P 2226 GH DASPA2.24 115 mW (0,63 µmol/s) [@100 mA, 2.1 V] 55 % typ. radiant efficiency (2,99 µmol/J)	 OSCONIQ P 2226 GF DASPA2.24 66 mW (0,39 µmol/s) [@100 mA, 1.8 V] 37 % typ. radiant efficiency (2,21 µmol/J)	White  DURIS S 8- GW P9LR3x.PM 200 lm [@45/180 mA, 22.2/5.55 V] 200 Lm/W typ.
	Best in Class!  Oslo SSL - GD CSxPM1.24 690 mW (2,6 µmol/s) [@350 mA, 2.85 V] 69 % typ. radiant efficiency (2,62 µmol/J)	Best in Class!  Oslo SSL - GH CSxPM1.24 126 mW (2,32 µmol/s) [@350 mA, 2,05 V] 57 % typ. radiant efficiency (3,23 µmol/J)	 Oslo SSL GF CSxPM2.24 317 mW (1,97 µmol/s) [@350 mA, 1.85 V] 46 % typ. radiant efficiency (2,96 µmol/J)	Oslo Square - GW CSSRM3.PM 337 lm [@700 mA, 2.8 V] 171 Lm/W typ.
	Best in Class!  Oslo Square - GD CSSRM2.14 1445 mW (5,3 µmol/s) [@700 mA, 2.85 V] 72 % typ. Radiant efficiency (2,63 µmol/J)	Best in Class!  Oslo Square - GH CSSRM3.24 965 mW (5,28 µmol/s) [@700 mA, 2.15 V] 64 % typ. radiant efficiency (3.52 µmol/J @700 mA; 3,81 µmol/J @350 mA)		Full Spectrum  Duris S 5 - GW PSLR31.FM 111 lm [@150 mA, 6,35 V] 115 Lm/W typ.  Duris S 5 - GW PSLM31.FM 26 lm [@65 mA, 2.77 V] 140 Lm/W typ.
Additional colors available in: Blue (465 nm), True Green (521 nm), Yellow (593 nm) and Red (630 nm) for specific customized spectra.				

OSRAM offers a diverse range of LEDs to meet your specific requirements

	Deep Blue	Blue	True Green	Lime	Yellow	Amber	Red	Hyper Red	Far Red	Purple	White
 OSCONIQ® P 2226	185 mW 64 %	9 lm 28 lm/W	36 lm 131 lm/W	- -	20 lm 89 lm/W	- -	21 lm 100 lm/W	115 mW 55%	66 mW 35 %	- -	- -
 DURIS® S 5 PSLR DURIS® S 5 PSLM	480 mW 51 % 180 mW 63%	- - 8 lm 28 lm/W	170 lm 181 lm/W 36 lm 131 lm/W	- - 58 lm 198 lm/W	- - 33 lm 111 lm/W	45 lm 48 lm/W 22 lm 102 lm/W	24 lm 26 lm/W 17 lm 81 lm/W	- - -	- - -	333 mW 35% 124 mW 43 %	- - -
 OSLON® SSL	690 mW 69 %	41 lm 41 lm/W	144 lm 152 lm/W	- -	76 lm 99 lm/W	100 lm 136 lm/W	68 lm 93 lm/W	425 mW 58 %	315 mW 49 %	- -	160 lm 163 lm/W
 OSLON® Square	1445 mW 72 %	- -	- -	- -	- -	- -	- -	905 mW 66 %	- -	- -	337 lm 171 lm/W

Hot performance

GH CSSRM2.24 & GH CSSRM3.24



Industry leading hot performance!

Competition

(based on 1mm² chips)

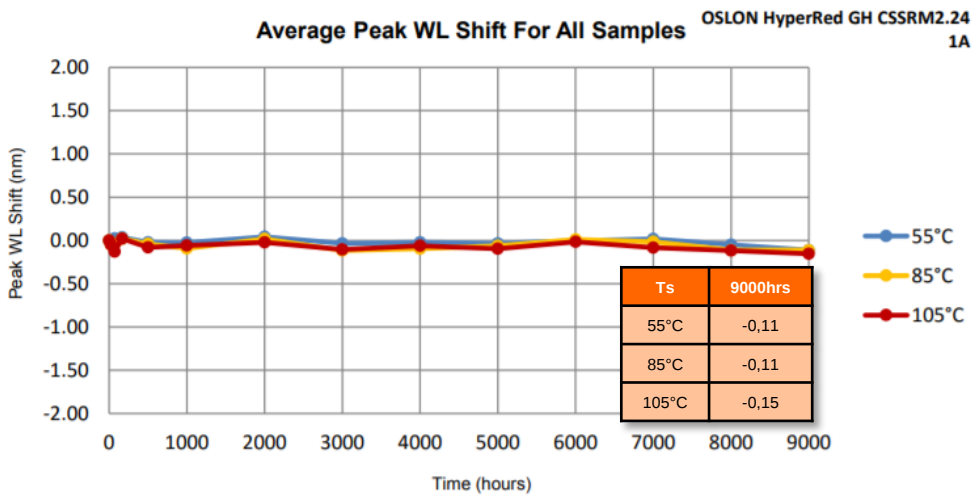
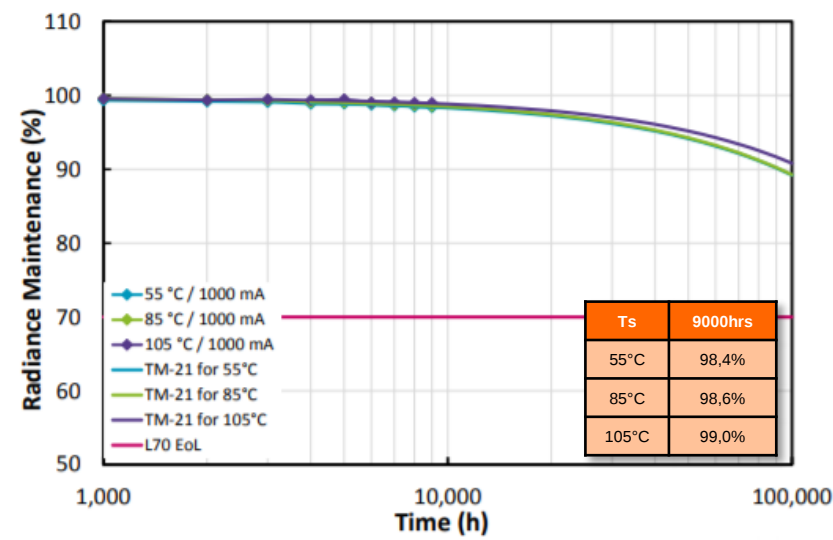
Sample	85°C/25°C	Comment
#1	92%	same chip type in different batches of same comp. package supplier
#2	86%	
#3	87%	
#4	84%	same chip type, but different package supplier
#5	87%	same chip type, but different package supplier

GH CSSRM2.24

LM80 status 1000 mA - 9000hrs

Lxx	Ts	TM-21 projection calculated	TM-21 projection reported
L70	55°C	324khrs	>54khrs
	85°C	321khrs	>54khrs
	105°C	376khrs	>54khrs
L80	55°C	200khrs	>54khrs
	85°C	200khrs	>54khrs
	105°C	234khrs	>54khrs
L90	55°C	91khrs	>54khrs
	85°C	92khrs	>54khrs
	105°C	109khrs	>54khrs
L95	55°C	41khrs	>40khrs
	85°C	42khrs	>40khrs
	105°C	51khrs	>50khrs

Enables stable crop yields!

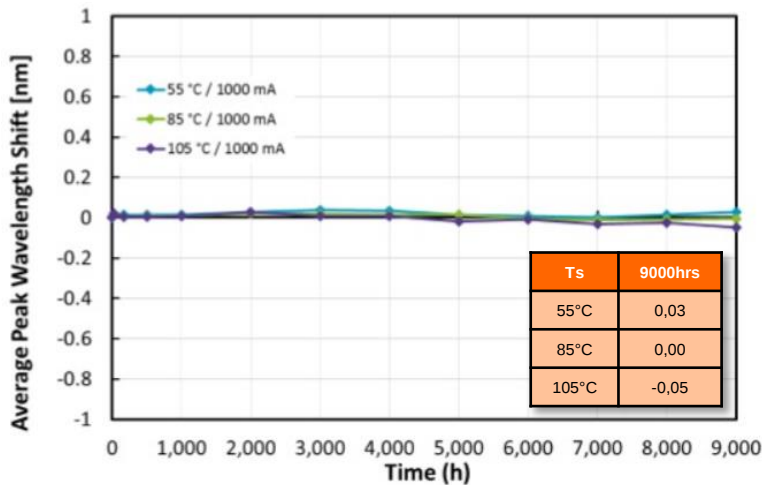
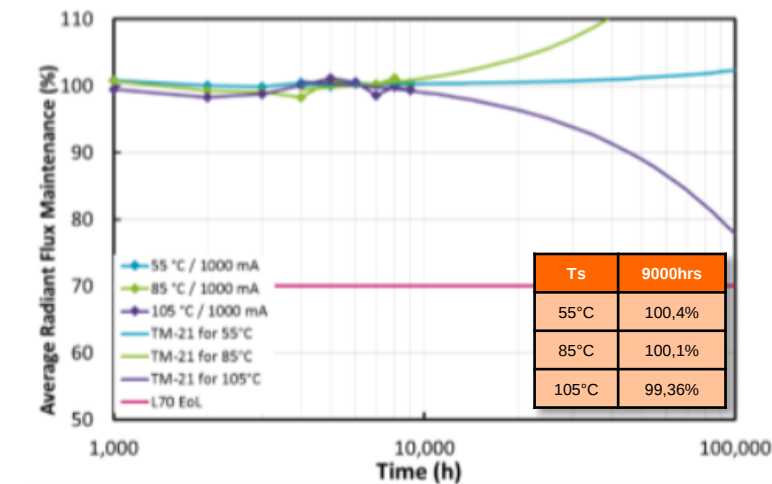


GD CSSRM2.14

LM80 status 1000 mA - 9000hrs

Lxx	Ts	TM-21 projection calculated	TM-21 projection reported
L70	55°C	--khrs	>54khrs
	85°C	--khrs	>54khrs
	105°C	139khrs	>54khrs
L80	55°C	--khrs	>54khrs
	85°C	--khrs	>54khrs
	105°C	89khrs	>54khrs
L90	55°C	--khrs	45khrs
	85°C	--khrs	45khrs
	105°C	45khrs	45khrs
L95	55°C	--khrs	25khrs
	85°C	--khrs	25khrs
	105°C	25khrs	25khrs

Enables stable crop yields!



OSRAM is committed to constantly improving and extending the product portfolio for horticulture!



Q4 2018

Osconiq P 3030 Hyper Red
0,7 W, 2 V,
430 mW, 61% rad. Eff.

Osconiq P 3030 Deep Blue
1 W, 2,8 V,
700 mW, 71% rad. Eff.

Osconiq P 3030 Far Red
0,6 W, 2,8 V,
330 mW, 51% rad. Eff.

Osconiq P 3030 White CRI 80
1 W, 2,8 V,
136 lm, 136 lm/W

Osconiq P 3030 White CRI 70
1 W, 2,8 V,
160 lm, 160 Lm/W

Osconiq P 3030 Lime
1 W, 2,8 V,
tbd., tbd.

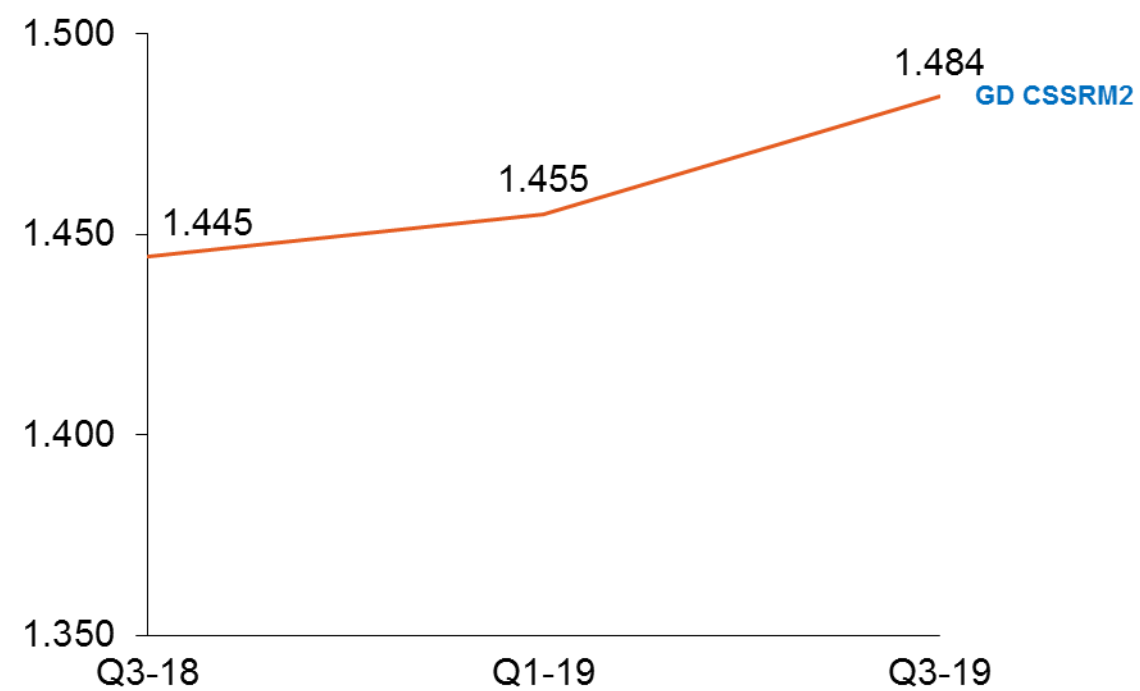
Q1 2019

Q3 2019

**Oslon Square Hyper Red Gen 3
GH CSSRM4.24**
0,7W, 2,08 V
1010 mW, 69 % rad. efficiency

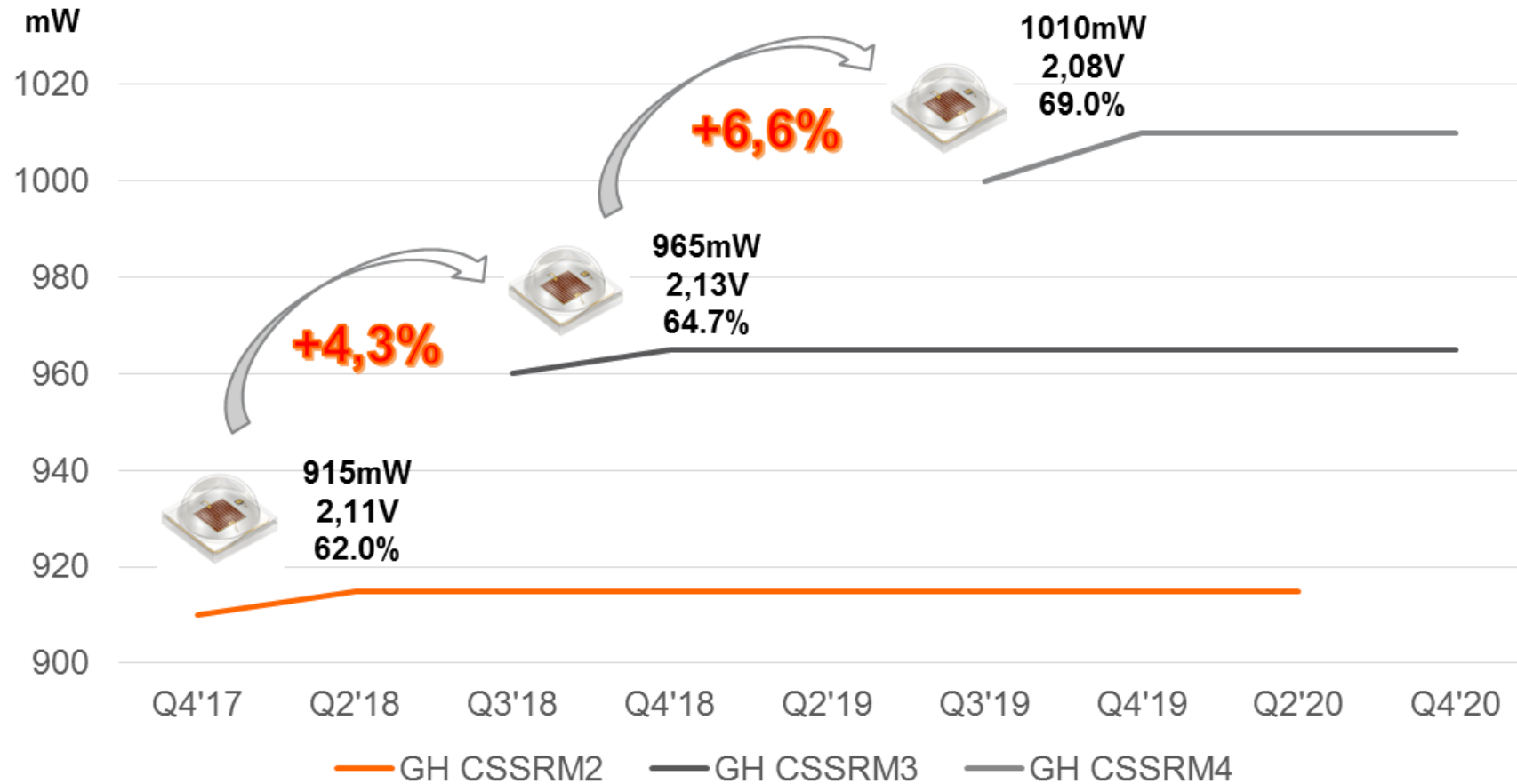
Roadmap

GD CSSRM2.14

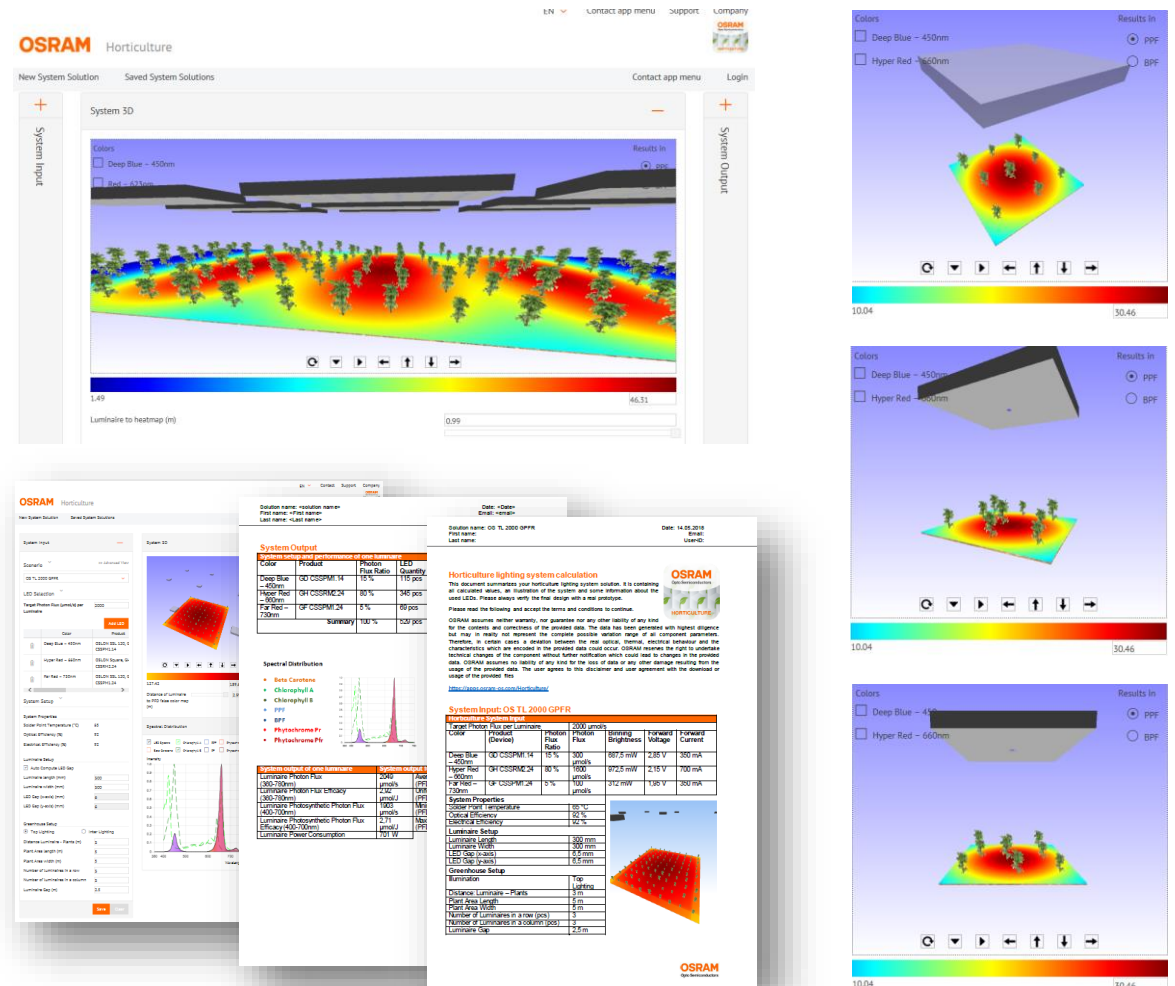
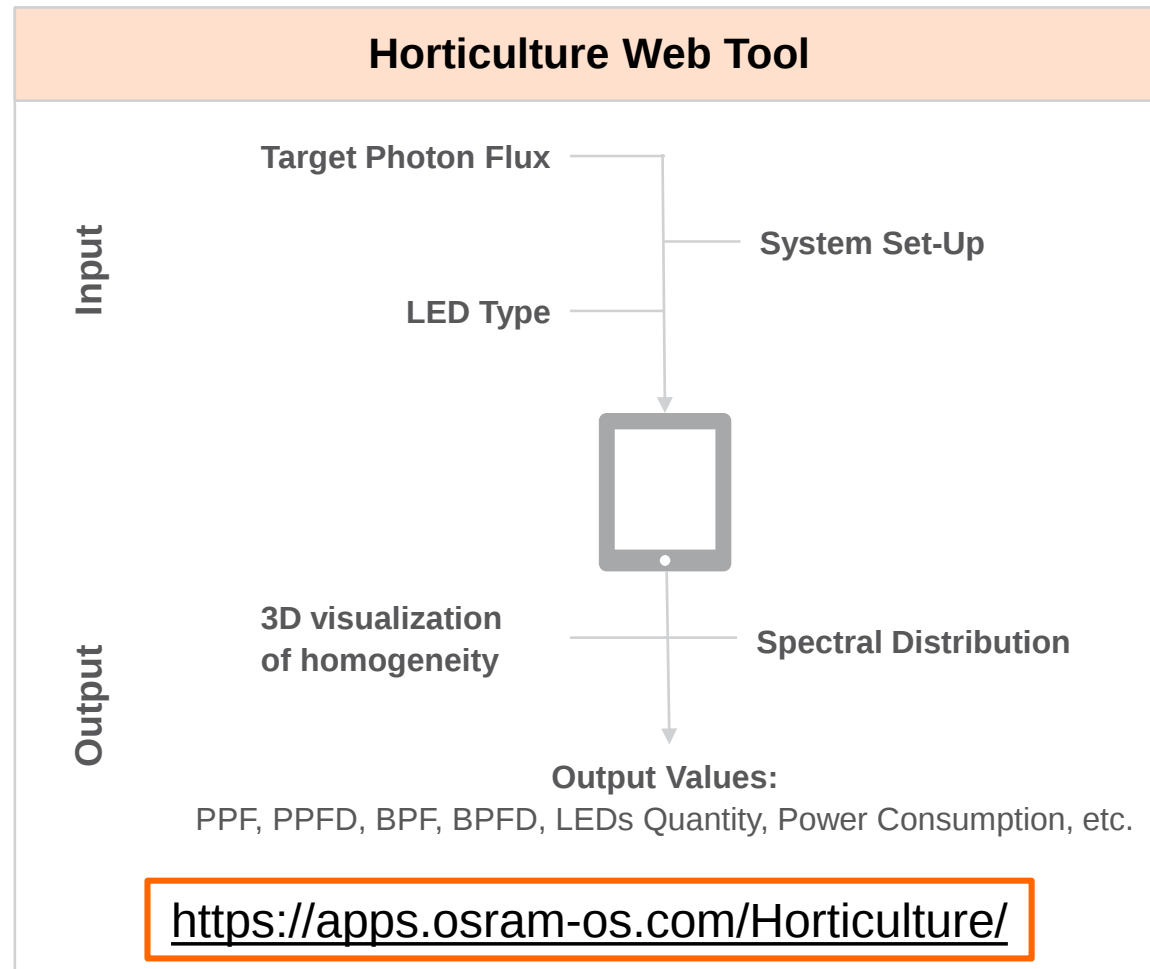


Roadmap

GH CSSRMx.24



How to determine the performance of specific LED mixtures under operation conditions? – With the OSRAM OS Horticulture Lighting Web Tool!



Thank you.