

Greenhouse Farming Solutions



Background

The growth of horticultural LED market is driven by following reasons

Transition to
highly efficient LED lighting



Legalization of
medical & recreational cannabis



LED Penetration

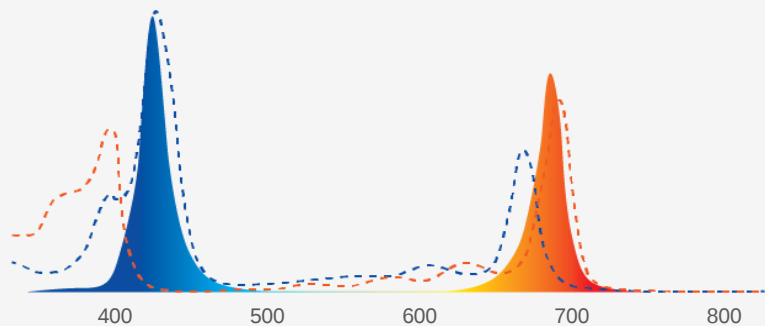
Penetration rate of LED is still low in horticulture market

		Fluorescent	MH	HPS	Conventional LED (Narrow Spectrum)
Product Specification	Market Share		90%		10%
	Efficacy ($\mu\text{mol/J}$)	1	1.4	1.8	> 2.5
	Heat	Low	High	High	Low
	Lifetime (hrs.)	< 20,000	<20,000	< 30,000	> 50,000
	Warm-up Time	Short	Long	Long	Short
	Design Flexibility	Low	Low	Low	High
	Lighting System Cost	Low	Low	Low	High

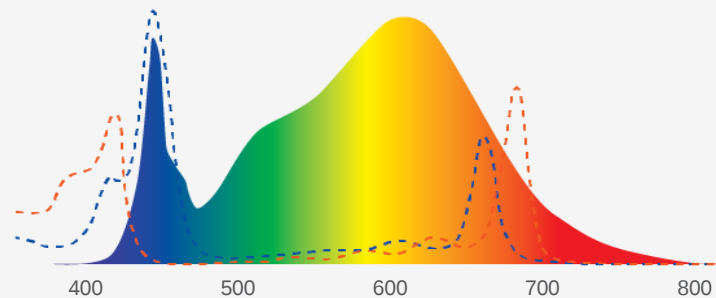
Full Spectrum LED

Full spectrum is a recent trend as more cost-effective HPS compatible solution

Conventional Narrow Spectrum



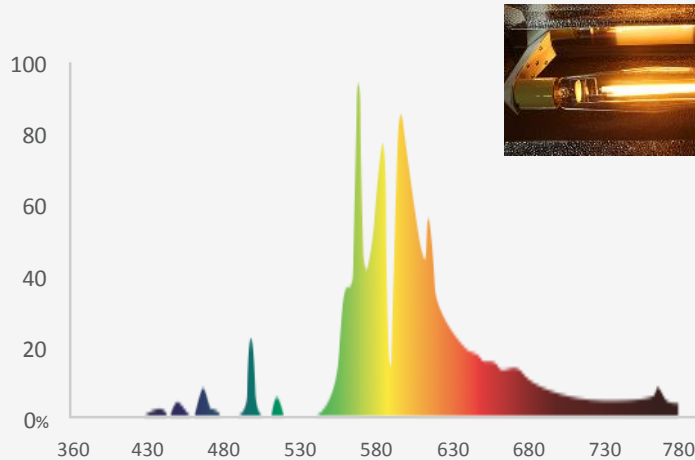
Full Spectrum



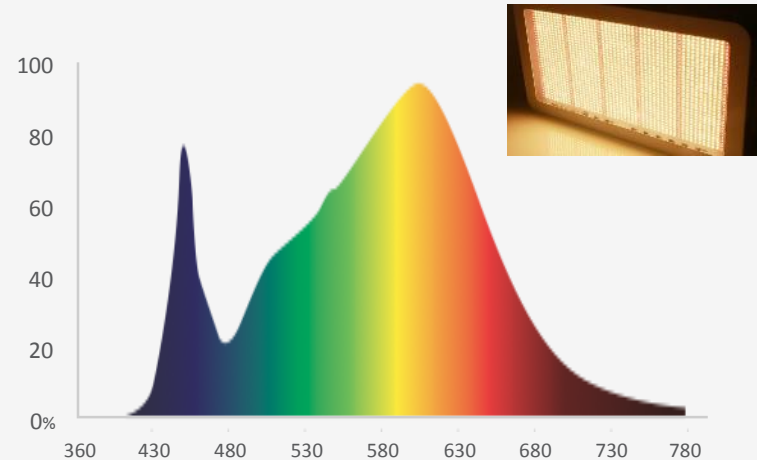
HPS Compatible Spectrum

Full spectrum provides similar spectrum as conventional HPS

HPS



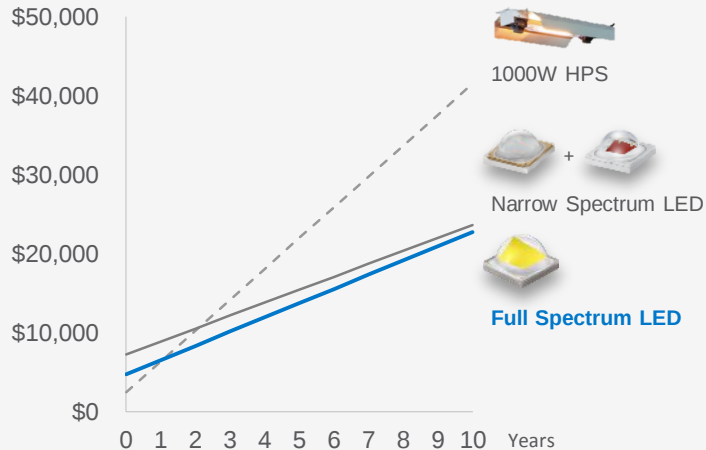
Full Spectrum LED



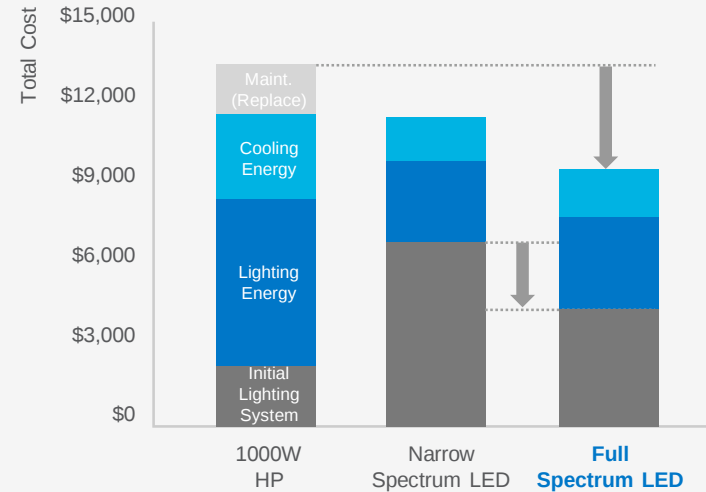
More Cost-effective Solution

Full spectrum reduces initial lighting system and operating cost

Accumulated Cost



Total Cost for 3 Years



※ Unit Price : HPS (\$400 x 6ea), Narrow (\$1200 x 6ea), Full (\$780 x 6ea) / Lifetime : HPS (2khrs), Narrow (60khrs), Full (60khrs) / Electricity Rate : \$0.1 per kWh

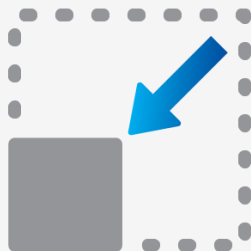
Key Considerations

Low Cost



Low initial lighting system cost
to minimize investment

Small Form Factor



Minimum fixture size and
shadow caused by the fixture

High Reliability

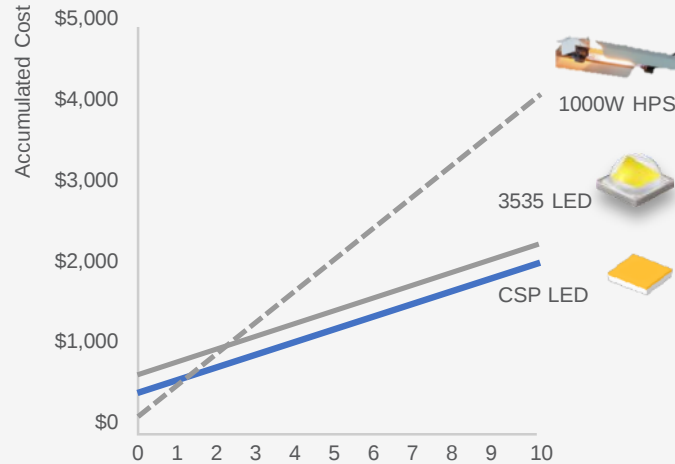


Industry proven reliability under
harsh horticulture environment

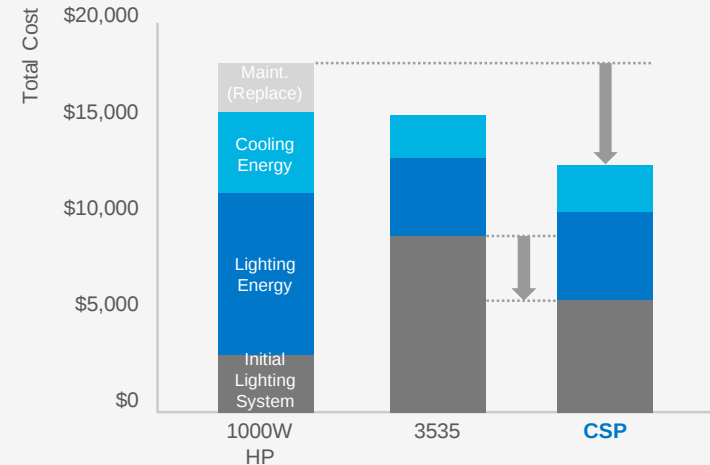
Minimum Lighting System Cost

CSP can further reduce initial lighting system costs

Accumulated Cost



Total Cost for 3 Years

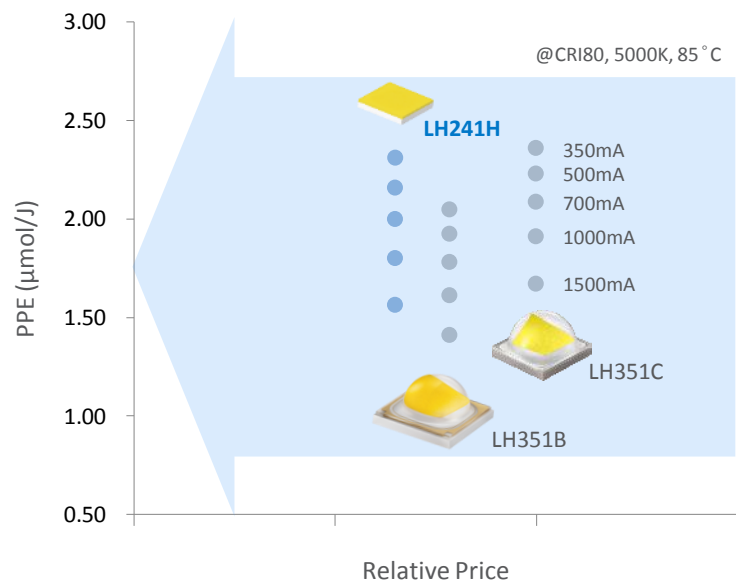


※ Unit Price : HPS (\$400 x 6ea), 3535 (\$1200 x 6ea), CSP (\$960 x 6ea) / Lifetime : HPS (2khrs), LED (60khrs) / Electricity Rate : \$0.12 per kWh

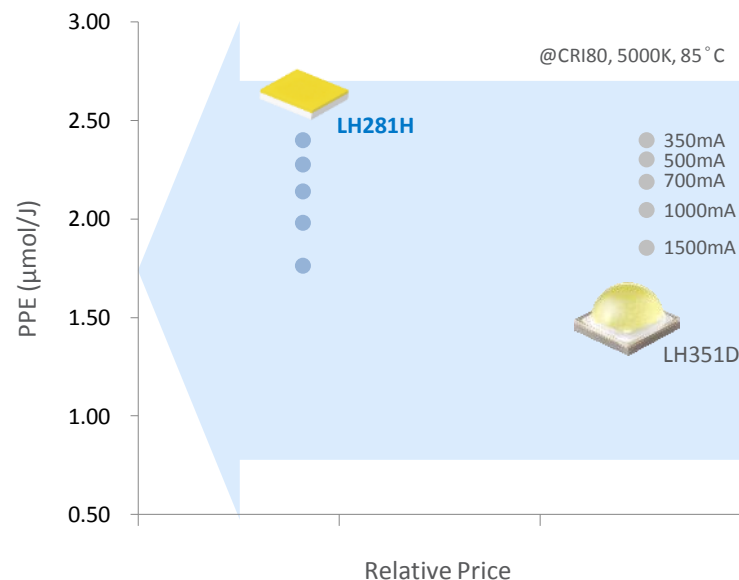
Better Performance/Price

CSP has better performance/price figure than 3535 LEDs

LH241H



LH281H



Minimum Fixture Size and Shading

CSP can reduce fixture size and minimize shadow area

Small LES



LH351C 9ea
132mm²



LH241H 12ea
88mm² (67%)

※ Heatsink also needs to be redesigned to minimize size of entire lighting fixture

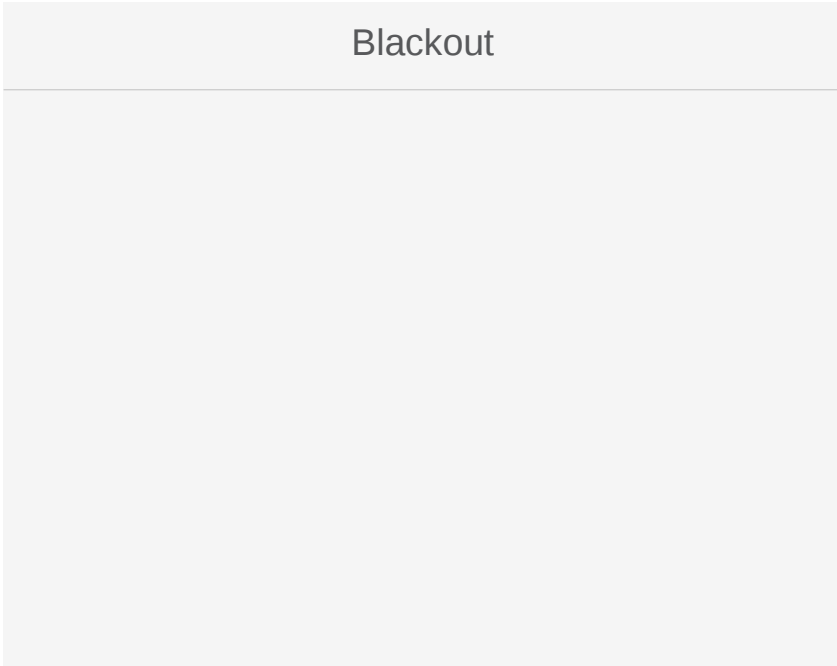
Less Shading



LED Failure Modes

Blackout and performance degradation over time are typical failure modes

Blackout



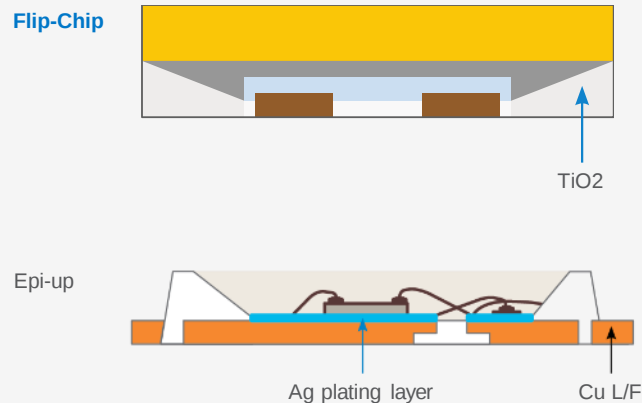
Performance Degradation



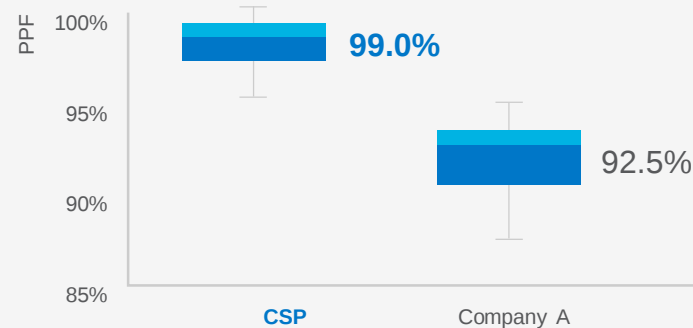
High Reliability

Flip chip technology ensures to excellent sulfur resistance and overall reliability

Wire-free Flip Chip Structure



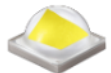
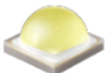
H2S 15ppm, 25°C / 75% humidity for 504hrs



※ IEC Pub.68-2-43

Greenhouse Farming Solution

- Crop: Tomato, Pepper, Cucumber, etc.
- LED Lighting Requirements: Cost↓, Size/Weight↓

White LED						Color LED				
    						    				
LH241H LH281H LH351H-B LH351H-C LH351H-D						LH351H Blue (450nm) LH351H Red (630nm) LH351H Deep Red (660nm) LH351H Deep Red (660nm) V2 LH351H Far Red (730nm)				
PPF (μmol/s)	2.51	2.59	2.48	2.56	2.58	2.80	1.57	2.32	2.63	*1.96
PPF/W (μmol/J)	2.52	2.65	2.51	2.60	2.69	2.80	2.14	3.12	3.73	**2.91
Footprint (mm ²)	2.4 × 2.4	2.8 × 2.8		3.5 × 3.5				3.5 × 3.5		

*BPF, **BPF/W

Thank you