TSL
HORTI·TECH

Central Power Solution

Power large scale horticulture

iHP, Lower Total Cost of Ownership (TCO)

The “Makes Sense” Architecture

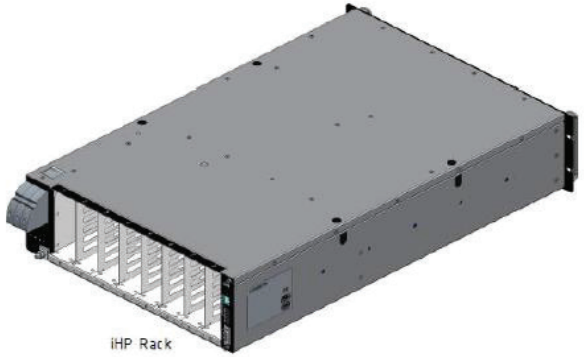
iHP LED Lighting Systems - 12KW & 24KW Units

Total Power:	Up to 24 KW
Input Voltage:	180-264 Vac 342-528 Vac Single Phase or 3-Phase
# of Outputs:	Up to 8

iHP12 iHP24

Available Modules

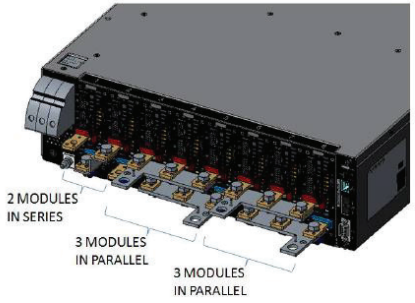
Parameter	SL	SQ	ST	SW	S8	S1	S2	SA
Nominal O/P Voltage (V)	12.0	24.0	32.0	48.0	80.0	125.0	200.0	250
O/P Voltage Range (V)	0.6 -14.4	1.2 -28.8	1.6-38.4	2.4 -57.6	4.0 -96.0	6.25 -150.0	10 -240	12.5 - 300
Max Power (W)	2400	2880	2880	3000	3000	3000	3000	3000
O/P Current Range (A)	0 -200	0 -120	0-90	0 -62.5	0 -37.5	0 -24	0 -15	0 -12



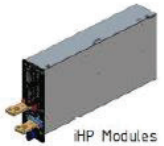
iHP Rack

SAFETY

- UL 60950-1 2nd Edition; EN60950-1; IEC60950-1/EN60950
- CSA C22.2 No. 60950-1-07, 2nd Edition
- EN60601-1; IEC60601-1; IEC60601
- UL 60601-1 1st Edition; ANSI/AAMI ES60601-1 (2005 + C1:09 + A2:10) 3rd Ed
- CAN/CSA-C22.2 No. 60601-1 (2008)
- CB Certificate and Report
- CE (LVD+RoHS), EN60950-1



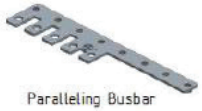
Accessories can include Parallel and Series bus bars



iHP Modules

Filler Plate

Wire Assembly



Paralleling Busbar

Series Busbar

iHP Configurable AC Inputs

1 Phase or 3 Phase / Low Line or High Line

New
For Canadian Market

iHP12L1A	iHP12L3A	iHP12H3A	iHP24L3A	iHP24H3A	iHP24C3A
220/240 1P	208/240 3P	380/480 3P	208/240 3P	380/480 3P	600 3P+N

iHP AC Input Configurations

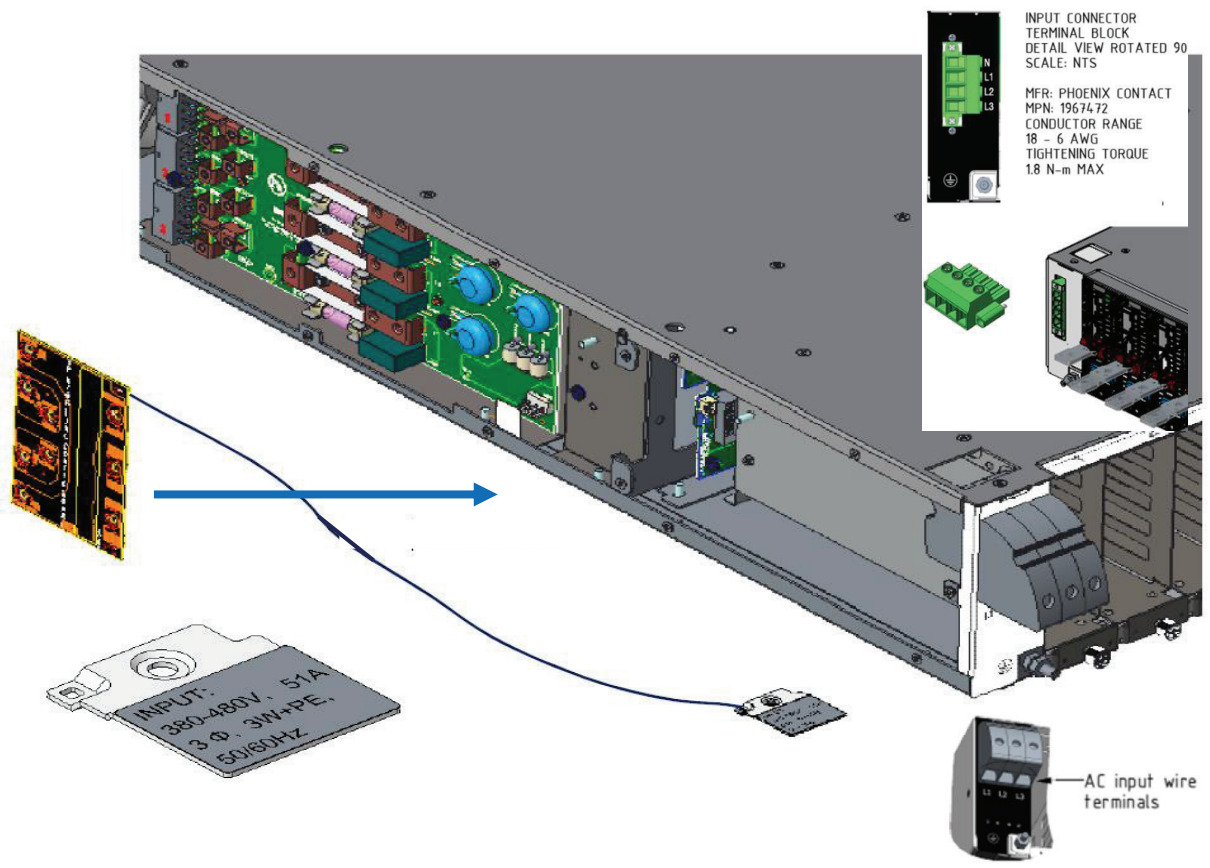
iHP AC Input Configurations

Fixed AC Input

VARs or Installers can easily configure the iHP AC inputs between 1 Phase or 3 Phase, Low Line or High Line in the field by simply changing to a different AC Config board within the iHP Chassis.

AC Input Config Board Options

1 Phase LL – 73-778-002
3 Phase LL – 73-778-001
3 Phase HL – 73-778-016

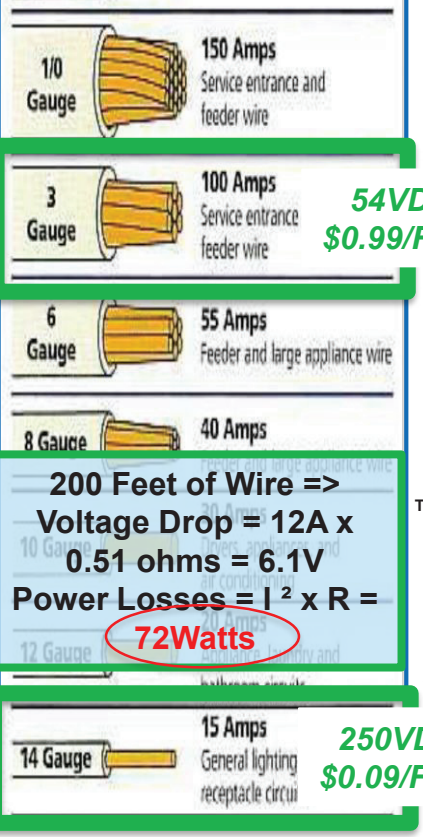


Centralized Remote DC Power System

Power = Volts x Amps ↑ ↓ $

Low Voltage Vs. High Voltage Architecture

200 Feet of Wire =>
Voltage Drop = 55.6A x 0.039 ohms = 2.2VDC
Power Losses = I ² x R =
121 Watts



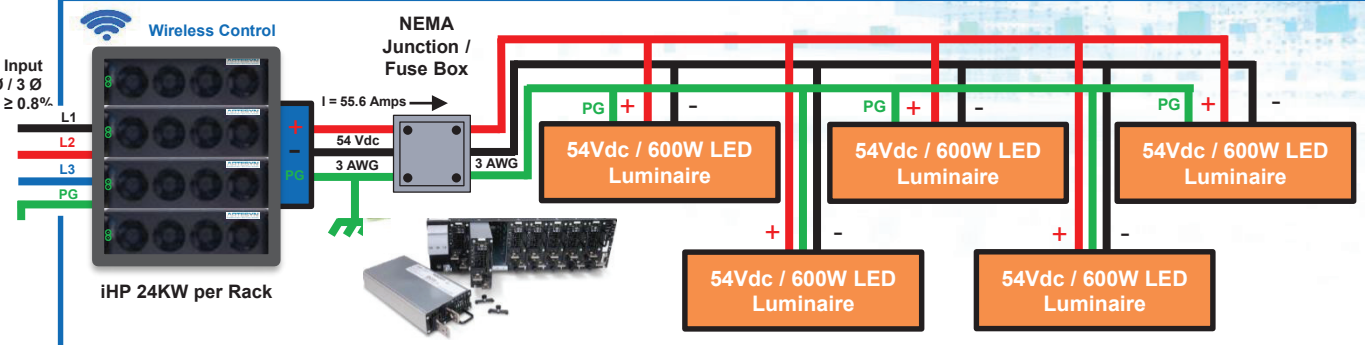
54VDC
$0.99/Foot

200 Feet of Wire =>
Voltage Drop = 12A x 0.51 ohms = 6.1V
Power Losses = I ² x R =
72Watts

250VDC
$0.09/Foot

Low Voltage losses = 49 Watt = 166 BTU/HR

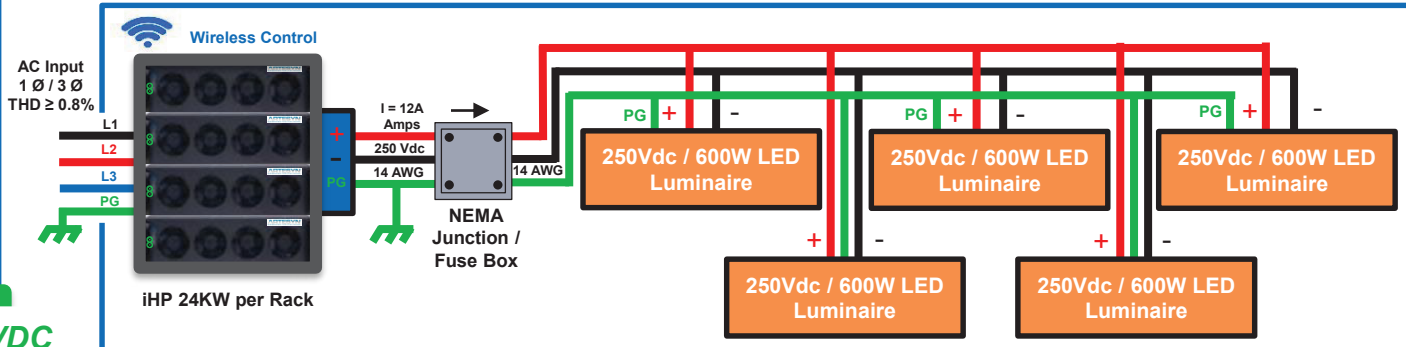
Wiring Diagram for a 3000W, 54Vdc LED Grow Light String in Parallel Configuration



Example shown above is just (1) of the (8) iHP 3KW modules set at 54Vdc & 55A constant current:

- The iHP Remote Power Source is located outside of the grow area to eliminate the added heat source from the LED drivers, lowering cooling and energy costs.
- Higher DC output voltages reduces the wire gauge size and cuts down on the installation costs.
- Faults in parallel configuration will not shut down all the luminaires connected on the same power rail.

Wiring Diagram for a 3000W, 250Vdc LED Grow Light String in Parallel Configuration



Example shown above is just (1) of the (8) iHP & (2) 3KW modules set at 250Vdc & 12A constant current:

- The iHP Remote Power Source is located outside of the grow area to eliminate the added heat source from the LED drivers, lowering cooling and energy costs.
- Higher DC output voltages reduces the wire gauge size and cuts down on the installation costs.
- Faults in parallel configuration will not shut down all the luminaires connected on the same power rail.

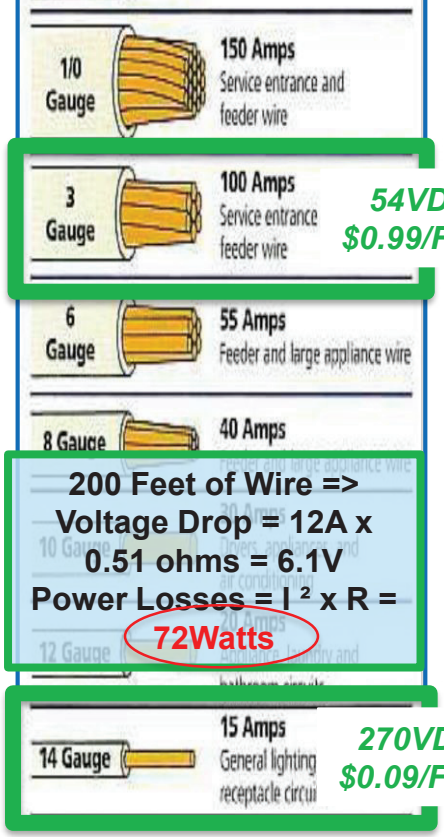
Centralized Remote DC Power System

Standard Lower Voltage 54Vdc LED Grow Lights with High Voltage DC Architecture

Power = Volts x Amps

$

200 Feet of Wire =>
Voltage Drop = 55.6A x 0.039 ohms = 2.2VDC
Power Losses = I ² x R =
121 Watts



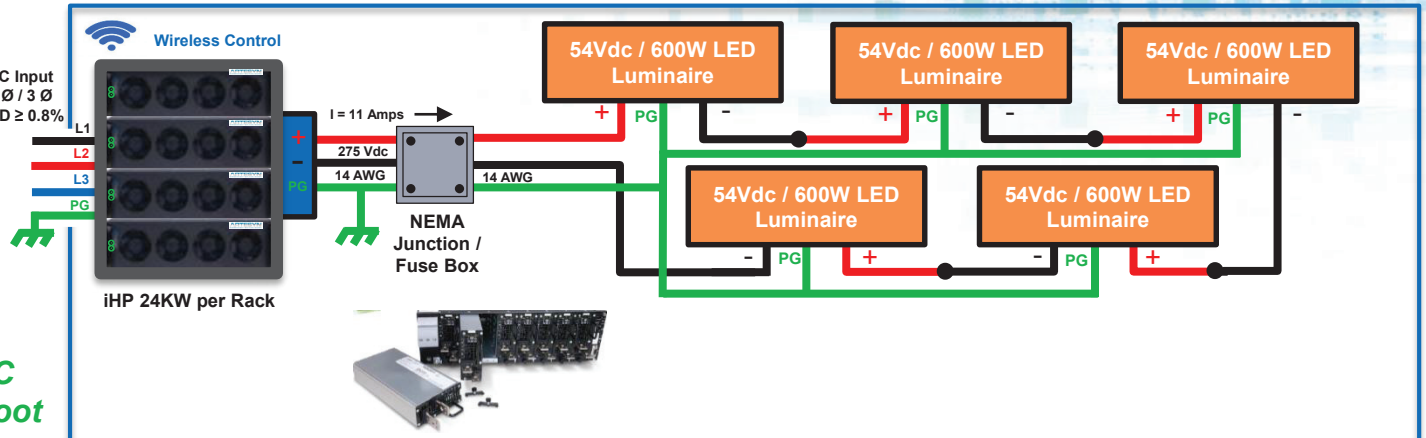
54VDC
$0.99/Foot

200 Feet of Wire =>
Voltage Drop = 12A x 0.51 ohms = 6.1V
Power Losses = I ² x R =
72Watts

270VDC
$0.09/Foot

Low Voltage losses = 49 Watt = 166 BTU/HR

Wiring Diagram for 54Vdc LED Grow Light String in Serial Configuration with 270Vdc Bus



Example shown above is just one of the eight iHP 3KW modules set at 270Vdc & 11A constant current:

- The iHP Remote Power Source is located outside of the grow area to eliminate the added heat source from the LED drivers, lowering cooling and energy costs.
- Higher DC output voltages reduces the wire gauge size and cuts down on the installation costs.
- Faults in serial configuration could shut down all the luminaires connected is the same serial loop.

Why we need to stop this….. HEAT

Power Losses for 40 - 600W LED Drivers

Typical Efficiency for LED Drivers = 95%

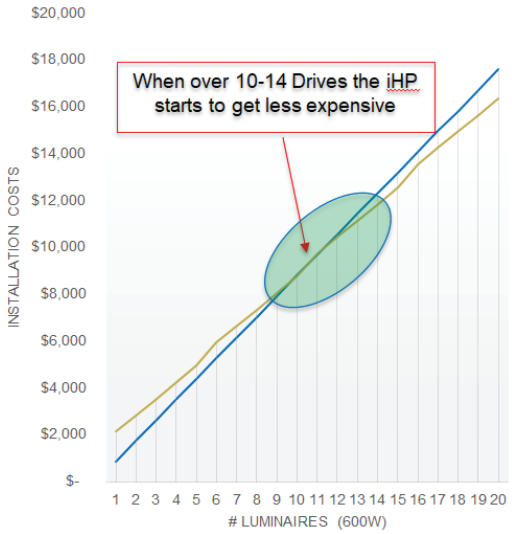
600W x 0.05 = 30W per driver

30W x 40 drivers = 1200W of heat

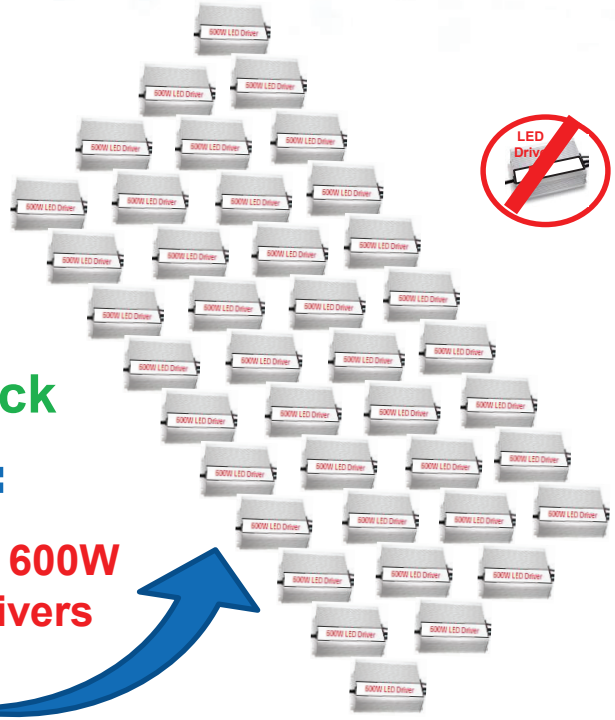
600W Drivers

4,100 BTU / Hour
-added Heat Within the Grow Area

Case study to follow:



1 module = 5- 600W drives



1 Rack

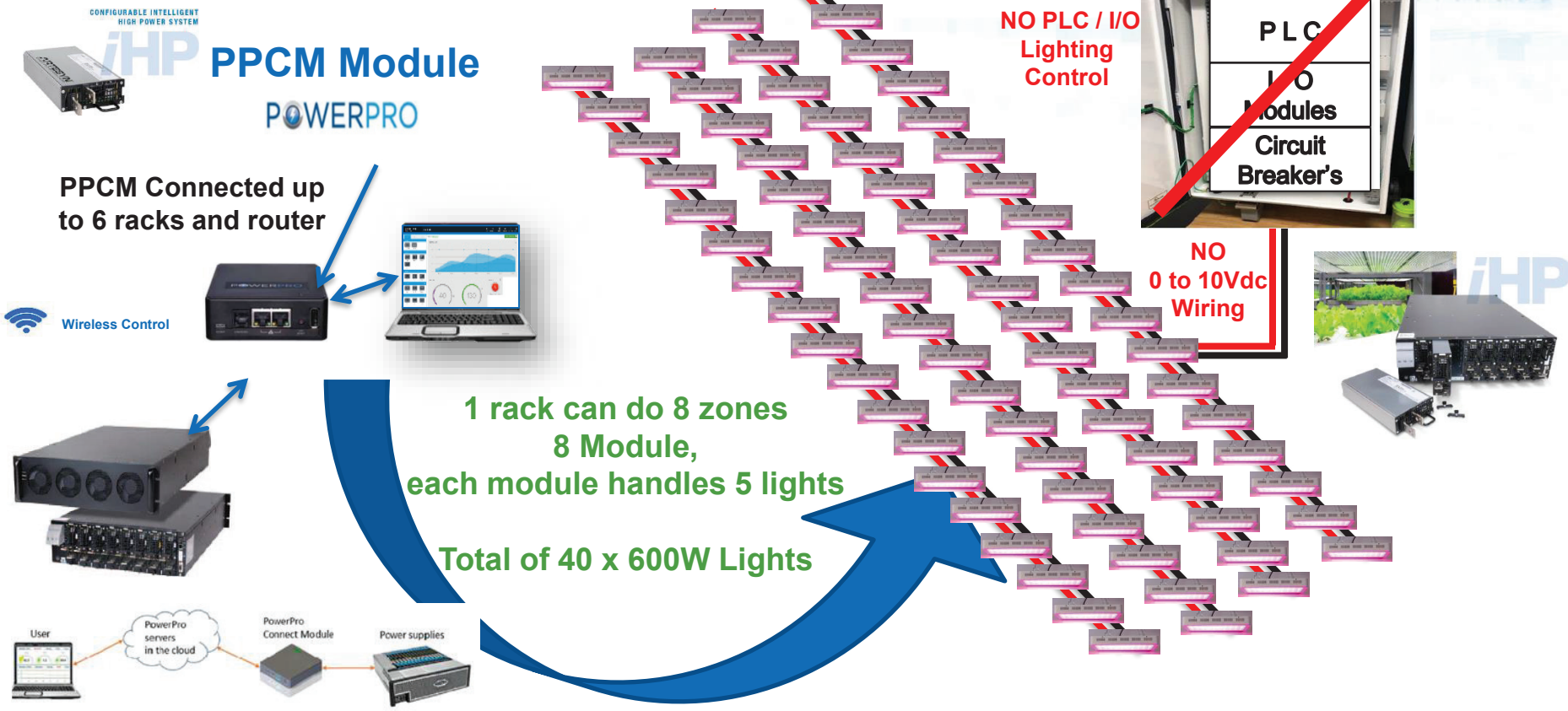
=

40 - 600W Drivers

One (1) iHP 24KW Rack, replaces Forty (40) 600 Watt LED drivers
- Reducing the LED light fixture heat contribution within the indoor Grow Area by 4,100 BTU / Hours.

Included Benefit…. Free lighting controls ….

Smart Power: Lighting Control (On-Off, Dimming and Programed Lighting Schedule)



One (1) PPCM Module, Can Provide Lighting Control (On-Off, Dimming and Programed Lighting Schedule for 240, 600W LED Grow Lights. **Eliminating the 0 to 10Vdc Wiring and Expensive Programmable Logic Controller & Input / Output Lighting Control System**.

iHP Digital-Off line &on Web Based Control

- Using PPCM module to control Dashboards/GUI

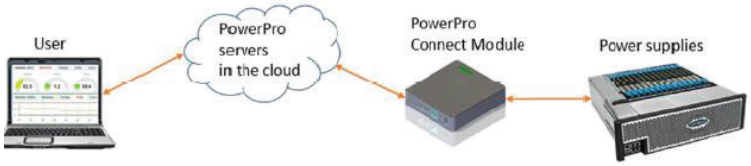
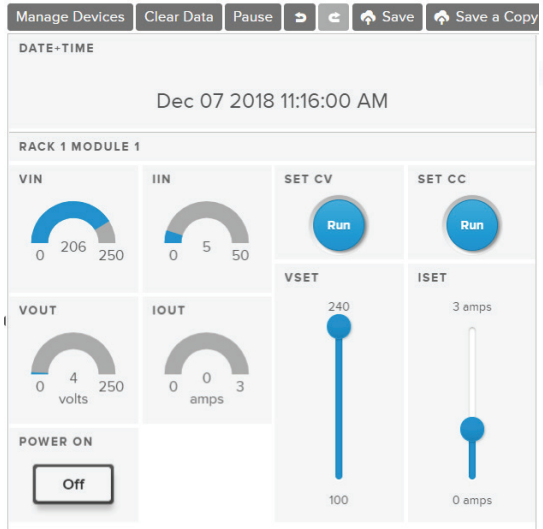
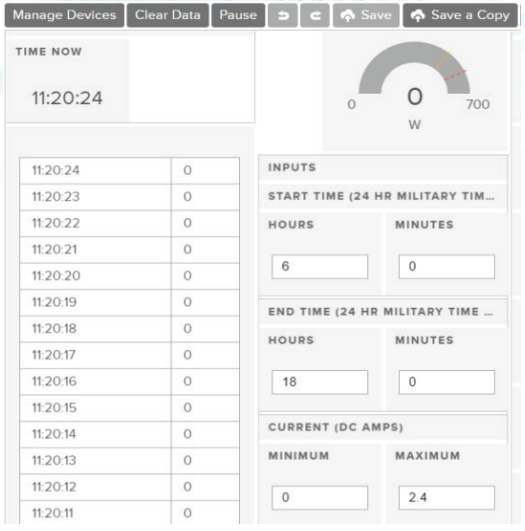


Figure 1 – "Online Mode" Connection Diagram

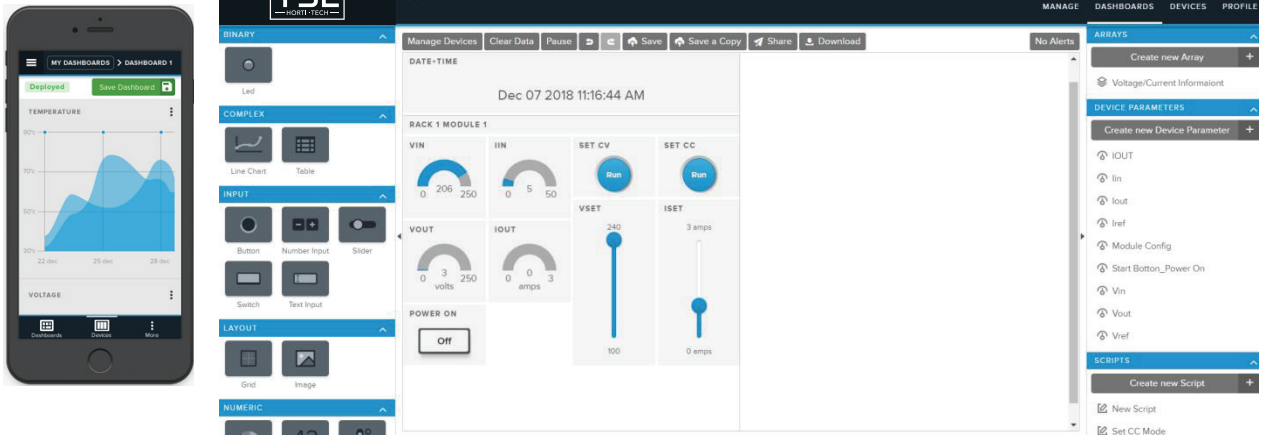
Figure 2 - "Offline Mode" Connection Diagram

Example of various Dashboards

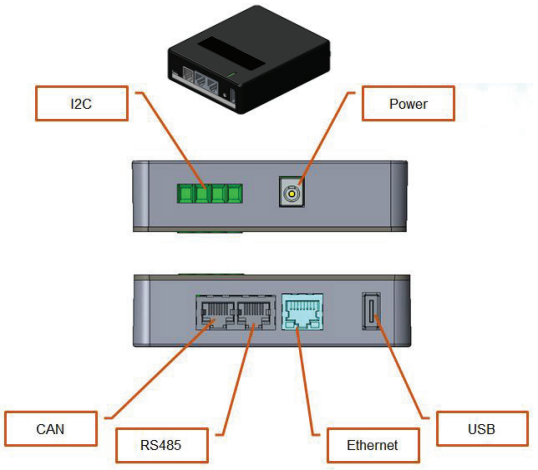




Design your own dashboard and control via mobile device



Supports various interfaces



iHP Analog Control

J1 Pin No.	Signal Name	Signal Type	Functions
1	0-10VEXT_VPROG	Input	Use to control the output voltage by applying 0 to 10V to this pin. This pin will function when the module is configured to Analog Voltage Source.
2	0-5VEXT_VPROG	Input	Use to control the output voltage by applying 0 to 5V to this pin. This pin will function when the module is configured to Analog Voltage Source.
3	0-10VEXT_IPROG	Input	Use to control the output current by applying 0 to 10V to this pin. This pin will function when the module is configured to Analog Current Source.
4	0-5VEXT_IPROG	Input	Use to control the output current by applying 0 to 5V to this pin. This pin will function when the module is configured to Analog Current Source.
5	Dummy Pin		
6	Dummy Pin		
7	SYS_M_INHIBIT	Input	Signal to Inhibit the module
8	SYS_RTN		Ground reference for J1 signals.
9	SYS_M_ENABLE#	Input	Signal to Enable the module
10	SYS_M_FAULT#	Output	Signal to notify user that Fault occurred.

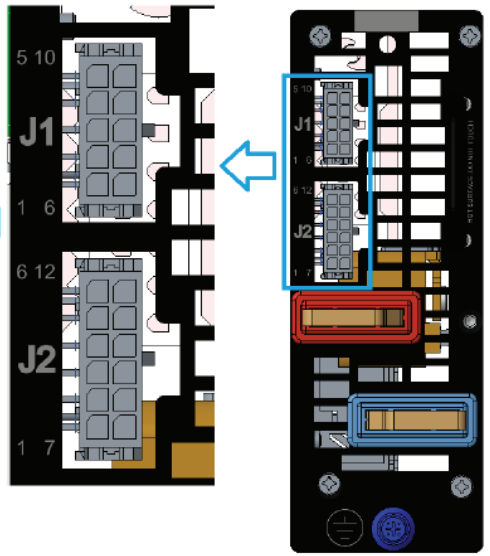
J2 Pin No.	Signal Name	Signal Type	Functions
1	V_SNS+	Input	Signal use for module positive remote sense
2	D_RTN		Ground reference for IMON or VMON signals
3	EXT_ISENSE+	Input	Input for external resistor shunt for external current sensing application.
4	D_RTN		Ground reference for ISHARE signal
5	IMON	Output	Analog signal to report the output current in scaled value (0-10V)
6	Dummy Pin		
7	D_RTN		Ground reference for IMON or VMON signals
8	V_SNS-	Input	Signal use for module negative remote sense
9	EXT_ISENSE-	Input	Input for external resistor shunt for external current sensing application
10	ISHARE	Output	Signal for active current sharing
11	VMON	Output	Analog signal to report the output voltage in scaled value (0-10V)
12	Dummy Pin		

J1 Signal

Pin#	Signal	Signal	Pin#
5	Dummy Net	SYS_M_FAULT#	10
4	0-5VEXT_IPROG	SYS_M_ENABLE#	9
3	0-10VEXT_IPROG	SYS_RTN	8
2	0-5VEXT_VPROG	SYS_M_INHIBIT	7
1	0-10VEXT_VPROG	Dummy Net	6

J2 Signal

Pin#	Signal	Signal	Pin#
6	Dummy Net	Dummy Net	12
5	IMON	VMON	11
4	D_RTN	ISHARE	10
3	EXT_ISENSE+	EXT_ISENSE-	9
2	D_RTN	V_SNS-	8
1	V_SNS+	D_RTN	7



Example using 0-5V control.
Both for controlling the voltage and/or current

0-5VEXT_IPROG	Corresponding Output Current
0V	0% Nominal Output Current
1.25V	25% Nominal Output Current
2.5V	50% Nominal Output Current
3.75V	75% Nominal Output Current
5V	Nominal Output Current

0-5VEXT_VPROG	Corresponding Output Voltage
0V – 0.21V	5% Nominal Output Voltage
1.25V	30% Nominal Output Voltage
2.5V	60% Nominal Output Voltage
3.75V	90% Nominal Output Voltage
4.166V	100% Nominal Output Voltage
5V	120% Nominal Output Voltage

Centralized Remote DC Power System

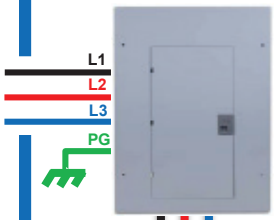
for ANY LED GROW LIGHT Installations

NO PLC / I/O Lighting Control

Simple 3 Wire (14AWG) Power & Lighting Control to Each Light
NEMA Junction / Fuse Box

iHP Remote Power
Wireless Control
Cloud Base or LAN

Versatile Input
180Vac to 600Vac
1 phase / 3 phase
THD ≤ 0.80%



PPCM

Indoor Grow

250VDC BUS

Greenhouse

Vertical Farming

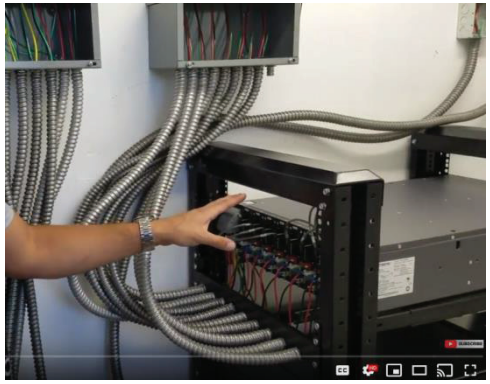
Programmable
DC Outputs
12Vdc to 1,000Vdc

Wireless Control
Digital – Cloud / LAN
Analog – 0 to 10V
Compatible with ALL
Control Systems

Junction / Fuse Box

LED Strips

Typical iHP Centralized Distributed 250VDC Installation for an Indoor Grow Facility



Traditional AC Distribution with LED Drivers

Versus

Centralized iHP Hi- Voltage DC Distribution

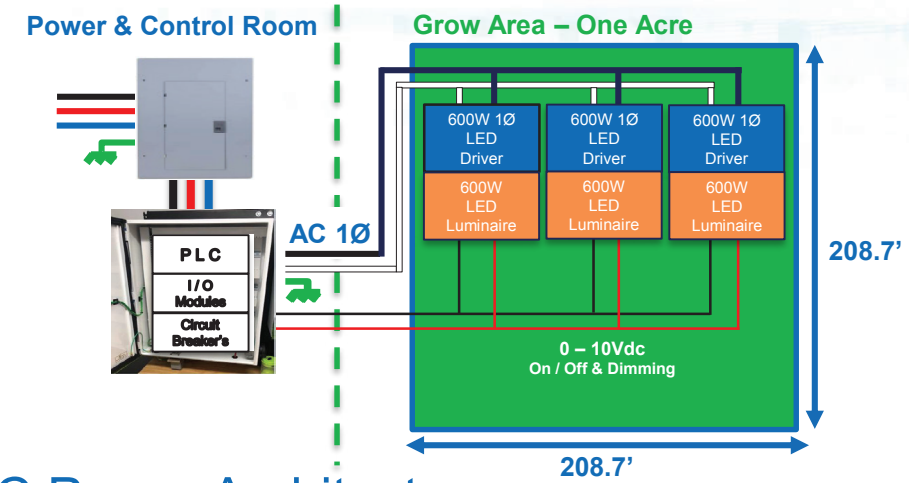
Real case study for current customer

Case Study - One Acre of Indoor Grow Area

Traditional AC Power Distribution with LED Drivers

Current State

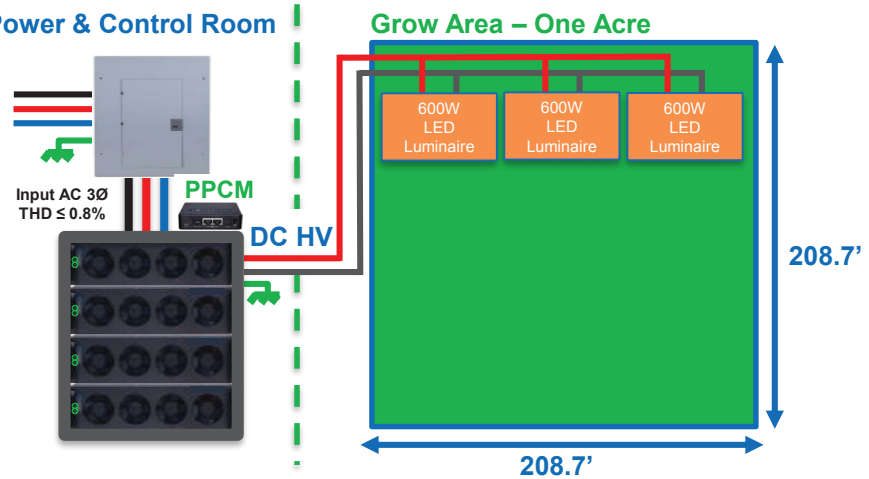
Versus



Centralized Remote High Voltage DC Power Architecture

Future State

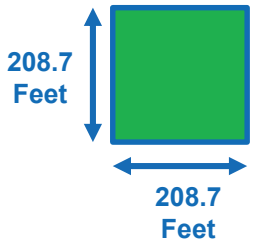
- Eliminate all of the 1Ø LED Drivers (added heat)
- Eliminate all of the Output Circuit Breakers
- Eliminate all the Input / Output Control Modules
- Eliminate the two wire (copper) going to each LED Driver for on/off & dimming control.
- Simplified Installation with iHP that Significantly Lowers the Labor & Installation Costs.



Power System Assumptions

iHP High Voltage DC Remote Power System

- Indoor Grow Area = One (1) Acre / 43,560 feet ²

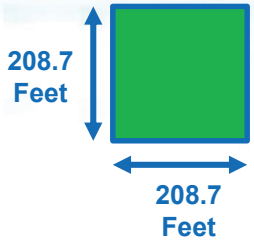


- 600W LED Grow Lights with **NO LED Driver**
  - LED Grow Lights Installed inside Grow Area, iHP DC Power System Installed Outside of the Grow Area
  - Number of LED Grow Lights Per Acre
    1,763 LED Grow Lights
  - Total System Output Power
    = 600W x 1,763 Lights
    1,057,800 Watts

Per iHP 24KW Rack = **44 Racks**
- Input Voltage = 480Vac 3Ø, PF 0.98, THD ≤ 0.8%
- Output Voltage = 250Vdc
- Constant Power = 24,000 Watts

Traditional AC Power Distribution with LED Drivers

- Indoor Grow Area = One (1) Acre / 43,560 feet ²



- 600W LED Grow Lights **WITH LED Driver**
  - LED Grow Lights with Driver Installed inside Grow Area
  - Number of LED Grow Lights Per Acre
    1,763 LED Grow Lights
  - Total System Output Power
    = 600W x 1,763 Lights
    1,057,800 Watts

Per LED Driver = **1,763 Drivers**
- Input Voltage = 480Vac 1Ø, PF 0.93, THD < 16%
- Output Voltage = 116Vdc
- Constant Power = 600 Watts

Capital Expense - Lights and Controls

iHP High Voltage DC Remote Power System

- **Power Conversion**
- Artesyn iHP 24KW / 250Vdc Power Rack
- Part Number – iHP24H3A-SA(8)-GS
  - Chassis – (1) 24KW High Line Chassis
  - Modules – (8) 250Vdc Modules
- Budgetary Unit Price = $5,500.00
- Total Power System Price = 44 Racks x $5,500.00

$242,000.00

- **Lighting Control Software / Hardware**
- Artesyn PowerPro Connect Module (PPCM)
- Part Number – 73-778-000
  - PPCMs – (8) PPCM Modules
  - Lighting Control Software – Digital Scheduler
- Unit Price - $120.00
- Total Control System Price = 8 PPCMs x $120.00

$960.00

- **Additional (0 to 10Vdc) Control Wiring & Labor Costs**
- iHP has both Analog and Digital Control
  - With Digital Control (Dimming to Off)
  - NO two wire Control Wiring is Required

$0.00

Total Capital Expense = $242,960.00 / $0.23 per Watt

Traditional AC Power Distribution with LED Drivers

- **Power Conversion**
- 600W Constant Power LED Driver
  - Wide 1Ø Input Range
  - 0 to 10Vdc (Dimming to Off)
  - 96% Efficiency
  - One Driver Per LED Grow Light
- Estimated Unit Price = $97.50
- Total Power System Price = 1,763 Drivers x $97.50

$171,892.50

- **Lighting Control Software / Hardware**
- Control Hardware / Software **for 1,763 Lights**
  - Programmable Logic Controller
  - Input / Output Modules
  - Control Software / Display
- Estimated Unit Price = $180,000.00
- Total Control System Price = $180,000.00

$180,000.00

- **Additional (0 to 10Vdc) Control Wiring & Labor Costs**
  - Two wire cable = 0.30/ft. x 10,000 ft. = $3,000.00
  - Labor cost = 80 hrs. x $250.00 = $20,000.00
- Estimated Wire & Labor Cost =

$23,000.00

Total Capital Expense = $374,892.50 / $0.35 per Watt

CapEx is 35% less cost

Capital Expense

- Additional Air Conditioning Required for Indoor & Vertical Farming

iHP High Voltage DC Remote Power System

- **Additional AC Required within the Indoor Grow Area**
- iHP High Voltage DC Remote Power System Resides Outside of the Grow Area and **DOSE NOT ADD** any Additional Heat to Indoor Grow or Vertical Farming Applications.
- iHP Power Losses within the Grow Area

  0.00 BTUs / Hour

  ENERGY SAVING of 5%
- Additional AC Cooling Capacity Required within Indoor Grow or Vertical Farming Applications

  0 Tons
- Additional Cost for Cooling Capacity

  $0.00
- **Operating Temperature - 0°C to +50°C at 100% Load**
- Air Cooled

Traditional AC Power Distribution with LED Drivers

- **Additional AC Required within the indoor Grow Area**
- **Power Losses within the Grow Area**
  - LED Driver Efficiency = 95%
  - 600 Watts x 0.05 = 30 Watt of Heat Per Driver
  - 30 Watts x 1,763 LED Drivers = **52,890 Watts**
  - 1 Watt = 3.4121 BTU / Hour
  - **52,890 Watts** x 3.4121 =

  180,466 BTUs / Hour

  - 12,000 BTU / Hour = 1 Ton of Cooling Capacity
  - Additional AC Cooling Capacity
  - 144,375 / 12,000 =

  15 Tons + AC

  - Additional Cost for 12 Tons of AC + Labor =

  $16,500.00

Operating Expense for Input Saving

Lighting Energy Costs Only (Does not include HVAC)

iHP High Voltage DC Remote Power System

- **Total Power Draw**

  1,057,800 Watts

  - iHP Efficiency = 93.5%
  - Power Factor = 0.98
  - **Total Harmonic Distortion = 0.8%**
  - Real Power KW = 1,131.34 KW
  - Reactive Power KVAR = 238.96 KVAR
  - **Apparent Power KVA = 1,156.30 KVA**

ENERGY SAVING of 10%

- **Energy Cost Per Hour (Operation)**

  $ per KW / KVA hour
  - Tier 1 = **$0.10 / kWh** => **$115.63 kWh**
  - Tier 2 = **$0.18 / kWh** => $208.13 kWh
  - High Usage = **$0.23 / kWh** => $265.95 kWh

- **Energy Cost Per Year (Operation) – 60% Usage**

  - **$115.63 kWh x 14,600 hours x 0.6 = $1.01M**
  - $208.13 kWh x 14,600 hours x 0.6 = $1.82M
  - $265.95 kWh x 14,600 hours x 0.6 = $2.33M

Capital Expense ROI ≤ **2.2 Years**

Annual Operating Expense = Energy Cost @ $0.10 / kWh **$1.01M / Year**

Traditional AC Power Distribution with LED Drivers

- **Total Power Draw**

  1,057,800 Watts

  - LED Driver Efficiency = 95%
  - Power Factor = 0.93
  - **Total Harmonic Distortion = 16%**
  - Real Power KW = 1,169.15 KW
  - Reactive Power KVAR = 631.64 KVAR
  - **Apparent Power KVA = 1,280.15 KVA**

- **Energy Cost Per Hour (Operation)**

  $ per KW / KVA hour
  - Tier 1 = **$0.10 / kWh** => **$128.02 kWh**
  - Tier 2 = **$0.18 / kWh** => $230.43 kWh
  - High Usage = **$0.23 / kWh** => $294.43 kWh

- **Energy Cost Per Year (Operation) – 60 Usage**

  - **$128.02 kWh x 14,600 hours x 0.6 = $1.12 M**
  - $230.43 kWh x 14,600 hours x 0.6 = $2.02 M
  - $294.43 kWh x 14,600 hours x 0.6 = $2.58 M

Additional Energy Cost Per Year

$110K+

Total Operating Expense = Energy Cost @ $0.10 / kWh **$1.12M / Year**

Operating Expense for Input Saving

Lighting Energy Costs Only (includes HVAC)

iHP High Voltage DC Remote Power System

- **Total Power Draw**

  1,057,800 Watts

  - iHP Efficiency = 93.5%
  - Power Factor = 0.98
  - Total Harmonic Distortion = **0.8%**
  - Real Power KW = 1,131.34 KW
  - Reactive Power KVAR = 238.96 KVAR
  - **Apparent Power KVA = 1,156.30 KVA**

ENERGY SAVING of 15%

- **Energy Cost Per Hour (Operation)**

  $ per KW / KVA hour
  - Tier 1 = **$0.10 / kWh** => **$115.63 kWh**
  - Tier 2 = **$0.18 / kWh** => $208.13 kWh
  - High Usage = **$0.23 / kWh** => $265.95 kWh

- **Energy Cost Per Year (Operation) – 60% Usage**
  - **$115.63 kWh x 14,600 hours x 0.6 = $1.01M**
  - $208.13 kWh x 14,600 hours x 0.6 = $1.82M
  - $265.95 kWh x 14,600 hours x 0.6 = $2.33M

Capital Expense ROI ≤ **1.6 Years**

Annual Operating Expense = Energy Cost @ $0.10 / kWh **$1.01M / Year**

Traditional AC Power Distribution with LED Drivers

- **Total Power Draw**

  1,057,800 W + 52,890 W = 1,110,690 W

  - LED Driver Efficiency = 95%
  - Power Factor = 0.93
  - Total Harmonic Distortion = **16%**
  - Real Power KW = 1,113.47 KW
  - Reactive Power KVAR = 663.22 KVAR
  - **Apparent Power KVA = 1344.16KVA**

- **Energy Cost Per Hour (Operation)**

  $ per KW / KVA hour
  - Tier 1 = **$0.10 / kWh** => **$132.42 kWh**
  - Tier 2 = **$0.18 / kWh** => $241.95 kWh
  - High Usage = **$0.23 / kWh** => $309.17 kWh

- **Energy Cost Per Year (Operation) – 60 Usage**
  - **$132.42 kWh x 14,600 hours x 0.6 = $1.16M**
  - $241.95 kWh x 14,600 hours x 0.6 = $2.12 M
  - $309.17 kWh x kWh x 14,600 hours x 0.6 = $2.71 M

Additional Energy Cost Per Year at $0.10 / kWh

$150K+

Total Operating Expense = Energy Cost @ $0.10 / kWh **$1.16M / Year**

Centralized Power
The "Makes Sense" Architecture for Horticulture

- **Removes LED Driver Heat from Grow Area:**
  Saves 5% energy on HVAC per one acre

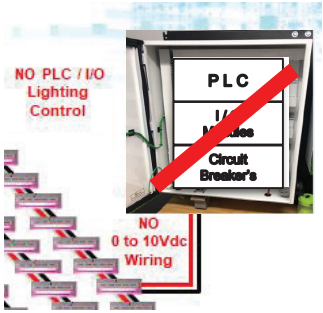
- **Reduced Input Energy:** High Efficient 3Ø, low THD ≤ 0.8% Centralized Power Conversion Vs. Traditional 1Ø LED Drivers with a THD > 12%
  Saves 10% on the input energy per one acre (THD ≤ 0.8% vs. THD > 16%)

- **Use High Voltage DC Distribution**: Higher DC voltage Reduces Current and Copper Costs and have Less Overall System Losses. With 352 Zone at 49W loss per = 17,248
  Saves 1.6% using 250Vdc vs. 54Vdc

- **3KW Scalability with Complete Dimming and Scheduling Control** that can drive both VEG and Flower rooms from one power & control system
  Saves power by dimming

Light Source	Watts	Dimmability	Dimming Limit
High Pressure Sodium	100 – 500	Requires special ballast	50%
LED	43 – 170	Yes	10%

- **Eliminates Expensive PLC & I/O:** Lighting Control Systems
  Saves power - no power for the PLC needed



Thank You For Your Time

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