

Solelgrossisten

Huawei Växelriktare

3-10KTL-M1, 12-20KTL-M2, Optimerare & Energilager

2021-03-25

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SOLEL FÖR
SOLELSPROFFS

Agenda

- Välkomna
- Niklas Knöppel (CEO Solelgrossisten)
- Magnus Weberg (CEO Huawei Enterprise) & Patrik Salklev (ansvarig Huawei Växelriktare Sverige)
- Presentation & Vad är nytt 3-10KTL-M1 Växelriktare
- Presentation & Vad är nytt 12-20KTL-M2 Växelriktare
- Optimerare 450W
- Energilager LUNA 5-30 kWh
- Frågor

FusionSolar

Residential Smart PV Solution Walking Through

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Security Level:

01 Product Portfolio

02 Single Phase Residential Application

03 Three Phase Residential Application

FusionSolar Smart PV Residential Inverter Portfolio



SUN2000-2/3/3.68/4/4.6/5/6KTL-L1
(Single phase inverter)

MPPT/Inputs: 2/2

Local commissioning: Built-in WLAN

Communication:

- Built-in WLAN (Standard)
- Smart Dongle-WLAN-FE (Optional)
- Smart Dongle-4G (Optional)

AFCI: Yes

Compatible Optimizer: SUN2000-450W-P

* Test result shows nominal DC voltage of SUN20002-6KTL-L1 inverter does not induce significant PID of connected PV module.



SUN2000-3/4/5/6/8/10KTL-M1
(Three phase inverter)

MPPT/Inputs: 2/2

Local commissioning: Built-in WLAN

Communication:

- Smart Dongle-WLAN-FE (Standard)
- Smart Dongle-4G (Optional)

AFCI: Yes

PID Recovery: Yes

Ripple Control Interface: Yes

Compatible Optimizer: SUN2000-450W-P

Optimizer and Smart Power Sensor



Smart PV Optimizer
SUN2000-450W-P

- DC MBUS communication to Inverter
- Maximum power harvesting from each module
- Module-level monitoring
- Open circuit impedance **1K** Ohms for installation verification
- Reduces PV wires to a safe voltage when inverter is shut down (Compliant to NEC2017)

Compatible to SUN2000-2-6KTL-L1, SUN2000-3-10KTL-M1 inverter



Smart Power Sensor
DDSU666-H (Single Phase)
DTSU666-H 250A/50mA (Three Phase)

- RS485 connected to inverter
- Class 1 high accuracy meter readings for production/consumption monitoring
- Import/export meter readings for export limitation functionality
- Current transformer included

External Communication Modules



Smart Dongle-WLAN-FE

- Max **10** device communication connected
- Plug & play USB interface connected to inverter for monitoring through WLAN or fast Ethernet

Compatible to SUN2000-2-6KTL-L1, SUN2000-3-10KTL-M1 inverter

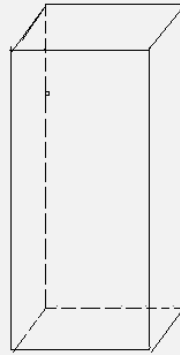


Smart Dongle-4G

- Max **10** device communication connected
- Plug & play USB interface connected to inverter for monitoring through 4G

Compatible to SUN2000-2-6KTL-L1, SUN2000-3-10KTL-M1 inverter

Energy Storage Product



Energy Storage System

PowerMate 5-30kWh

Capacity: 5kWh per modular, up to 30 kWh

Output Power: 5 KW

Peak Output Power: 7 KW, 10 s

Cell Type: LiFePO4

Output Voltage: 400 / 800 Vdc

FusionSolar APP & Smart PV Management System



FusionSolar

FusionSolar APP

- Support local system commissioning and plant registration on management system
- Auto-detection of system equipment
- Registering plant by scanning any equipment in the system



FusionSolar Smart PV Management System

- Unified address
<https://intl.fusionsolar.huawei.com>
- Real-time energy flow and energy balance
- Module-level performance management
- Demo site for all guests to experience system

01 Product Portfolio

02 Single Phase
Residential Application

03 Three Phase
Residential Application

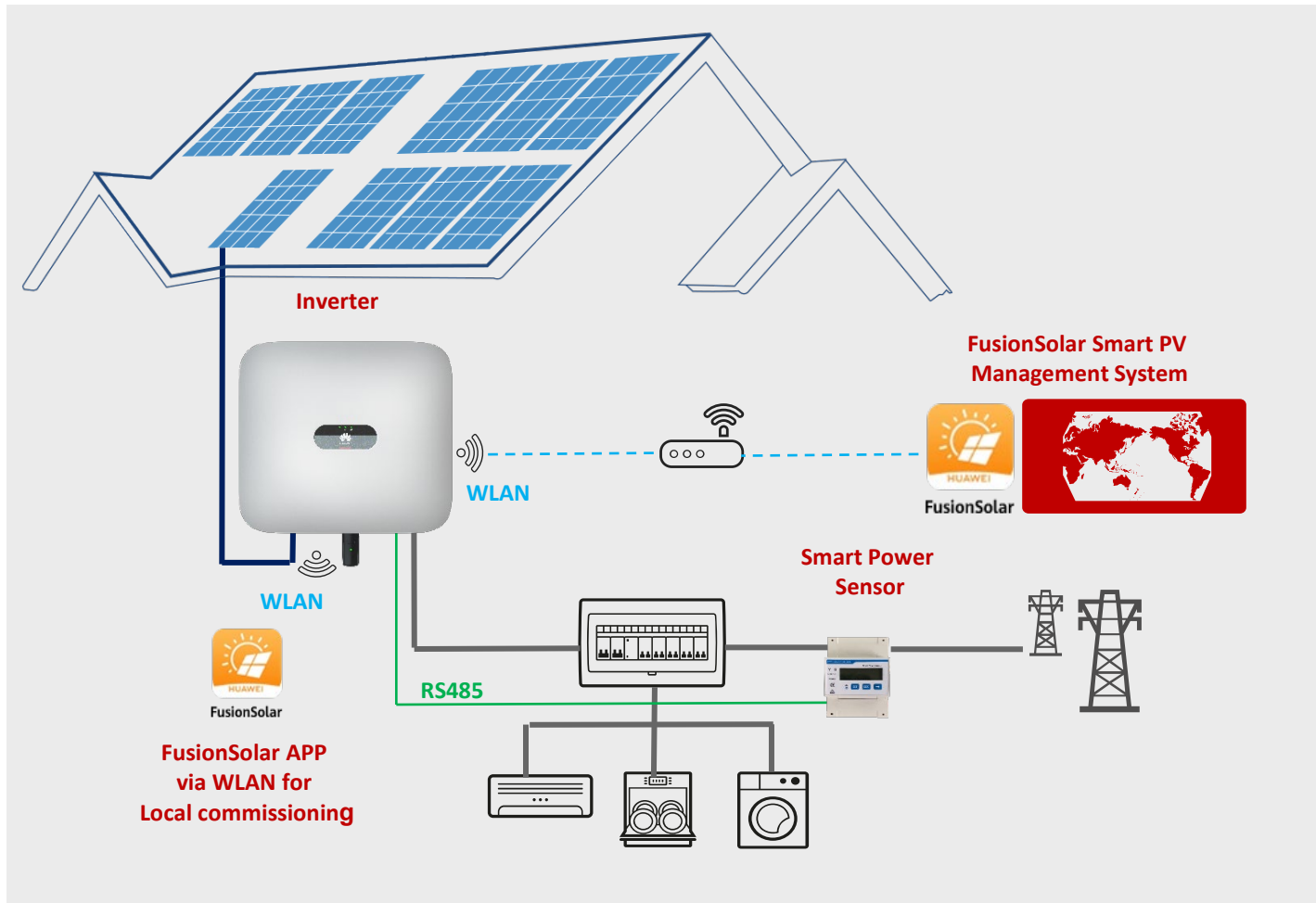
Residential Three Phase Solution

SUN2000-3/4/5/6/8/10KTL-M1

Compatible Optimizer	Inverter	Smart Power Sensor	Battery	Backup Power Supply	Communication	Management System	AFCI	PID Recovery	Ripple Control
SUN2000-450W-P	SUN2000-3/4/5/6/8/10KTL-M1	DTSU666-H 250A/50mA (Three Phase)	HUAWEI ESS PowerMate 5-30kWh	Yes	<ul style="list-style-type: none">Local commissioning: Inverter built-in WLAN for commissioning;Standard WLAN or Ethernet communication: smart dongle-WLAN-FEOptional 4G communication: smart dongle-4G	FusionSolar	Yes	Yes	Yes

Residential Three Phase Inverter Without Optimizer

SUN2000-3/4/5/6/8/10KTL-M1



Communication:

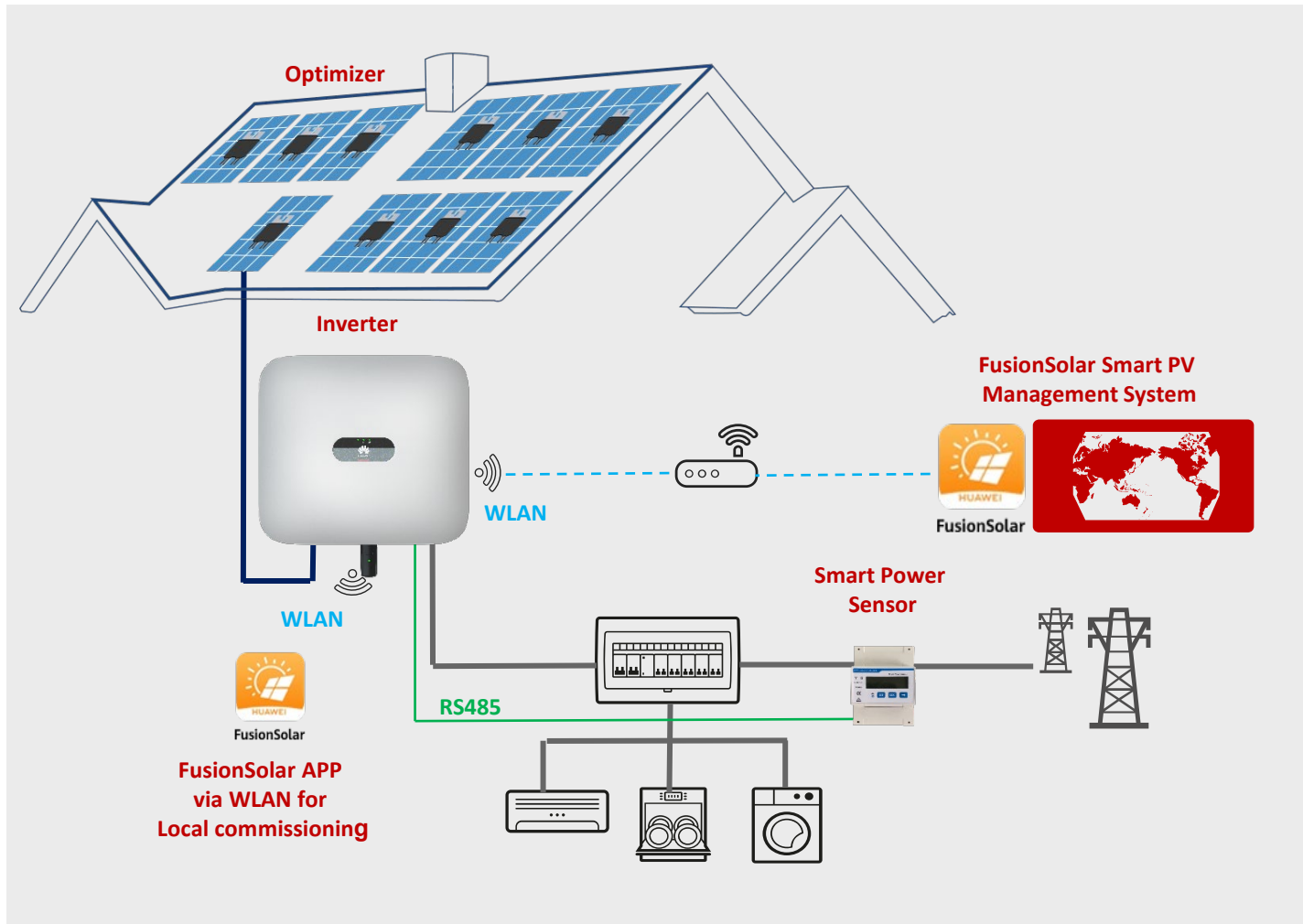
- Local Commissioning: Inverter built-in WLAN communication to FusionSolar App
- Remote Monitoring: WLAN-FE Dongle(Standard) 4G Dongle (Optional) communicating to FusionSolar smart PV management system for site creation and monitoring

Smart Power Sensor (Optional):

- DTSU666-H 250A/50mA (three phase) connects to inverter via RS485 for power output monitoring or export control.

Residential Three Phase Inverter with Optimizer

SUN2000-3/4/5/6/8/10KTL-M1



Optimizer:

SUN2000-450W-P Optimize attached to all modules.

Support long string design, each string power is up to 10KW.

Communication:

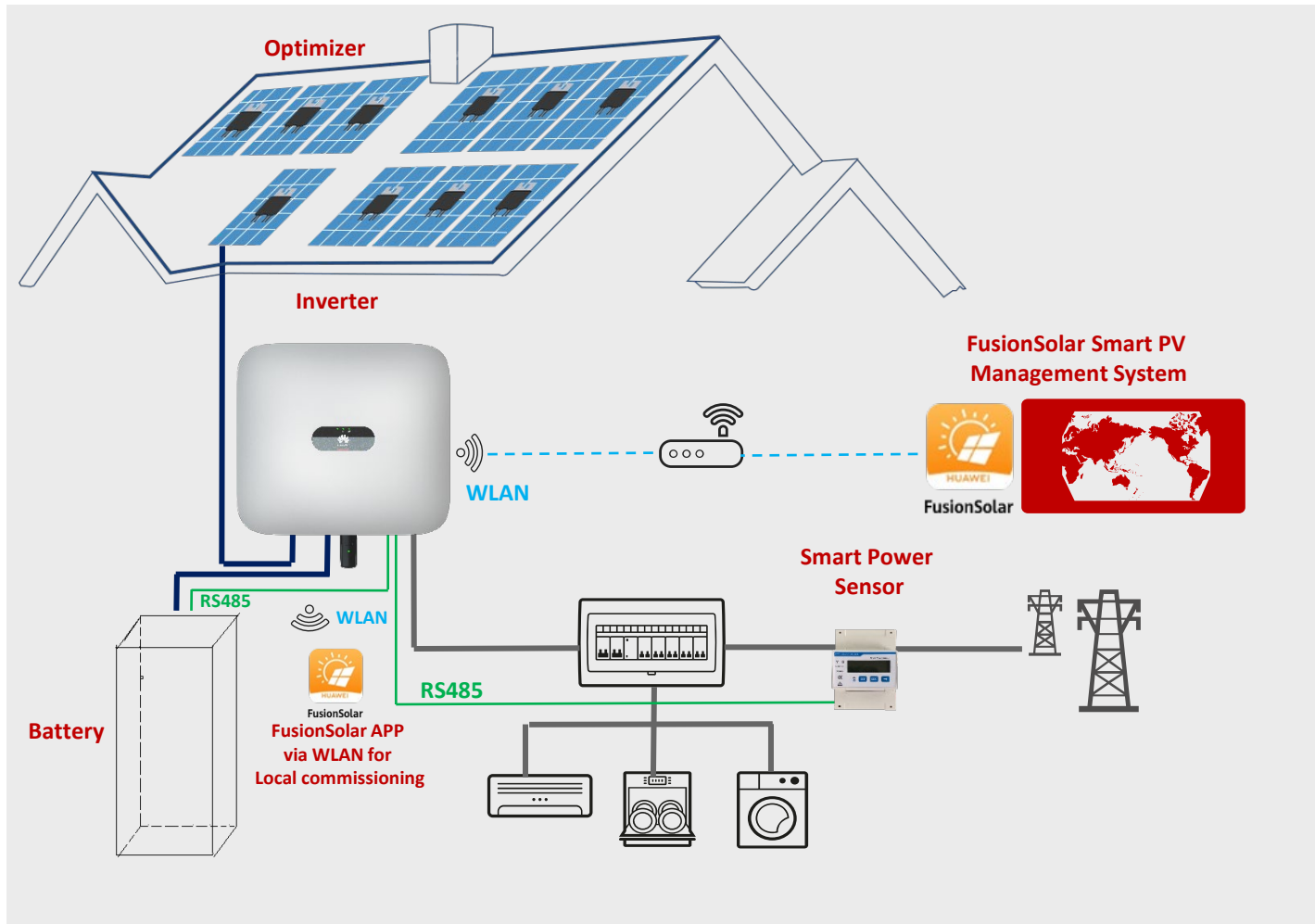
- Local Commissioning: Inverter built-in WLAN communication to FusionSolar
- Remote Monitoring:
 - WLAN-FE Dongle (Standard)
 - 4G Dongle (Optional)communicating to FusionSolar smart PV management system for site creation and monitoring

Smart Power Sensor (Optional):

- DTSU666-H 250A/50mA (three phase) connects to inverter via RS485 for power output monitoring or export control.

Residential Three Phase Inverter with Battery Storage

SUN2000-3/4/5/6/8/10KTL-M1



Communication:

- Local Commissioning: Inverter built-in WLAN communication to FusionSolar App
- Remote Monitoring:
 - WLAN-FE Dongle (Standard)
 - 4G Dongle (Optional)communicating to FusionSolar smart PV management system for site creation and monitoring

Compatible Battery:

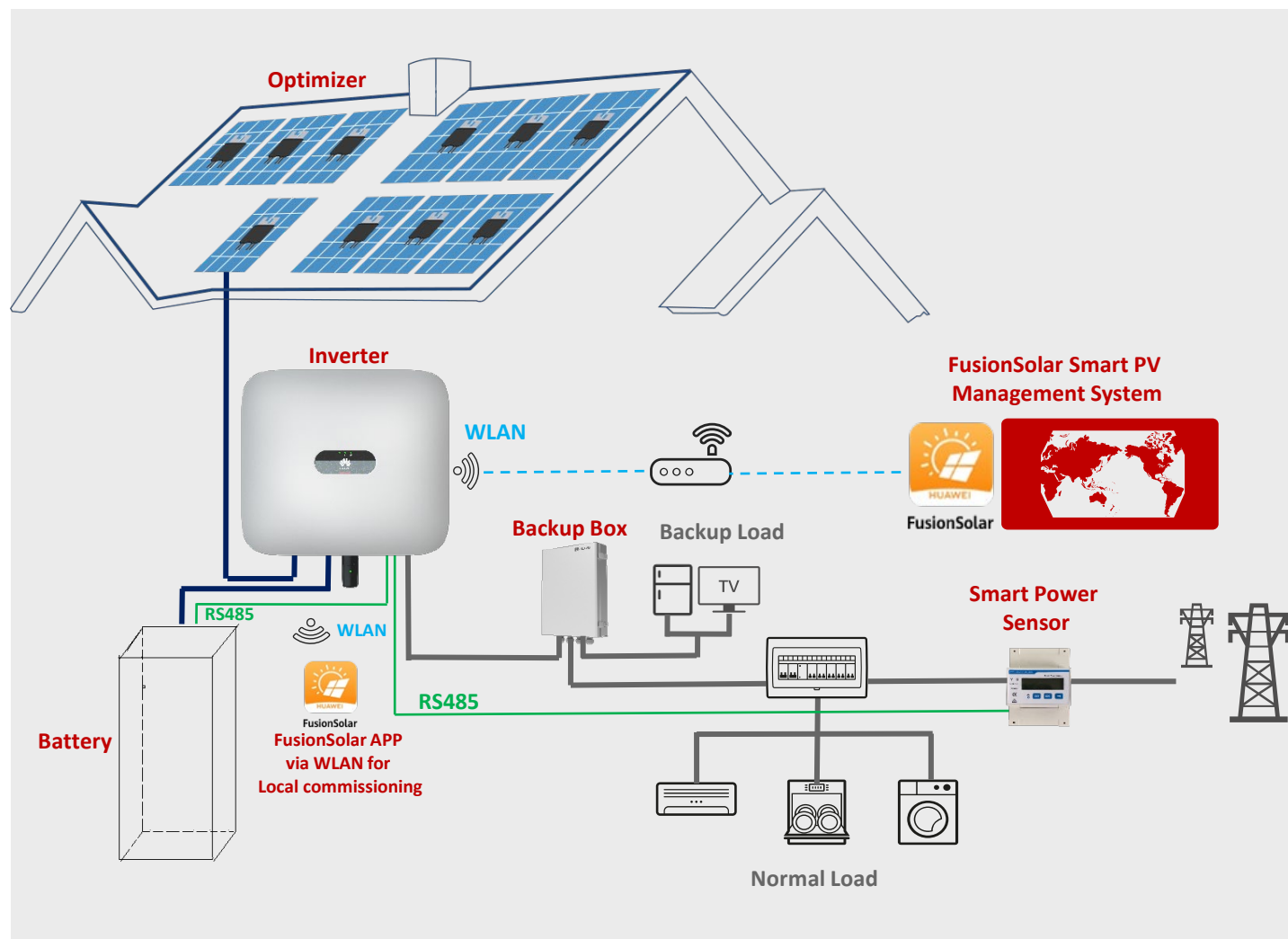
- HUAWEI ESS PowerMate 5-30kWh
- High voltage DC coupled battery plug & play integration to inverter. Battery is managed by inverter via RS485 communication.
- Fix charge/discharge, self-consumption maximization & time of use control mode can be selected

Smart Power Sensor (necessary with battery installed):

- DTSU666-H 250A/50mA (three phase) connects to inverter via RS485 for power output monitoring or export control.

Residential Three Phase Inverter with Backup Power Supply

SUN2000-3/4/5/6/8/10KTL-M1



Communication:

- Local Commissioning: Inverter built-in WLAN communication to FusionSolar App
- Remote Monitoring:
 - WLAN-FE Dongle (Standard)
 - 4G Dongle (Optional)communicating to FusionSolar smart PV management system for site creation and monitoring

Compatible Battery:

- HUAWEI ESS PowerMate 5-30kWh
- High voltage DC coupled battery plug & play integration to inverter. Battery is managed by inverter via RS485 communication.
- Fix charge/discharge, self-consumption maximization & time of use control mode can be selected

Backup Power Supply (Not available to SUN2000-3-10KTL-M0):

- Only support one phase backup load Inverter,
- Automatically supplies power to backed-up loads in the event of grid outages

Smart Power Sensor (necessary with battery installed):

- DTSU666-H 250A/50mA (three phase) connects to inverter via RS485 for power output monitoring or export control.

Residential Full Product Portfolio & Main Feature Difference Matrix



Main Feature Difference	SUN2000L-2-5KTL	SUN2000-2-5KTL-L0	SUN2000-2-6KTL-L1	SUN2000-3-10KTL-M0	SUN2000-3-10KTL-M1
MPPT/Inputs	2/2	2/2	2/2	2/2	2/2
Compatible with Huawei new optimizer SUN2000-450W-P			✓		✓
Inverter built-in AFCI			✓	✓	✓
Module-level arc fault circuit interrupter (AFCI)			✓		✓
Support smart dongle-WLAN-FE			✓	✓	✓
Support smart dongle-4G		✓	✓	✓	✓
Integrated PID recovery					✓
Ripple Control Interface				✓	✓
Battery interface	✓		✓	✓	✓
Backup Support			✓		✓

FusionSolar

Commercial & Industrial Smart PV Solution Walking Through

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01 Product Portfolio

02 Small Scale
C&I Application
(Single Inverter)

03 Medium Scale
C&I Application
(≤ 10 Inverters)

04 Large Scale
C&I Application
(> 10 Inverters)

05 Special Application
(AFCI, Partial
Optimization)

FusionSolar C&I Range of Inverters up to 100KTL



SUN2000-12/15/17/20KTL-M0/M2
(Three phase inverter)

MPPT/Inputs: 2/4

Local commissioning:

- Built-in WLAN

Communication:

-Smart Dongle-WLAN-FE (Optional)

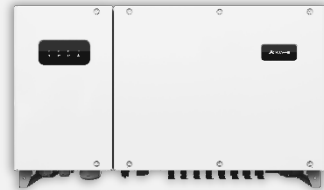
-Smart Dongle-4G (Optional)

-SmartLogger3000A (Optional)

AFCI: Yes

PID Recovery: Yes

Ripple Control Interface: Yes



SUN2000-29.9KTL/33KTL-A/36KTL
(Three phase inverter)

MPPT/Inputs: 4/8

Local commissioning:

- USB WLAN adapter

Communication:

-SmartLogger3000A (RS485/AC MBUS)

AFCI: SUN2000-36KTL (Optional model)



SUN2000-50/60KTL-M0
(Three phase inverter)

MPPT/Inputs: 6/12

Local commissioning:

- USB WLAN adapter

Communication:

-SmartLogger3000A (RS485/AC MBUS)

-Smart Dongle-4G (Optional)



SUN2000-100KTL-M1
(Three phase inverter)

MPPT/Inputs: 10/20

Local commissioning:

- USB WLAN adapter

Communication:

-SmartLogger3000A (RS485/AC MBUS)

-Smart Dongle-4G (Optional)

AFCI: optional model (New version)

PID Recovery: optional model (New version)

Communication Options



Smart Dongle-WLAN-FE

- Max **10** devices communication supported
- Plug & play USB interface connected to inverter for monitoring through WLAN or Fast Ethernet

Compatible with SUN2000-12-20KTL-M0/M2 Inverters



Smart Dongle-4G

- Max **10** devices communication supported
- Plug & play USB interface connected to inverter for monitoring through 4G

Compatible with SUN2000-12-20KTL-M0/M2, 50/60KTL-M0, 100KTL-M1 inverters



SmartLogger3000A

- Maximum connected devices: **80**
- Communication interface to inverter :
 - ✓ RS485
 - ✓ AC MBUS (isolation transformer)
- Communication option to Cloud:
 - ✓ Ethernet
 - ✓ 4G via built-in 4G module
- Local commissioning option:
 - ✓ Ethernet to WEB UI
 - ✓ App via built-in WLAN
- Power reduction interface for inverter's power control
- Digital & Analog IO for EMI integration



USB-Adapter2000-C

- WLAN adapter
- USB interface connected to inverter for local commissioning only
- App connected via WLAN

Compatible with SUN2000-29.9KTL, 33KTL-A, 36KTL, 50/60KTL-M0, 100KTL-M1 inverters

Power Meter Options



**Smart Power Sensor
DTSU666-H 250A/50mA (Three Phase)**

- RS485 connected to inverter
- Class 1 high accuracy meter readings for production/consumption monitoring
- 1
- Current transformer included

Compatible with SUN2000-12-20KTL-M0/M2, 50/60KTL-M0, 100KTL-M1 Inverters



3rd Party Smart Power Meter

- Compatible Smart Power Meter for SmartLogger3000A in Appendix 1
- Compatible Smart Power Meter for 50/60KTL-M0, 100KTL-M1 in Appendix 2

FusionSolar APP, Web UI & Smart PV Management System



FusionSolar APP
(local & remote)

- Support inverter commissioning and plant registration on management system
- Auto-detection of system equipment
- Registering plant by scanning any equipment in the system



Web UI

- Local commissioning Web based software to SmartLogger3000A
- Ethernet connection between SmartLogger3000A and software installed laptop



**FusionSolar Smart PV
Management System**

- Unified address <https://intl.fusionsolar.huawei.com>
- Real-time energy flow and energy balance
- Smart IV Curve Diagnosis
- Demo site for all guests to experience system

01 Product
Portfolio

02 Small Scale
C&I Application
(Single Inverter)

03 Medium Scale
C&I Application
(≤ 10 Inverters)

04 Large Scale
C&I Application
(> 10 Inverters)

05 Special Application
(AFCI, Partial
Optimization)

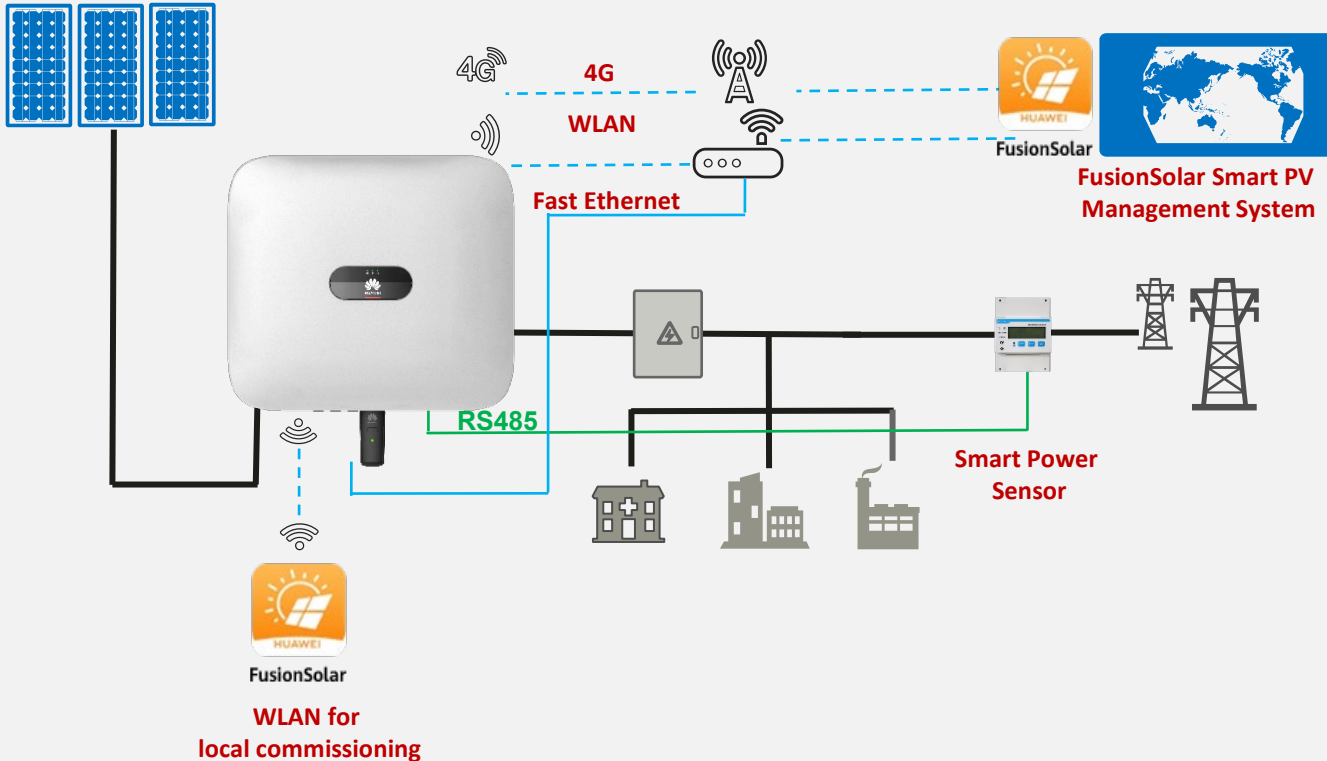
Small Scale C&I Application (single inverter)

SUN2000-12/15/17/20KTL-M0/M2, 29.9KTL, 33KTL-A, 36KTL, 50/60KTL-M0, 100KTL-M1

Inverter	Communication	Smart Power Sensor	Mgt. System	AFCI	PID Recovery	Ripple Control
SUN2000-12/15/17/20KTL-M0/M2	Smart Dongle WLAN-FE Smart Dongle 4G	DTSU666-H 250A/50mA (Three Phase)	FusionSolar	Yes	Yes	Yes (Inverter has built-in RRCR interface)
SUN2000-29.9KTL, 33KTL-A SUN2000-36KTL	SmartLogger3000A	Compatible smart meter listed in Annex 1	FusionSolar	Only applicable to SUN2000-36KTL (AFCI model)	No	Yes (SmartLogger has built-in RRCR interface)
SUN2000-50/60KTL-M0	Smart Dongle 4G	Compatible smart meter listed in Annex 2	FusionSolar	No	No	No
	SmartLogger3000A	Compatible smart meter listed in Annex 1				Yes (SmartLogger has built-in RRCR interface)
SUN2000-100KTL-M1	Smart Dongle 4G	Compatible smart meter listed in Annex 2	FusionSolar	New version	New version	No
	SmartLogger3000A	Compatible smart meter listed in Annex 1				Yes (SmartLogger has built-in RRCR interface)

Small Scale C&I Application

SUN2000-12/15/17/20KTL-M0/M2 – Single Inverter



Local Commissioning: Inverter built-in WLAN communicates to FusionSolar App.

Remote Monitoring

- Optional WLAN or Ethernet communication to FusionSolar Smart PV Management System via Smart Dongle WLAN-FE.
- Optional 4G communication to FusionSolar Smart PV Management System via Smart Dongle 4G.

DTSU666-H 250A/50mA three phase smart power sensor connects to inverter via RS485 for power output monitoring or control.

Built-in RRCR (Radio Ripple Control Receiver) interface allows to control the inverter's power production through 4 digital inputs.

AFCI function to mitigate fire risk.

PID recovery for better module performance.

01 Product Portfolio

02 Small Scale C&I Application (Single Inverter)

03 Medium Scale C&I Application (≤ 10 Inverters)

04 Large Scale C&I Application (> 10 Inverters)

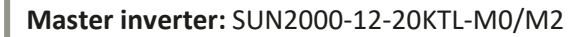
05 Special Application (AFCI, Partial Optimization)

Medium Scale C&I Application (≤ 10 inverters)

SUN2000-12/15/17/20KTL-M0/M2, 29.9KTL, 33KTL-A, 36KTL, 50/60KTL-M0, 100KTL-M1

Master	Communication	Smart Power Sensor	Mgt. System	AFCI	Ripple Control
SUN2000-12/15/17/20KTL-M0/M2	Smart Dongle WLAN-FE / Smart Dongle 4G (connected to master inverter)	DTSU666-H 250A/50mA (Three Phase)	FusionSolar	Applicable to system only consist of SUN2000-12-20KTL-M0/M2, 36KTL (AFCI model) 100KTL-M1 (New version)	Applicable to system only consist of SUN2000-12- 20KTL-M0/M2 (Inverter has built-in RRCR interface)
SUN2000-50/60KTL-M0	Smart Dongle 4G (connected to master inverter)	Compatible smart meter listed in Annex 2	FusionSolar	No	No
	SmartLogger3000A	Compatible smart meter listed in Annex 1	FusionSolar	No	Yes (SmartLogger has built-in RRCR interface)
SUN2000-100KTL-M1	Smart Dongle 4G (connected to master inverter)	Compatible smart meter listed in Annex 2	FusionSolar	Applicable to system only consist of SUN2000-12-20KTL-M0/M2, 36KTL (AFCI model) 100KTL-M1 (New version)	No
	SmartLogger3000A	Compatible smart meter listed in Annex 1	FusionSolar		Yes (SmartLogger has built-in RRCR interface)

SUN2000-12-20KTL-M0/M2 as master inverter – Less than or equal to 10 Inverters



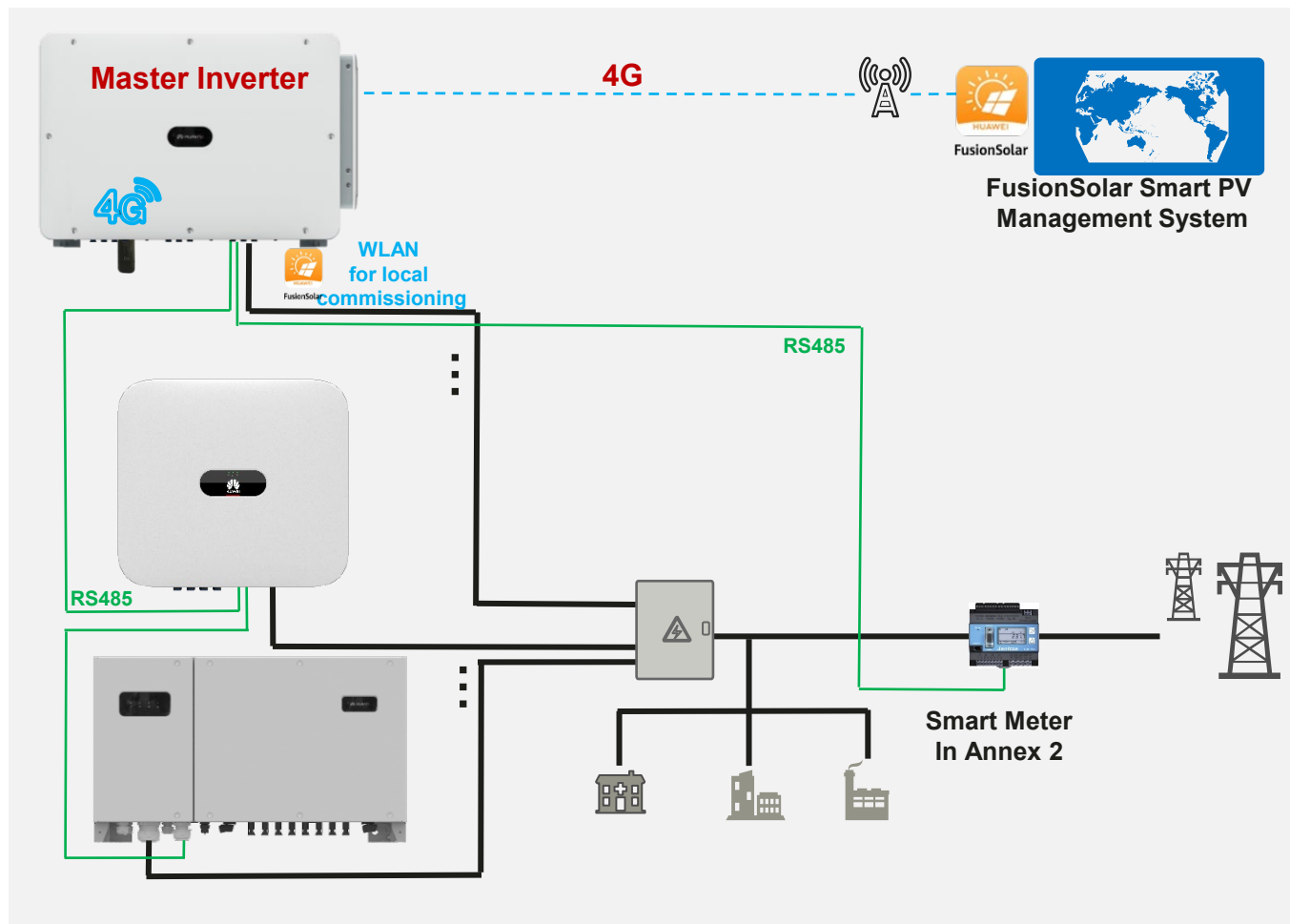
Local Commissioning: FusionSolar App connects to master inverter via built-in WLAN and all slave inverter settings will be synchronized.

- Optional WLAN or Ethernet communication to FusionSolar Smart PV Management System via Smart Dongle WLAN-FE.
- Optional 4G communication to FusionSolar Smart PV Management System via Smart Dongle 4G.

System power capacity shall not be higher than 170KW due to the power measurement limit of DTSU666-H 250A/50mA smart power sensor. Future white list power meter will be available 2020.06 without this restriction.

Medium Scale C&I Application

SUN2000-100KTL-M1 as master inverter – Less than or equal to 10 Inverters



Master inverter: SUN2000-100KTL-M1

Slave inverters: max 9 inverters are connected.

Local Commissioning: FusionSolar App connects to master inverter via USB-Adapter2000-C and all slave inverter settings will be synchronized.

Remote Monitoring:

- 4G communication to FusionSolar Smart PV Management System via Smart Dongle 4G connected to master inverter.

Smart meter(Listed in Annex 2) connects to master inverter via RS485 for power output monitoring or control.

01 Product Portfolio

02 Small Scale C&I Application (Single Inverter)

03 Medium Scale C&I Application (≤ 10 Inverters)

04 Large Scale C&I Application (> 10 Inverters)

05 Special Application (AFCI, Partial Optimization)

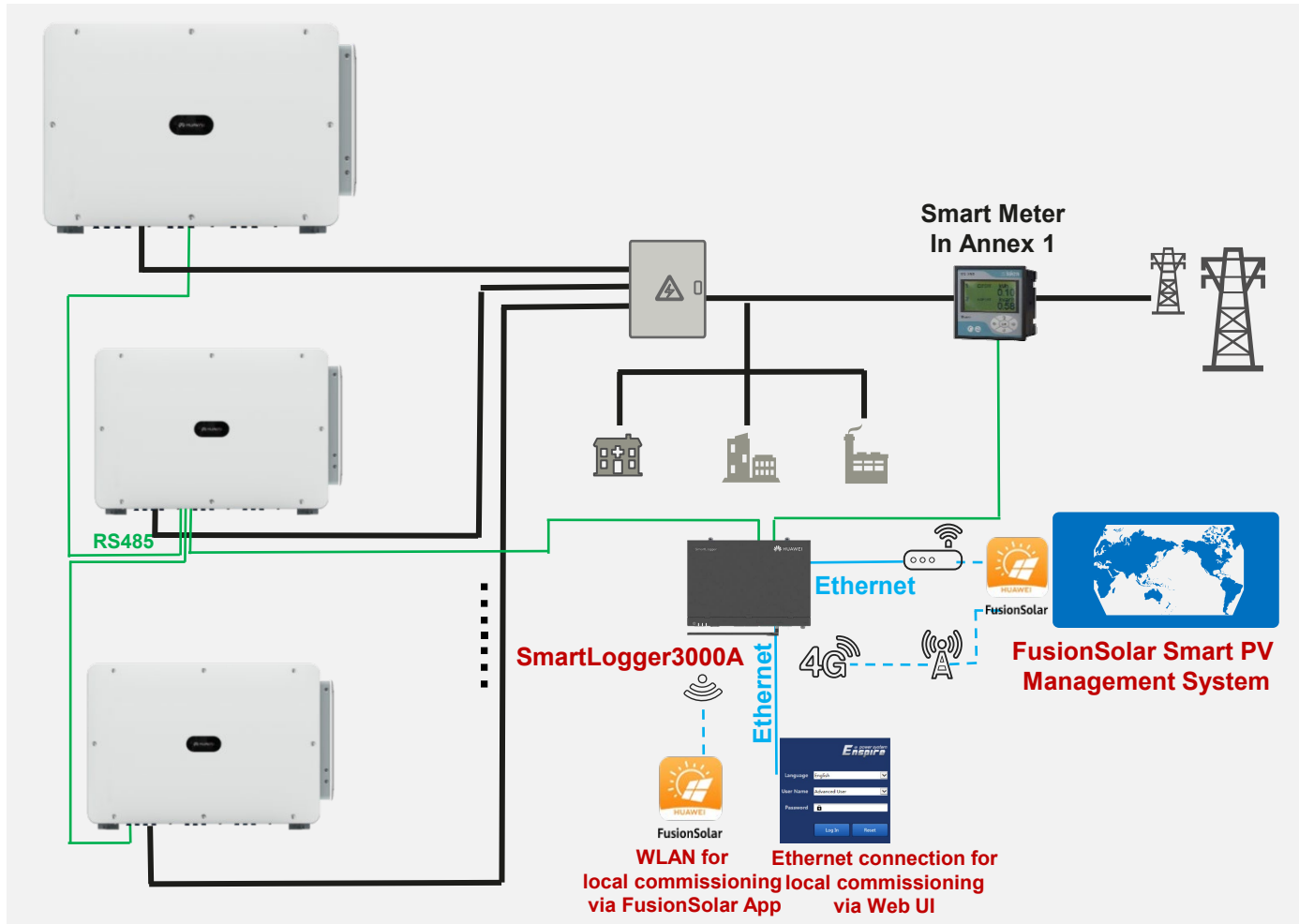
Large Scale C&I Application (>10 Inverters)

SUN2000-12/15/17/20KTL-M0/M2, 29.9KTL, 33KTL-A, 36KTL, 50/60KTL-M0, 100KTL-M1

Master	Slave	Communication	Smart Power Sensor	Mgt. System	AFCI	Ripple Control
SmartLogger3000A	SUN2000-12-20KTL-M0/M2 SUN2000-29.9/33/36KTL SUN2000-50/60KTL-M0 SUN2000-100KTL-M1	SmartLogger3000A	Compatible smart meter listed in Annex 1	FusionSolar	No	Yes

Large Scale C&I Application

SmartLogger3000A as master unit – Less than or equal to 80 Inverters



Master Unit: SmartLogger3000A

Slave inverters: max **80** inverters are connected.

Local Commissioning:

- Web UI software installed laptop connecting to SmartLogger3000A via its Ethernet port
- FusionSolar App connecting to SmartLogger3000A via its built-in WLAN communication

Remote Monitoring:

- SmartLogger3000A communicates to FusionSolar Smart PV Management System via Ethernet
- SmartLogger3000A communicates to FusionSolar Smart PV Management System via built-in 4G

Smart meter (Listed in Annex 1) connects to SmartLogger3000A via RS485 for power output monitoring or control.

Four DI of SmartLogger3000A can be used as RRCR (Radio Ripple Control Receiver) interface allows to control the inverter's power production.

01 Product Portfolio

02 Small Scale C&I Application (Single Inverter)

03 Medium Scale C&I Application (≤ 10 Inverters)

04 Large Scale C&I Application (> 10 Inverters)

05 Special Application (AFCI, Partial Optimization)

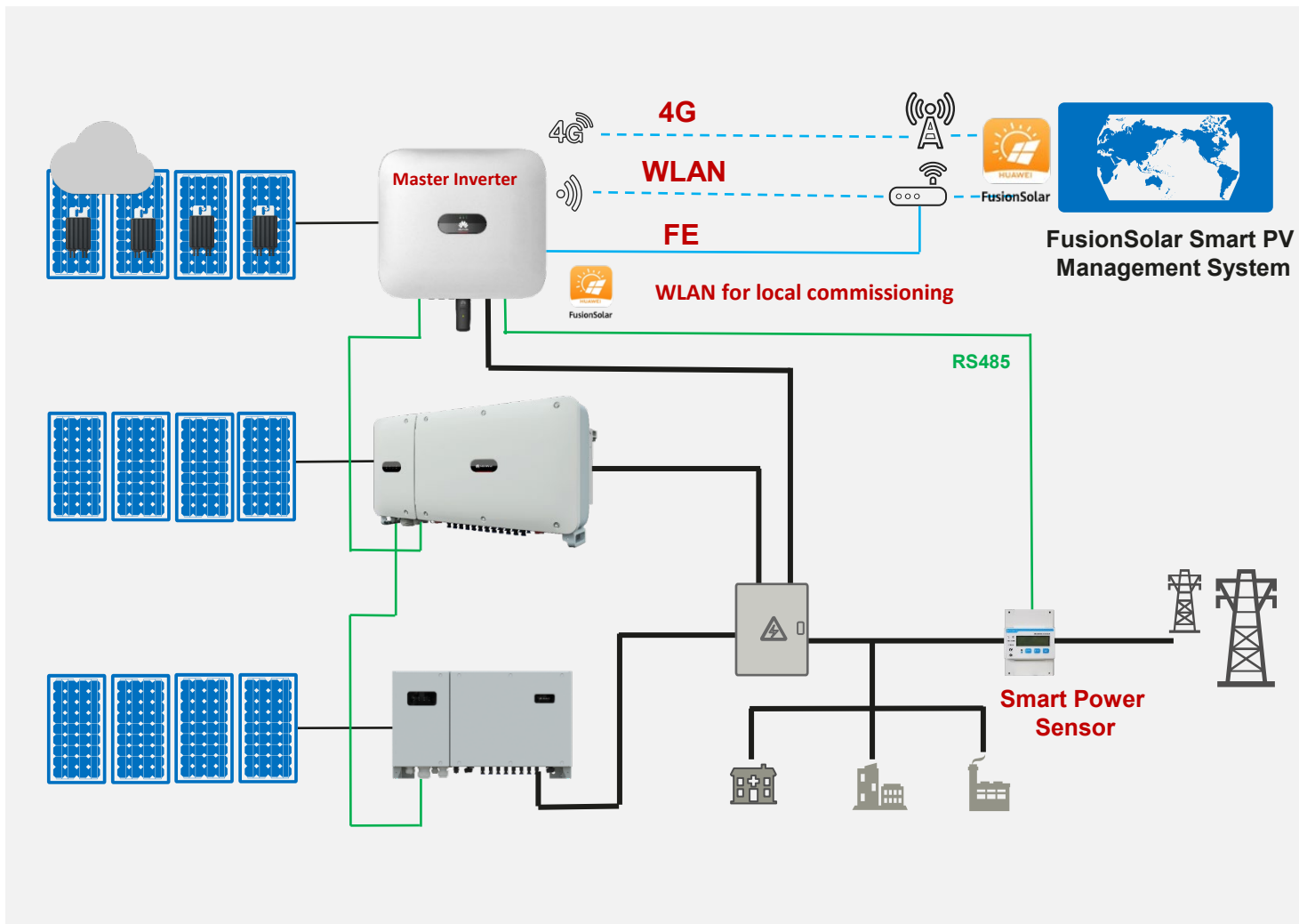
C&I Partial Optimization Solution

SUN2000-12/15/17/20KTL-M2 with full optimizers

Master	Slave	Optimizer	Communication	Smart Power Sensor	Mgt. System	Partial Optimization
SUN2000-12/15/17/20KTL-M2	SUN2000-12-20KTL-M0/M2 SUN2000-29.9/33/36KTL SUN2000-50/60KTL-M0 SUN2000-100KTL-M1	SUN2000-450W-P ,full optimizers for SUN2000-12-20KTL-M2	Smart Dongle WLAN-FE Smart Dongle 4G	DTSU666-H 250A/50mA (Three Phase)	FusionSolar	Yes
SUN2000-50/60KTL-M0	Must include SUN2000-12-20KTL-M2	SUN2000-450W-P ,full optimizers for SUN2000-12-20KTL-M2	Smart Dongle 4G	Compatible smart meter listed in Annex 2	FusionSolar	Yes
SmartLogger3000A	Must include SUN2000-12-20KTL-M2	SUN2000-450W-P ,full optimizers for SUN2000-12-20KTL-M2	SmartLogger3000A	Compatible smart meter listed in Annex 1	FusionSolar	Yes

C&I Partial Optimization Solution

SUN2000-12/15/17/20KTL-M2 full optimizers for modules under shaded area



Master inverter: SUN2000-12-20KTL-M2

Slave inverters: max **9** inverters are connected.

Optimizers: SUN2000-450W-P, **full optimizers for SUN2000-12-20KTL-M2**, accurately optimize the modules under shading for higher yields. Other inverters do not need to install optimizers for Capex saving.

Local Commissioning: FusionSolar App connects to master inverter via built-in WLAN and all slave inverter settings will be synchronized.

Remote Monitoring:

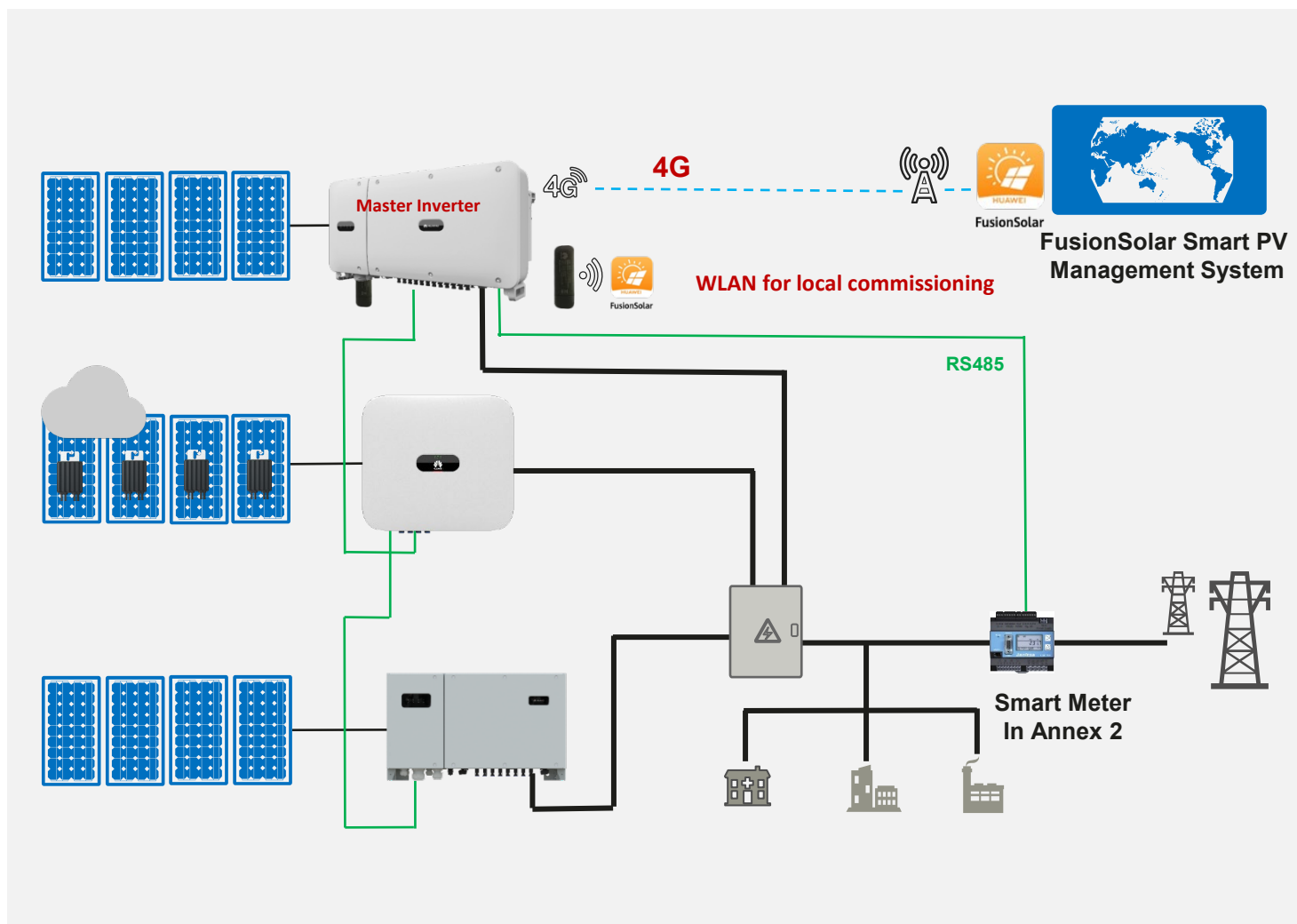
- Optional WLAN or Ethernet communication to FusionSolar Smart PV Management System via Smart Dongle WLAN-FE.
- Optional 4G communication to FusionSolar Smart PV Management System via Smart Dongle 4G.

DTSU666-H 250A/50mA three phase smart power sensor connects to master inverter via RS485 for power output monitoring or control.

System power capacity shall not be higher than 170KW due to the power measurement limit of DTSU666-H 250A/50mA smart power sensor. Future white list power meter will be available 2020.06 without this restriction.

C&I Partial Optimization Solution

SUN2000-12/15/17/20KTL-M2 full optimizers for modules under shaded area



Master inverter: SUN2000-50/60KTL-M0

Slave inverters: max **9** inverters are connected.

Optimizers: SUN2000-450W-P, **full optimizers for SUN2000-12-20KTL-M2**, accurately optimize the modules under shading for higher yields. Other inverters do not need to install optimizers for Capex saving.

Local Commissioning: FusionSolar App connects to the inverter via USB-Adapter2000-C

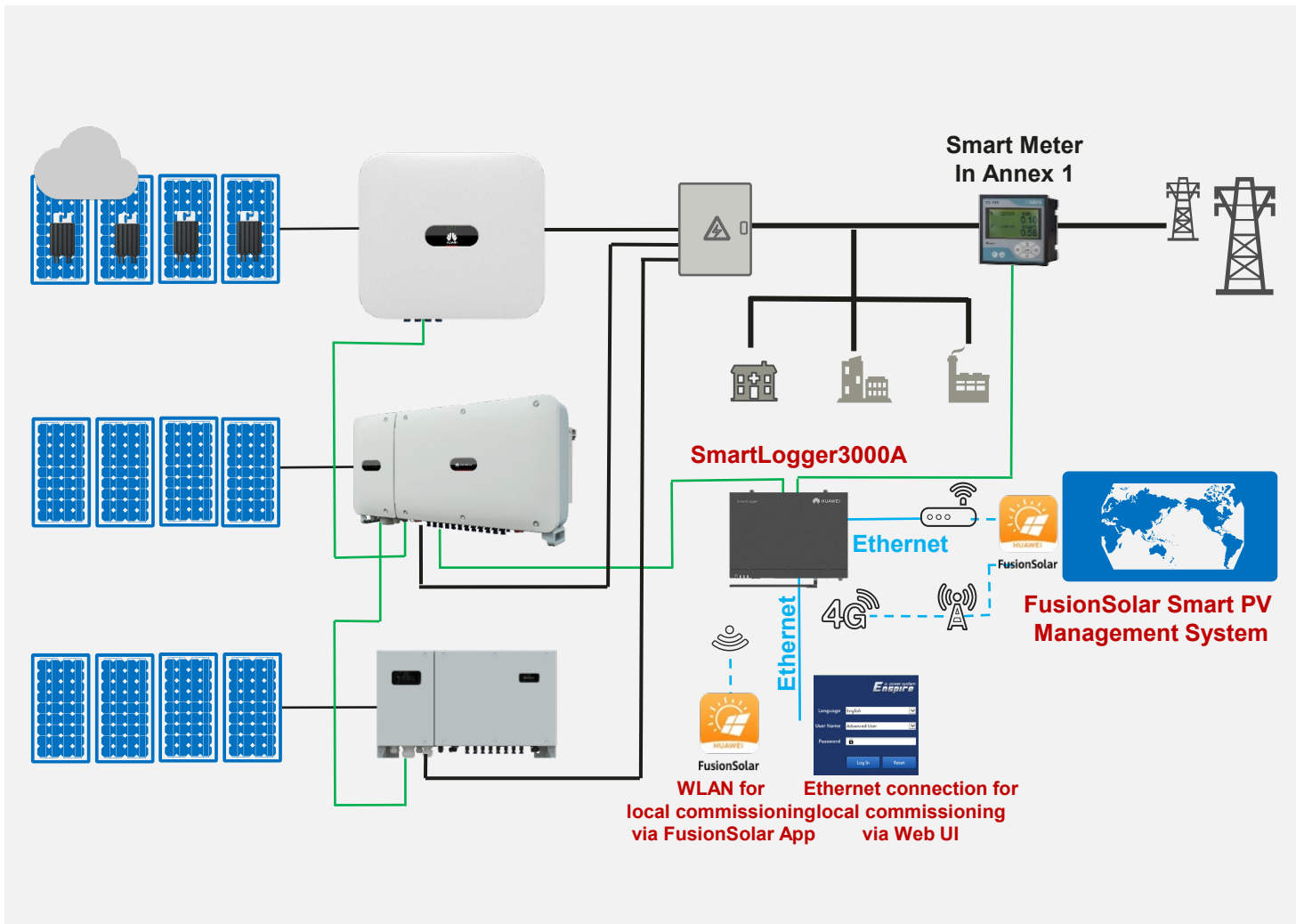
Remote Monitoring:

- Optional 4G communication to FusionSolar Smart PV Management System via Smart Dongle 4G.

Smart meter (Listed in Annex 2) connects to master inverter via RS485 for power output monitoring or control.

C&I Partial Optimization Solution

SUN2000-12/15/17/20KTL-M2 full optimizers for modules under shaded area



Master Unit: SmartLogger3000A

Slave inverters: max **80** inverters are connected.

Optimizers: SUN2000-450W-P, **full optimizers for SUN2000-12-20KTL-M2**, accurately optimize the modules under shading for higher yields. Other inverters do not need to install optimizers for Capex saving.

Local Commissioning:

- FusionSolar App connecting to SmartLogger3000A via its built-in WLAN communication
- Web UI software installed laptop connecting to SmartLogger3000A via its Ethernet port

Remote Monitoring:

- SmartLogger3000A communicates to FusionSolar smart PV management system via Ethernet
- SmartLogger3000A communicates to FusionSolar smart PV management system via built-in 4G

Smart meter (Listed in Annex 1) connects to SmartLogger3000A via RS485 for power output monitoring or control.

Four DI of SmartLogger3000A can be used as RRCR (Radio Ripple Control Receiver) interface allows to control the inverter's power production.

C&I Full Product Portfolio & Main Feature Difference Matrix



Main Feature Difference	SUN2000-12-20KTL-M0	SUN2000-12-20KTL-M2	SUN2000-29.9/33/36KTL	SUN2000-50/60KTL-M0	SUN2000-100KTL-M1
MPPT/Inputs	2/4	2/4	4/8	6/12	10/20
Arc fault circuit interrupter (AFCI)	✓	✓	✓ (only 36ktl)		New version support
Integrated PID recovery		✓			New version support
Smart I-V Curve Diagnosis	✓	✓	✓	✓	✓
Support Smart Dongle 4G	✓	✓		✓	✓
Support Smart Dongle WLAN-FE	✓	✓			

HUAWEI Optimizer Upgrade Your Optimizer Experience

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What is Power Optimizer ?



How Does Optimizer Work in PV System ?



Long String Design with Power Optimizer



Easy installation Verification and Safe Operating



Optimizer Pairing with Inverter



Module Performance Monitoring in Physical View

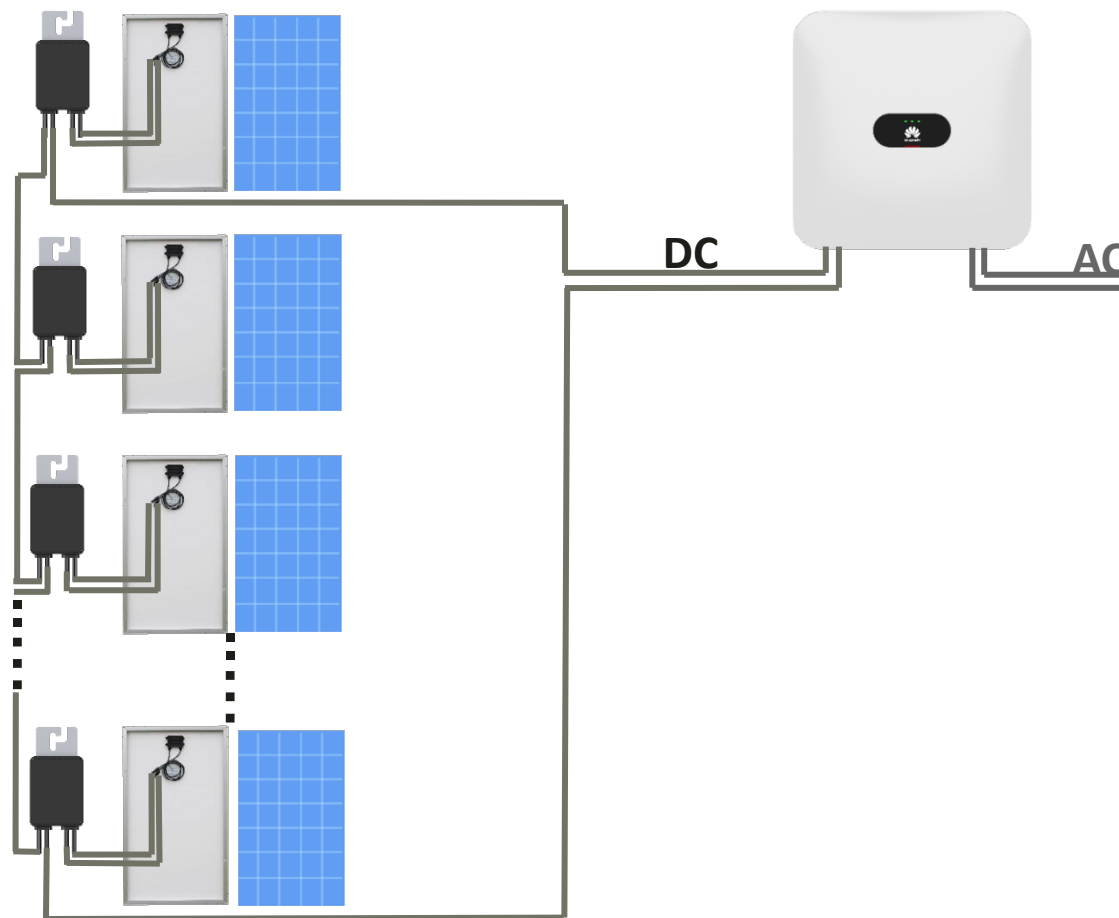
Introduction of Power Optimizer



Power Optimizer

A power optimizer is a DC/DC power electronics device attached to PV module to:

1. Capture the maximum power point of PV module
2. Shutdown module voltage to a safe voltage
3. Enable module level monitoring

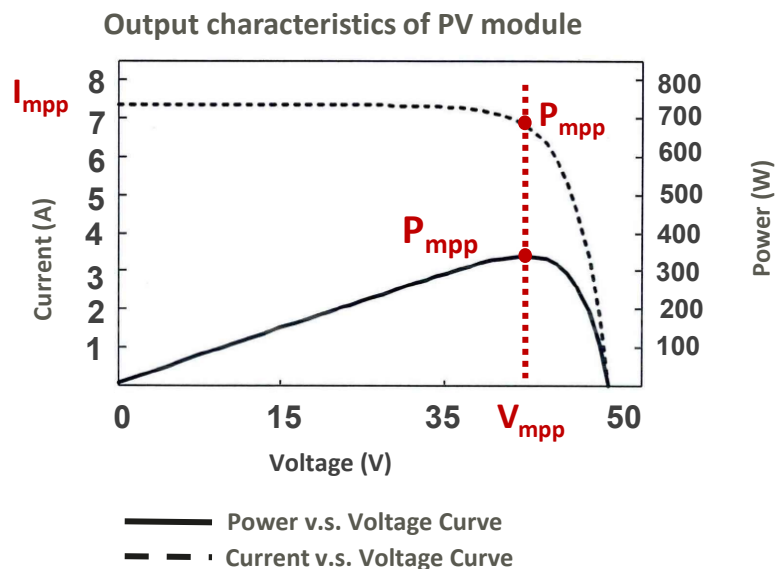


1. PV module output connect to the input of power optimizer
2. Power optimizer output connects in series to the input of inverter

Basic Function of Power Optimizer

1. Module-level Power Optimization

Power optimizer harvests the maximum power (P_{mpp}) of module onto which it is attached

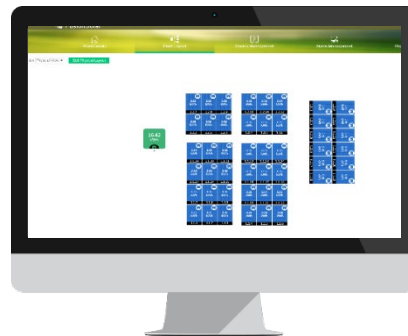


2. Module-level Voltage Shutdown



- Power optimizer could adjust to output a safety voltage whenever output is open or the connected inverter is shutdown.
- In this case, DC wires are de-energized to safe voltage level for personnel installation, O&M and firefighters.

3. Module-level Physical Viewing



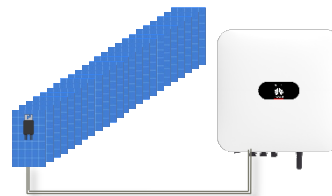
- More precise module operating information can be monitored via physical view in management system
- Pin-point alert of module operating for remote diagnosis and easier fault location.

4. Flexible Design



Modules affected by shading, multiple orientations can be connected in one string with power optimizer attached

5. Long String



- Optimizer make possible longer string to
- Increase DC/AC oversizing
 - Save BoS (Balance of System) cost



What is Power Optimizer ?



How Does Optimizer Work in PV System ?



Long String Design with Power Optimizer



Easy installation Verification and Safe Operating

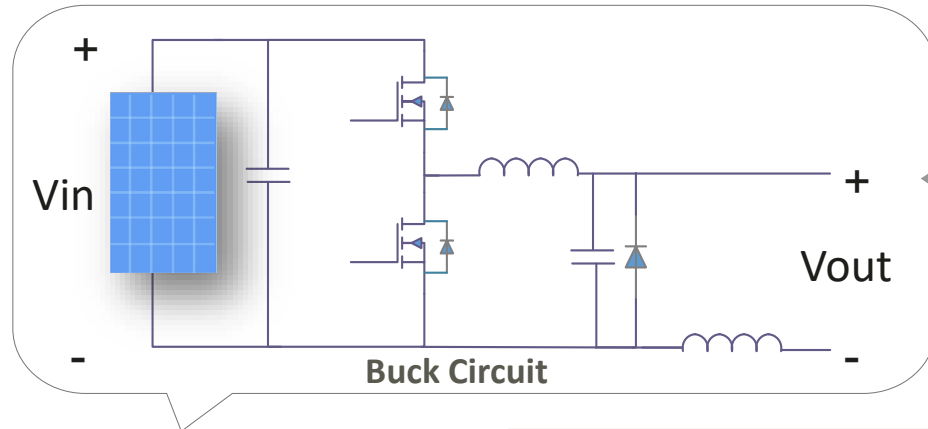


Optimizer Pairing with Inverter



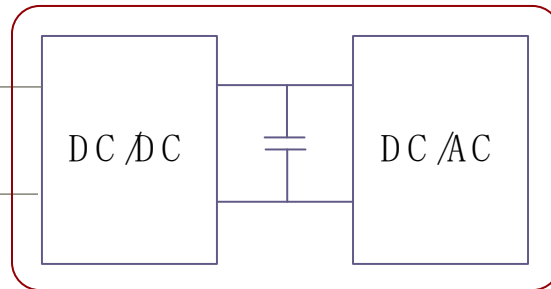
Module Performance Monitoring in Physical View

Optimizer Operation Mode: Buck / Bypass Mode



Buck Mode
 $V_{out} < V_{in}$

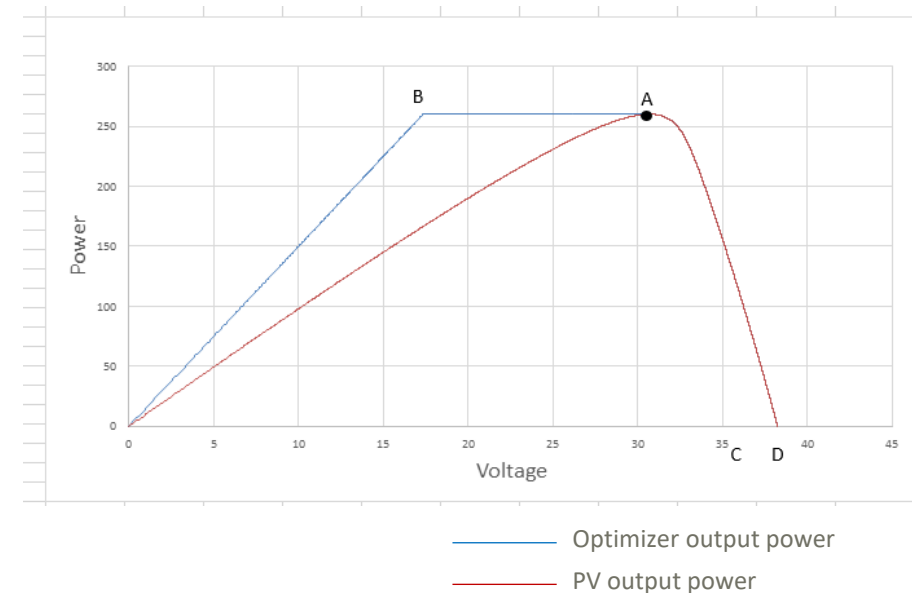
Bypass Mode
 $V_{out} \approx V_{in}$



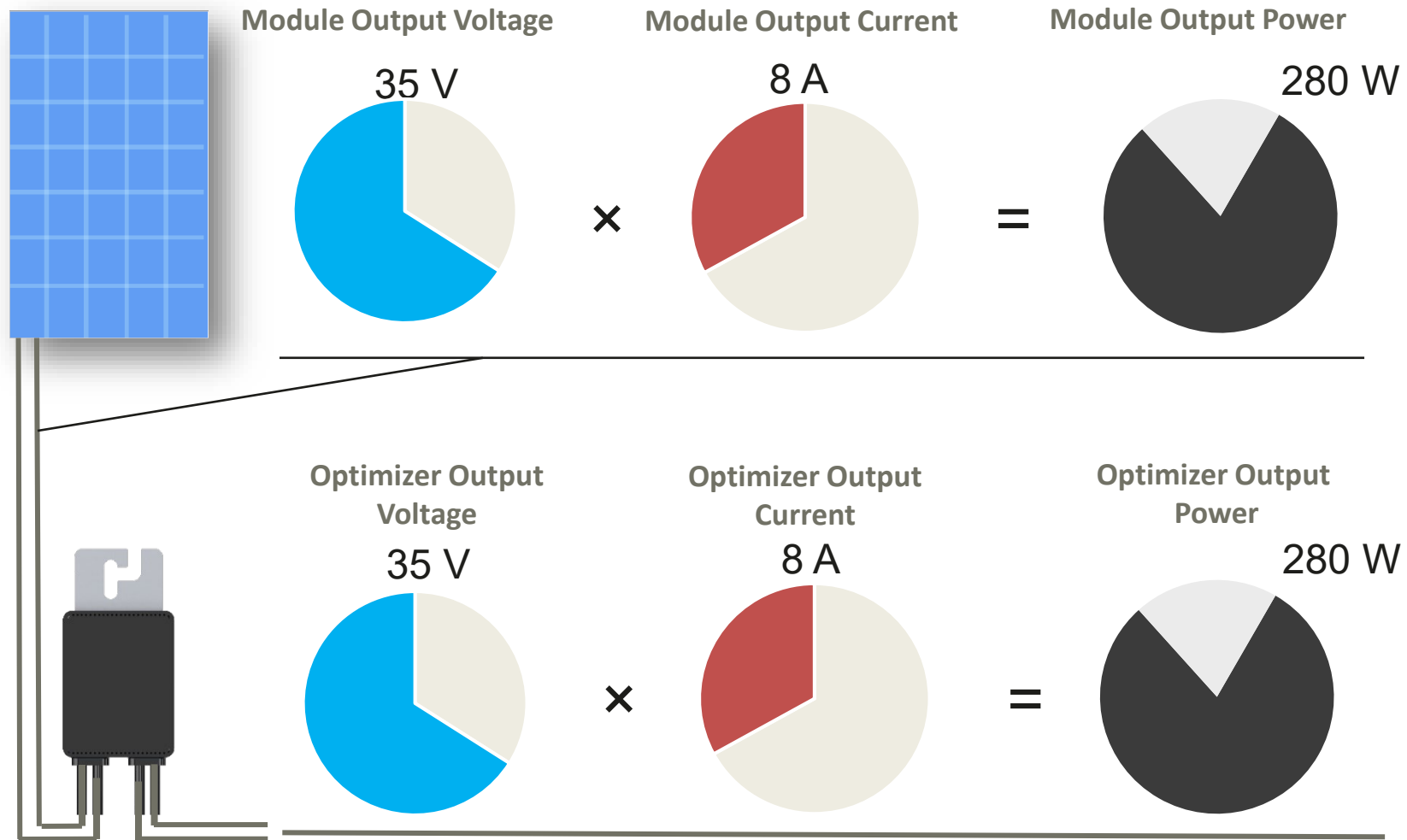
Two Stage Inverter

Optimizer in buck circuit steps down voltage (while stepping up current) from its input to its output.

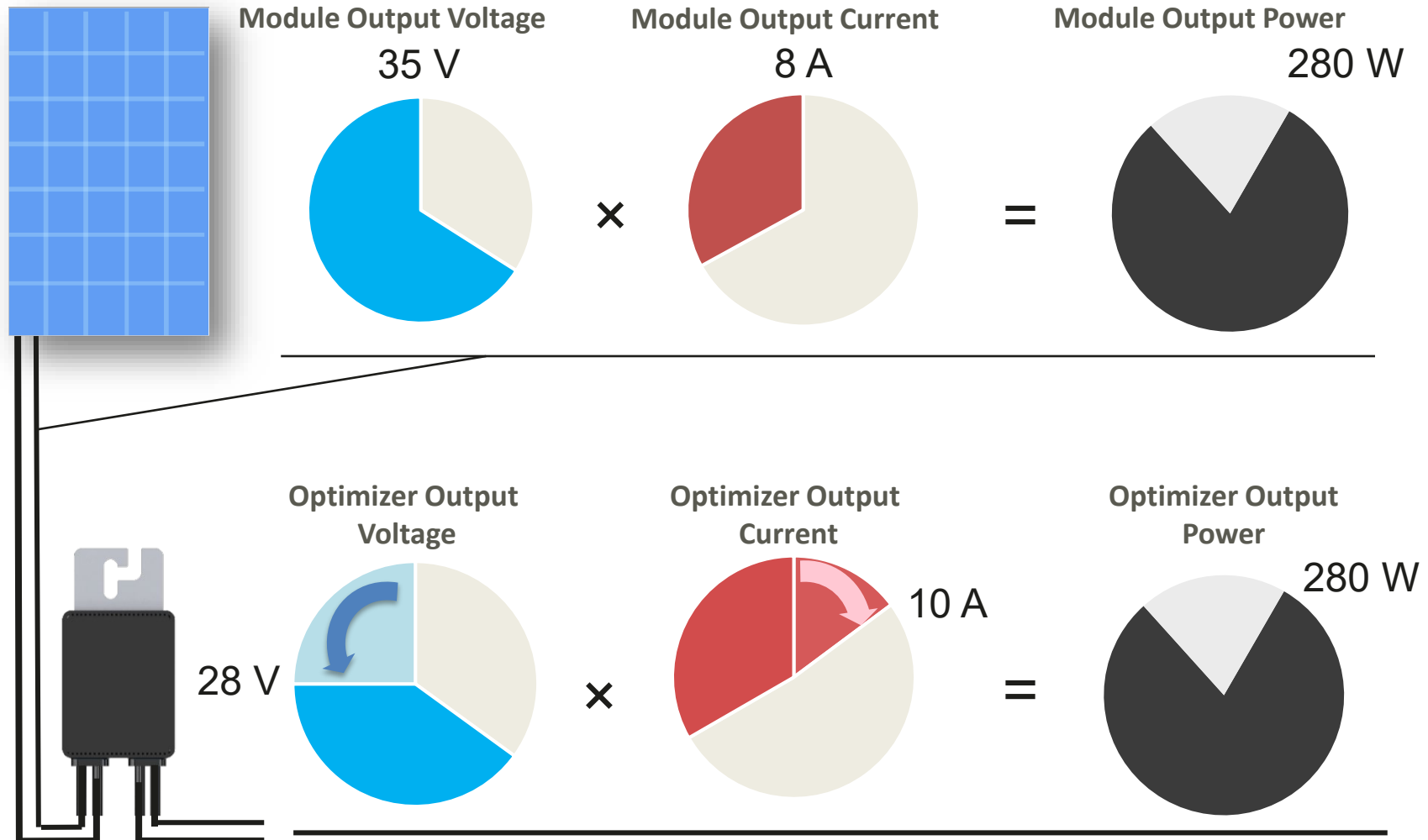
It interacts with two stage inverter while tracking maximum power point of PV module.



Optimizer Bypass Operating Mode



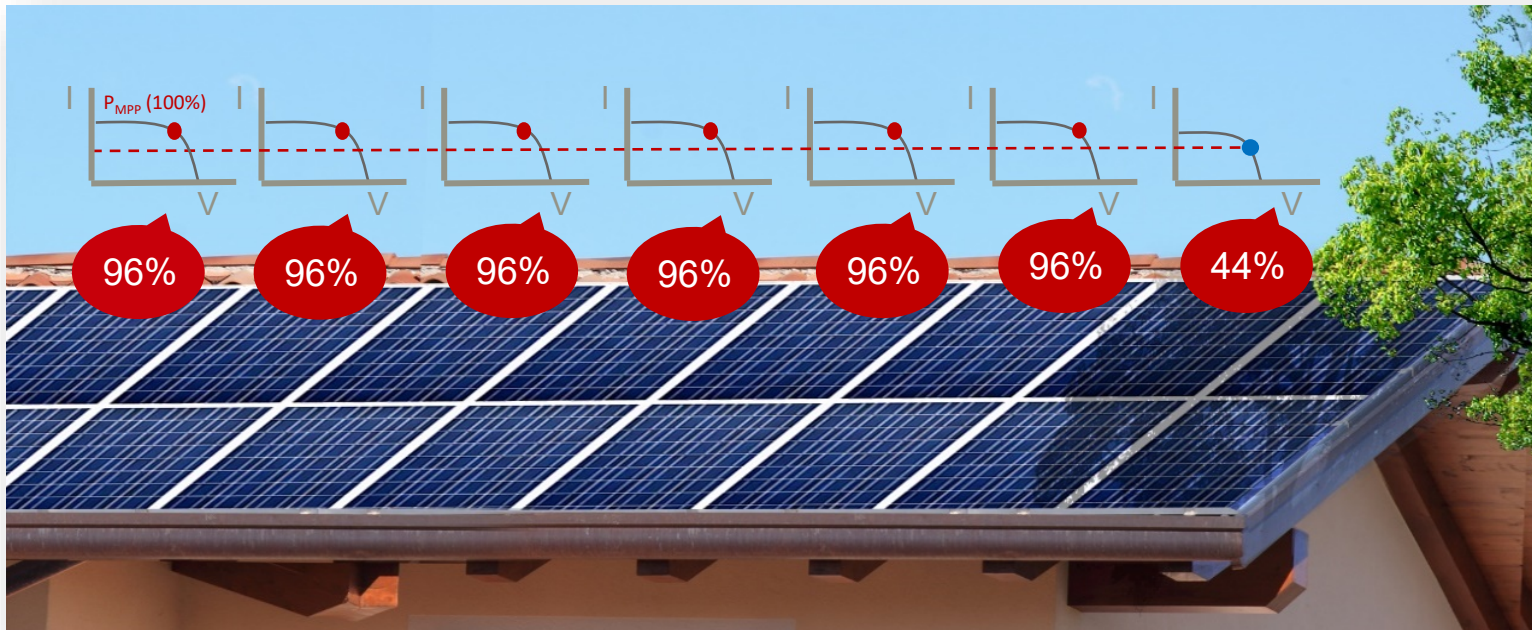
Optimizer Buck Operating Mode



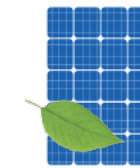
Without Optimizer : String Power Loss Caused By Mismatch

String Inverter tracks the maximum power point of whole string

- Modules connected in the same string operate at the same current.
- Affected module's operating point shifts with current decreasing, which leads to output power reduction of the whole string.



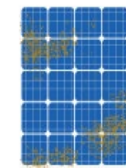
Common factors to cause power mismatch of PV module



Leaves



Shading



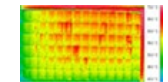
Soiling



Bird's
Dropping

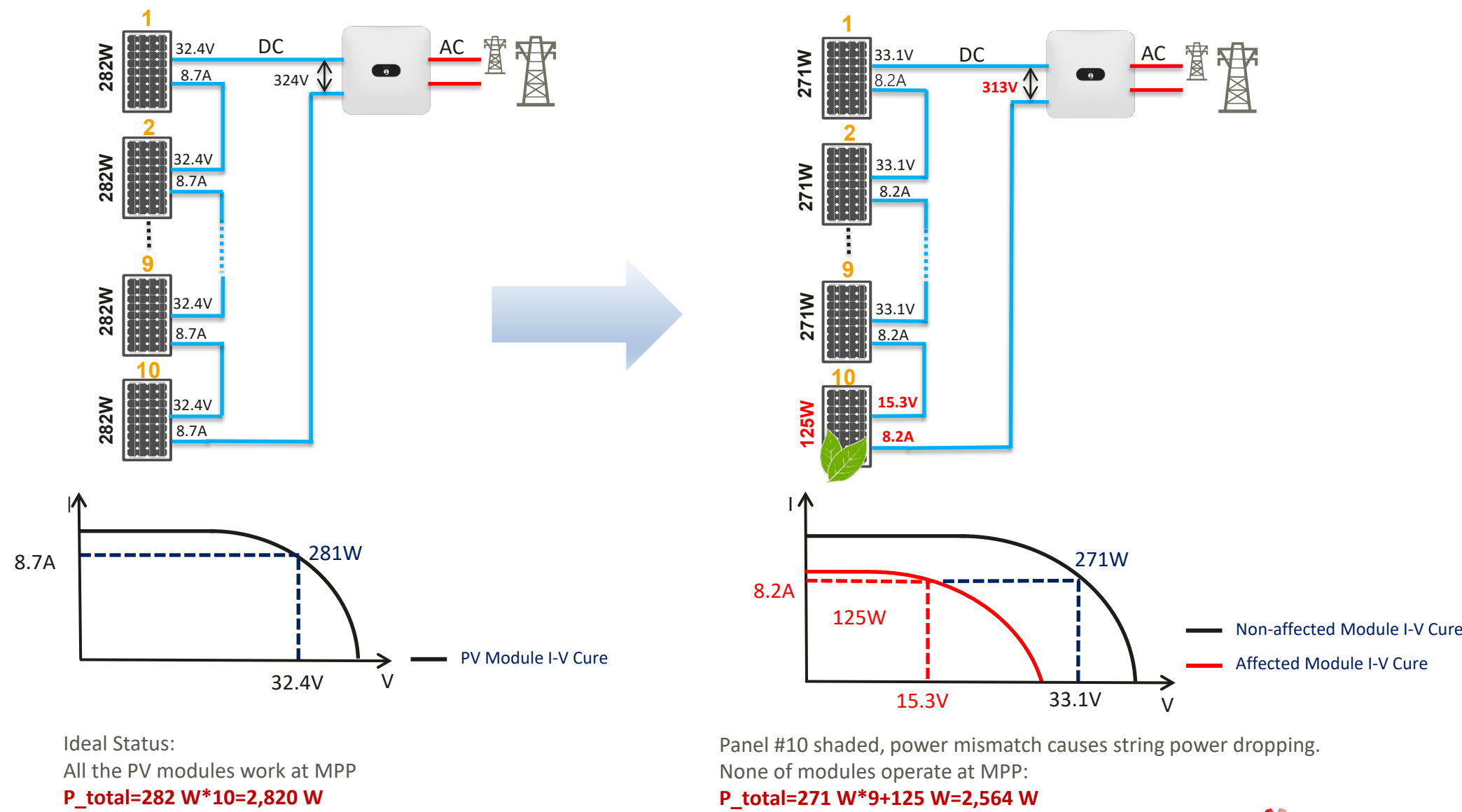


Tolerance
Mismatch



Thermal
Mismatch

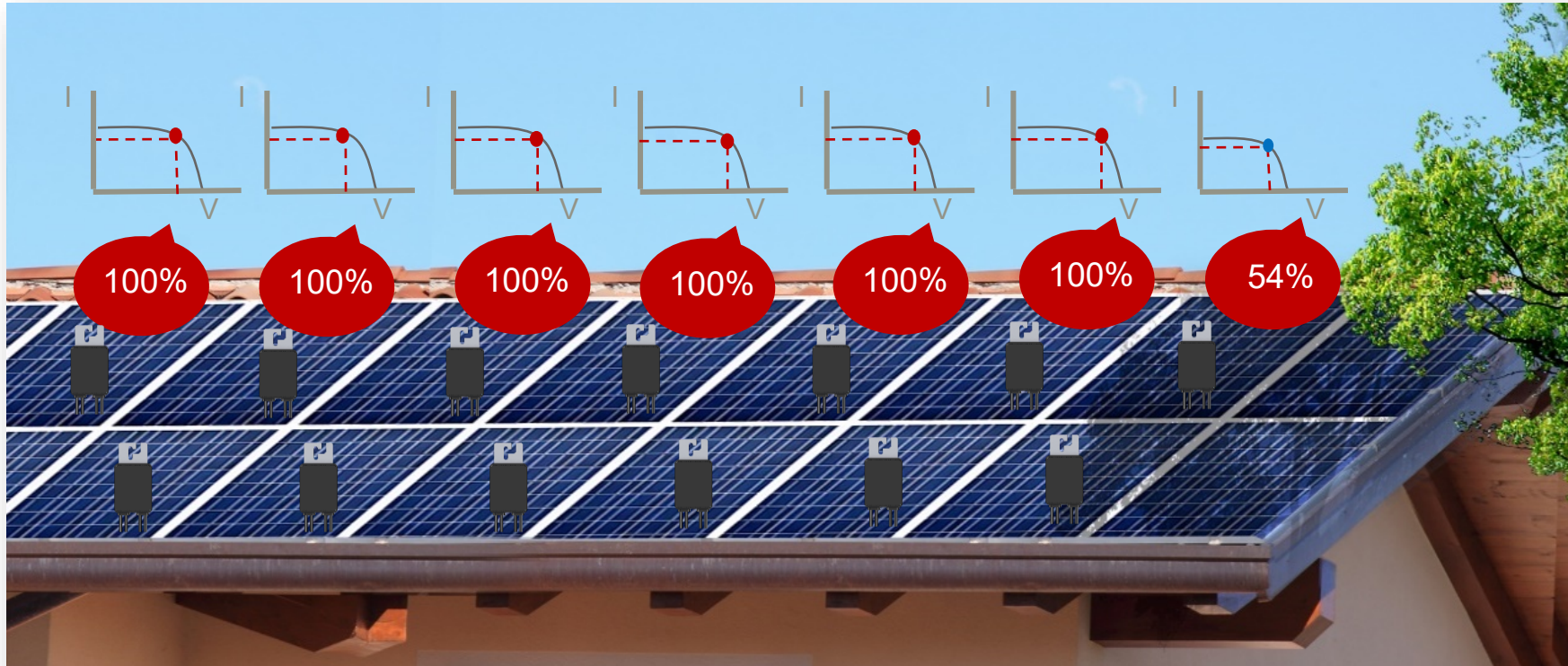
No Optimizer – Mismatch Causes Power Loss



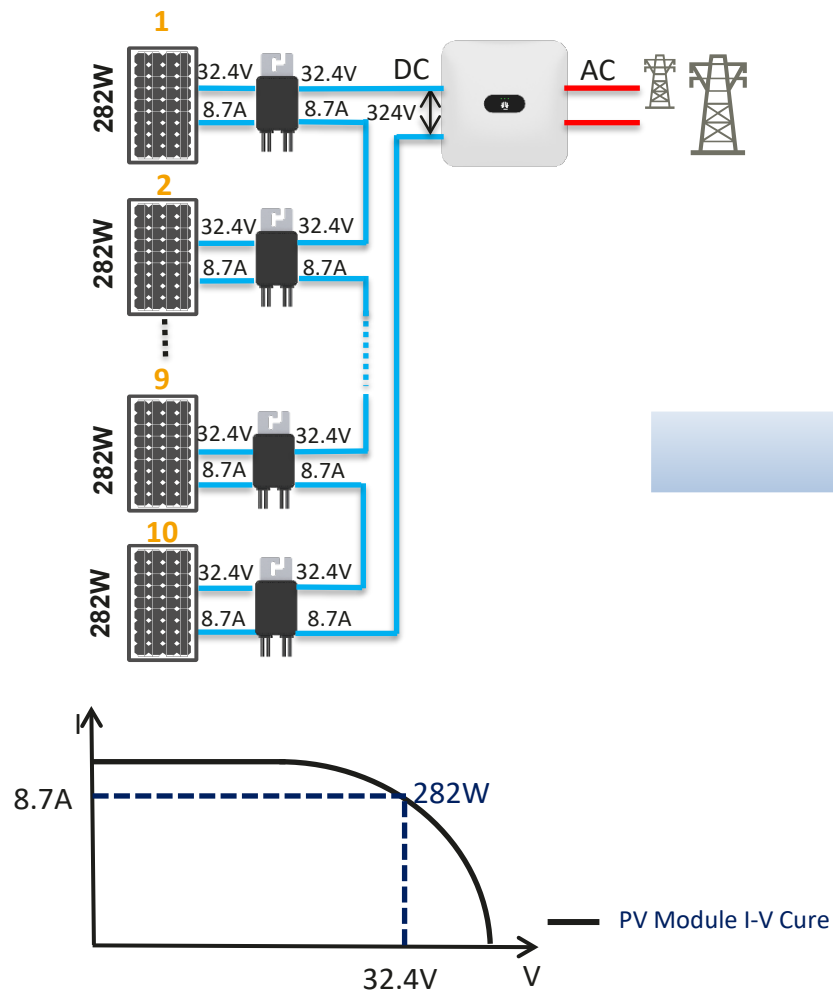
With Optimizer: Module Level MPPT to Mitigate Power Mismatch

With Power Optimizer installed to Each Module

- Track the maximum power point of each PV module independently
- Underperforming modules are isolated from impacting the other modules in the string

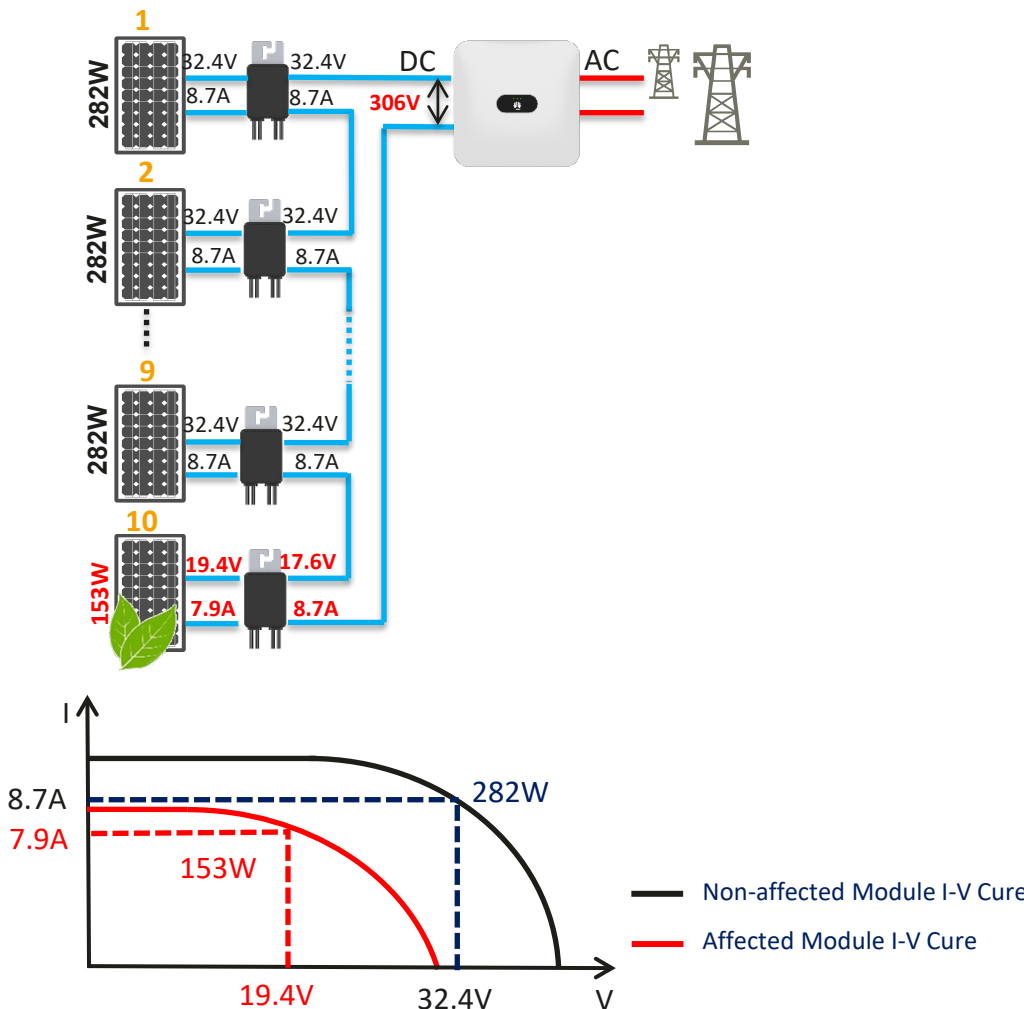


Full Optimizer System Operating



Ideal Status:
All the PV modules work at MPP with help of Optimizer
Optimizer then operates in bypass mode

$P_{total} = 282\text{ W} \times 10 = 2,820\text{ W}$



Panel #10 shaded, but it operates at MPP while optimizer operates in buck mode
Non-affected modules still operate at MPP, optimizers operate in bypass mode
Inverter adapt input voltage to optimizer output voltage in the string

$P_{total} = 282\text{ W} \times 9 + 153\text{ W} = 2,691\text{ W}$



What is Power Optimizer ?



How Does Optimizer Work in PV System ?



Long String Design with Power Optimizer



Easy installation Verification and Safe Operating



Optimizer Pairing with Inverter



Module Performance Monitoring in Physical View

Optimizer Compatibility with PV Module



JAM72S01-350/SC/1000V Temperature Coefficient	
Temperature Coefficient of Isc(α_{Isc})	+0.059% / °C
Temperature Coefficient of Voc(β_{Voc})	-0.330% / °C

JAM72S01-350/SC/1000V Specification (STC: 1000W/m², 25°C)	
Rated Max Power(Pmax) [W]	350
Open Circuit Voltage(Voc) [V]	46.89
Max Power Voltage(Vmp) [V]	38.46
Short Circuit Current(Isc) [A]	9.75
Max Power Current(Imp) [A]	9.11

Location: Germany
Minimum temperature: -9.3°C
Maximum temperature: 22.34°C

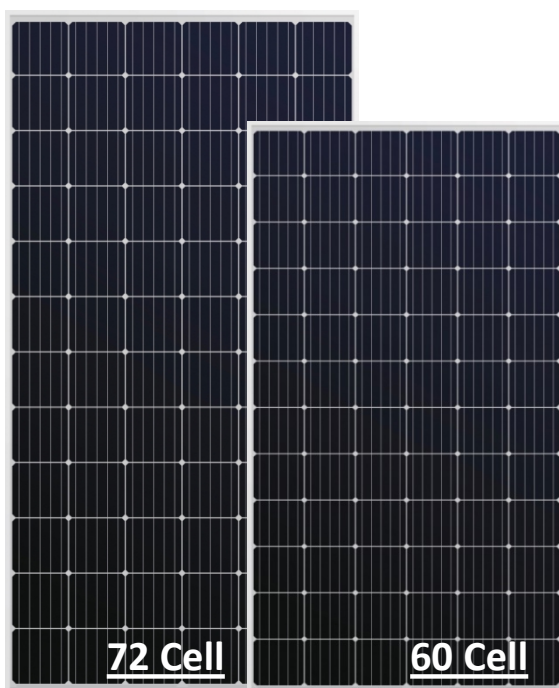
Maximum voltage at lowest temperature

$46.89V + 0.33\% \times [25^{\circ}C - (-9.3^{\circ}C)] \times 46.89V = \underline{52.2\text{ V}}$
(max. voltage reached at lowest temp temperature)



SUN2000-450W-P Datasheet		
Maximum Input DC Power (W)	450	✓
Absolute maximum input voltage (V)	80	✓
Maximum Short Circuit Current (Isc)	13	✓

One Power Optimizer Fits All Application Scenarios



One SUN2000-450W-P power optimizer fits

- **All** 60 & 72 cell crystalline silicon PV modules on the market
- **All** installation scenarios
 - Optimizer 1.2m output cable suits both landscape and portrait oriented installation of PV module
 - Optimizer support both rack and PV module frame mounting
- **All** HUAWEI residential Inverter
 - SUN2000-2/3/3.68/4/4.6/5/6KTL-L1 single phase
 - SUN2000-3/4/5/6/8/10KTL-M1 three phase

Single optimizer model simplifies business operating and reduces cost of warehouse management and logistic

Long String Design with Full Optimizer

What is long string design ?

- With power optimizer, the number of modules connected in a single string is more than that of traditional string without optimizer.

Why is long string design needed ?

- Enable higher DC/AC oversizing: Max 200% DC/AC ratio.



Comparison Between Normal and Long String Design

No Optimizer String Design

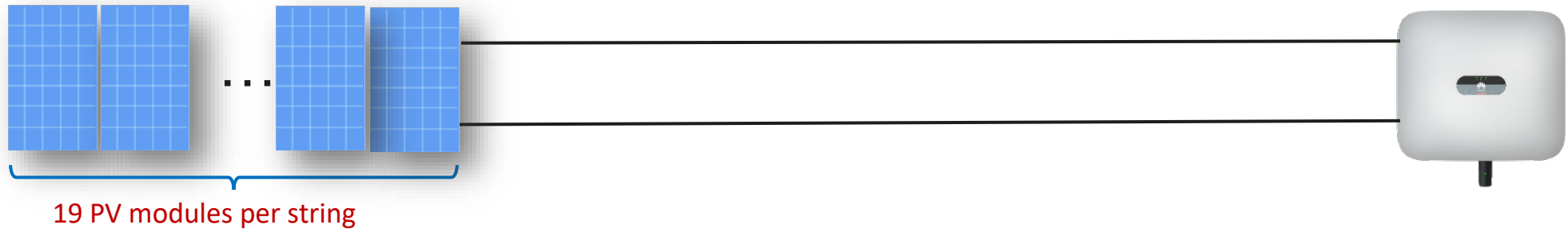
JAM72S01 330-350/SC/1000V Series datasheet

Maximum System Voltage	1000VDC (UL and IEC)
------------------------	----------------------

Max number of PV module in the string:

$1000\text{ Vdc} / 52.2\text{ Vdc} \approx 19$

Taking JAM72S01-350/SC/1000V as example with considering temperature coefficient of Voc



Full Optimizer String Design

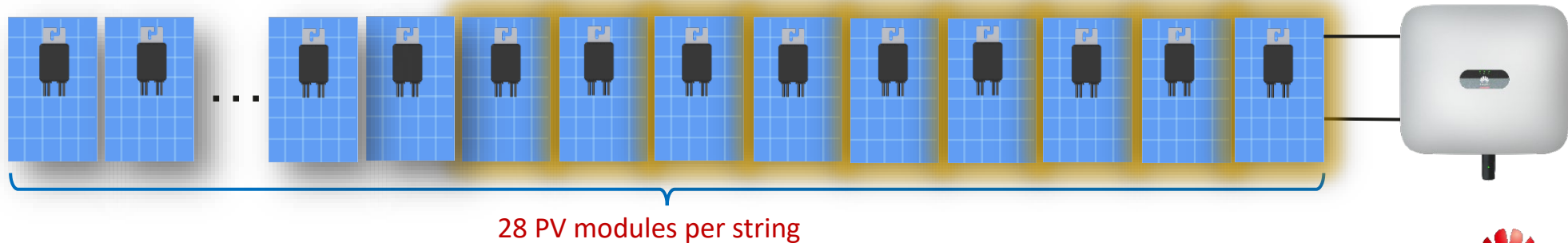
Refer to SUN2000-450W-P datasheet

Long String Design ²	SUN2000L-2-6KTL-L1	SUN2000-3-10KTL-M1	SUN2000-12-20KTL-M2
Minimum optimizer number per string	4	6	6
Maximum optimizer number per string	25	50	50
Maximum DC power per string	5,000 W	10,000 W	10,000 W

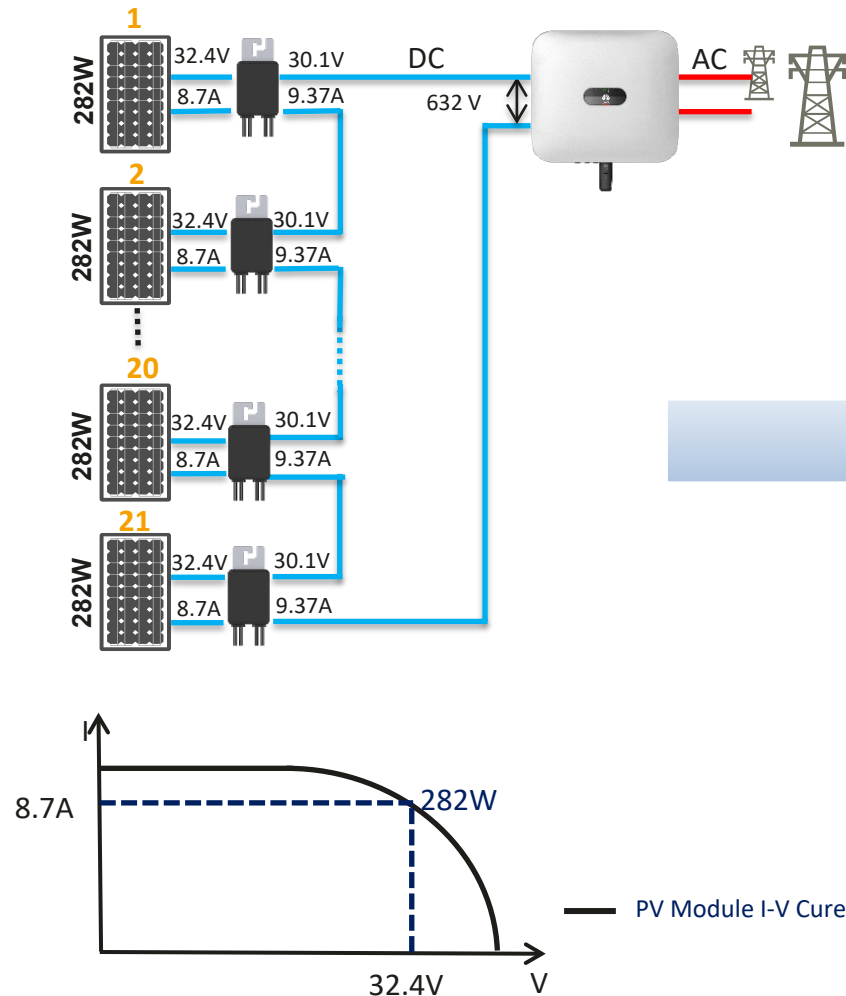
Max number of PV module in the string:

$10,000\text{ W} / 350\text{ W} \approx 28$

Taking JAM72S01-350/SC/1000V as example

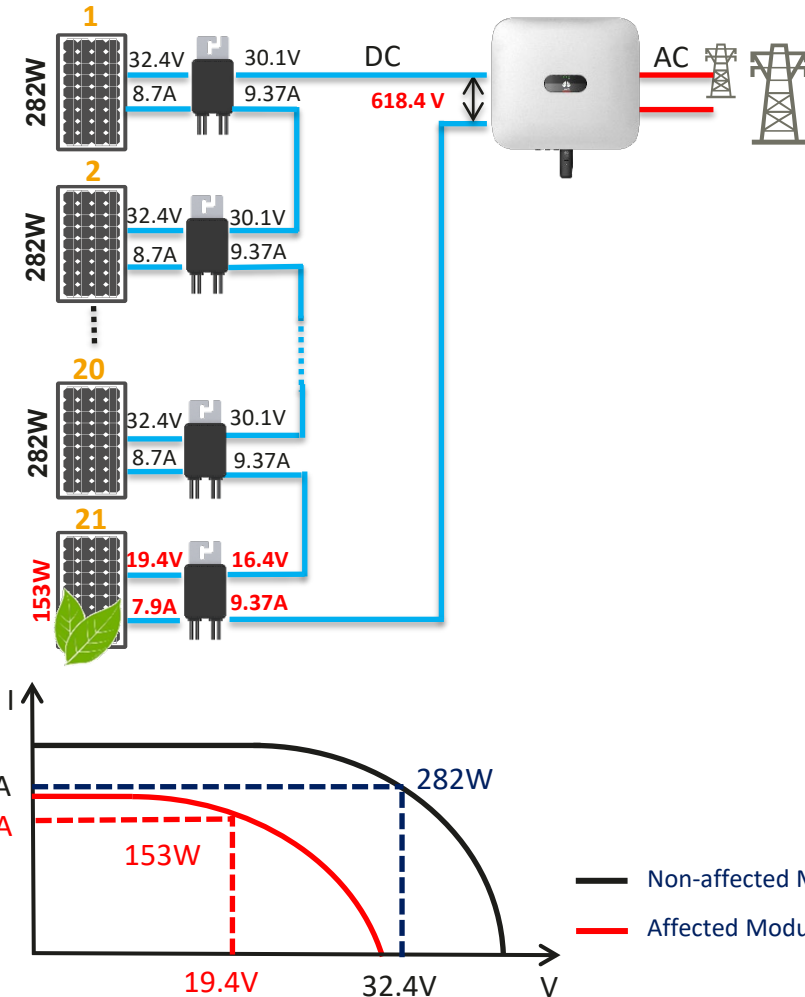


Full Optimizer Long String System Operating



Ideal Status:
All the PV modules work at MPP
Optimizer bucks output voltage

$$P_{\text{total}} = 282 \text{ W} \times 21 = 5,922 \text{ W}$$



Panel #10 shaded, but it operates at MPP while optimizer operates in buck mode
Non-affected modules still operate at MPP with optimizer working in buck mode
Inverter regulates input voltage to adapt to optimizers output voltage

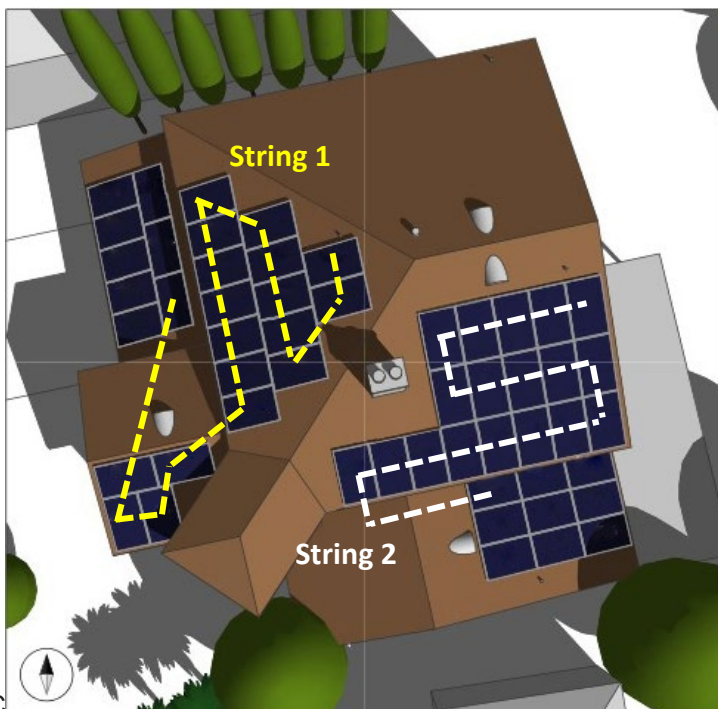
$$P_{\text{total}} = 282 \text{ W} \times 20 + 153 \text{ W} = 5,793 \text{ W}$$

Long String Design for Higher DC/AC Oversizing

A 10KTL inverter without optimizer, max DC/AC oversizing ratio :

$$= \frac{P_{pv}}{P_{inverter}} = \frac{19 \times 350 + 19 \times 350}{10000} = \mathbf{133\%}$$

Traditional string length is too short to cover all modules, only 38 modules can be connected



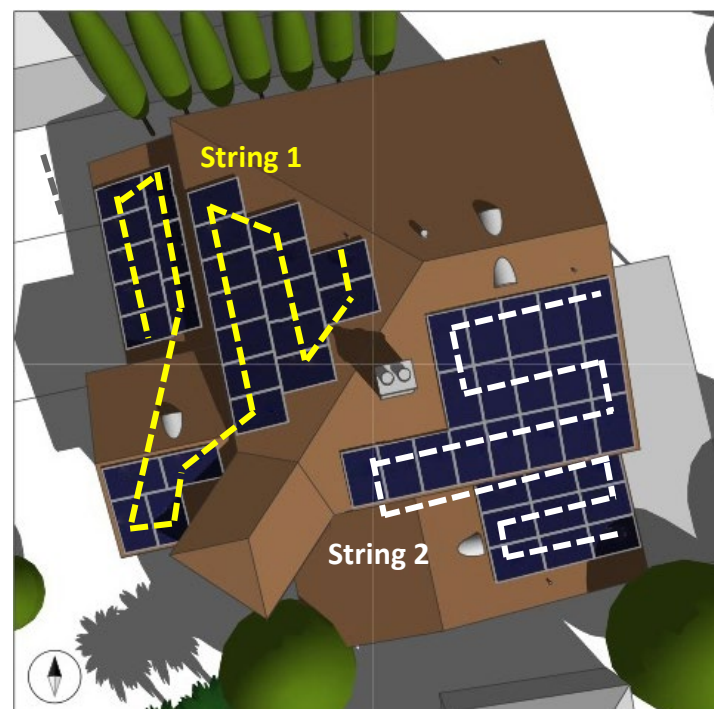
A 10KTL inverter, DC/AC oversizing ratio with long string design:

$$= \frac{P_{pv}}{P_{inverter}} = \frac{26 \times 350 + 27 \times 350}{10000} = \mathbf{185\%}$$

Two long string design:

String 1: 26 modules

String 2: 27 modules

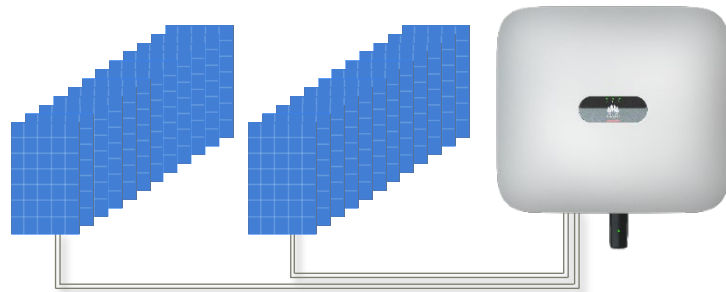


Lower BoS Cost & Flexible String Design

Lower BoS Cost

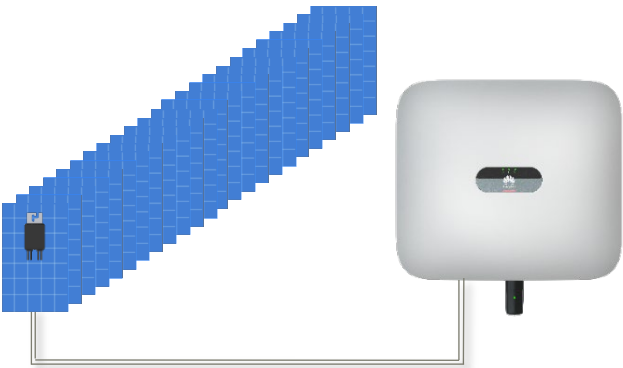
Without Optimizer

24 modules connected in two separated strings, 12 modules per string



With Optimizer

24 modules connected in a single string



Flexible String Design

Without Optimizer

Extra modules exceeding the limit of string have to be connected across rooftop with other string.

String 1: 18 modules
String 2: 18 modules



With Optimizer

Long string covers whole roof without PV cable across rooftops

String 1: 24 modules
String 2: 12 modules





What is Power Optimizer ?



How Does Optimizer Work in PV System ?



Long String Design with Power Optimizer



Easy installation Verification and Safe Operating

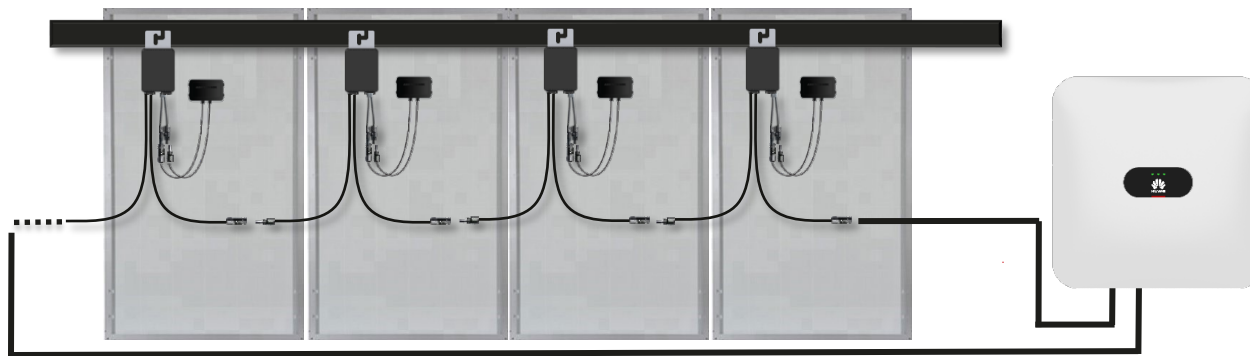


Optimizer Pairing with Inverter



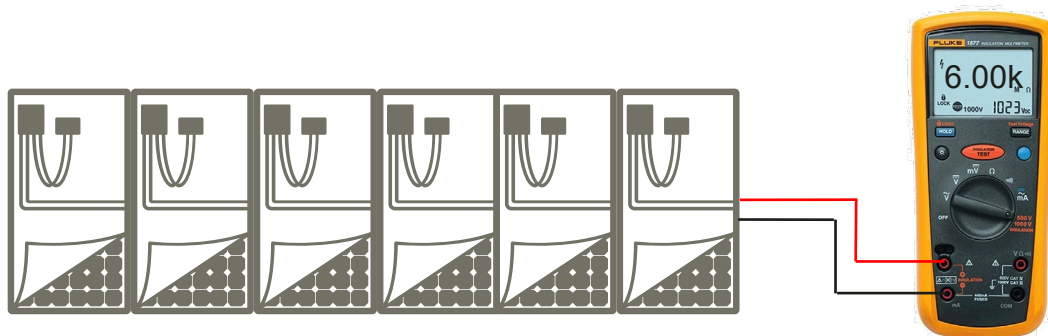
Module Performance Monitoring in Physical View

Easy installation Verification and Safe Operating



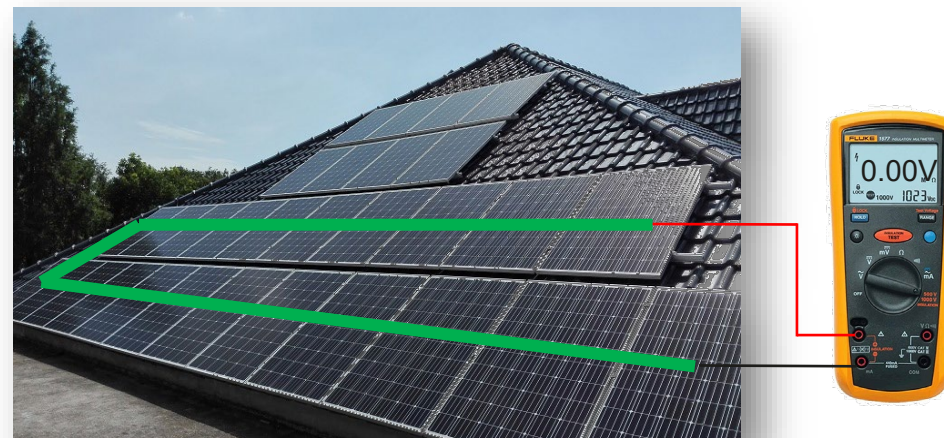
Optimizer shutdown impedance: **1K ohms**

To verify optimizer installation before connecting to inverter input, check impedance of optimizer formed string, 6 optimizers equals to 6K ohms



Optimizer shutdown safety voltage: **0 Vdc**

When the optimizers output cable is not connected or the inverter is shutdown, each optimizers outputs 0 Vdc. (Compliant to NEC 2017)





What is Power Optimizer ?



How Does Optimizer Work in PV System ?



Long String Design with Power Optimizer



Easy installation Verification and Safe Operating



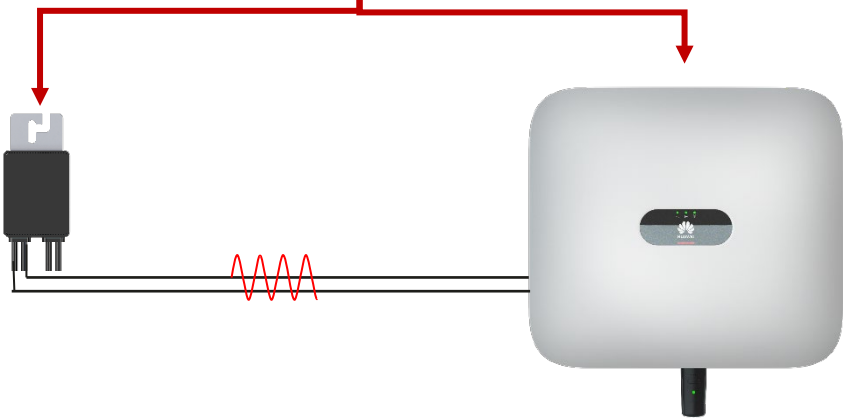
Optimizer Pairing with Inverter



Module Performance Monitoring in Physical View

HUAWEI HISILICON Chipset Inside Optimizer and Inverter for Faster Pairing

Pairing between optimizer and inverter is the process to establish communication between them.



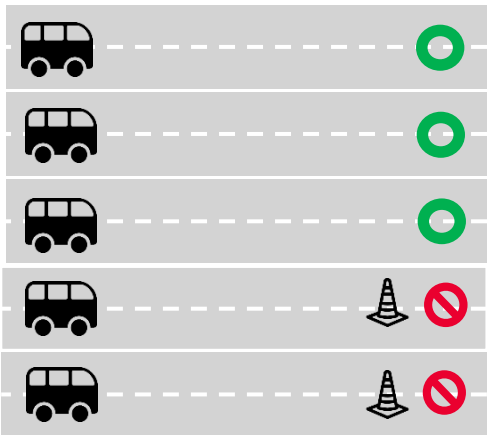
For a 10KWp typical residential system, pairing cycle-time usually takes 1.5 min

DIGITAL TURBO

Pairing through high performance DC MBUS Communication

- Orthogonal Frequency Division Modulation (OFDM) employed for high efficient communication
- Adaptive & robust to noise interference and selective attenuation for stable & reliable communication

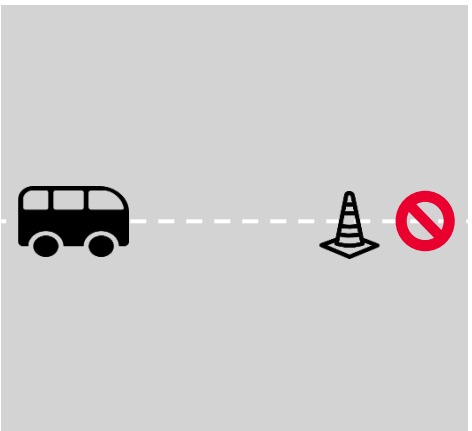
1.5 min @ 10KW System



OFDM: Signal samples are transmitted concurrently with multiple orthogonal sub-channels, even certain channels are blocked, signal can still be transmitted via non-blocked channel.

V.S.

3 min @ 10KW System

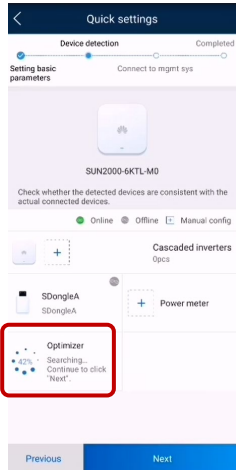


FSK: Signal sample is transmitted in one channel using the entire band. If channel is blocked, signal transmitting is suspended.

Optimizer Paring Setting

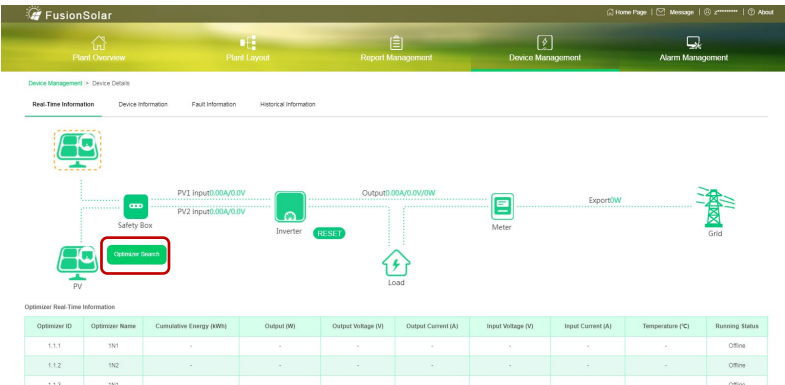
- Power optimizer paring to inverter is started when inverter is powered on.

Optimizer paring is automatically started when both inverter AC & DC is powered on. The process is shown in the second step of Quick Setting of FusionSolar



- Remote optimizer paring in FusionSolar Smart PV Management web tool

In web tool, under 'Device Management tab – Real-time Information' tab, click 'Optimizer Search' to trigger remote pairing of optimizer





What is Power Optimizer ?



How Does Optimizer Work in PV System ?



Long String Design with Power Optimizer



Easy installation Verification and Safe Operating

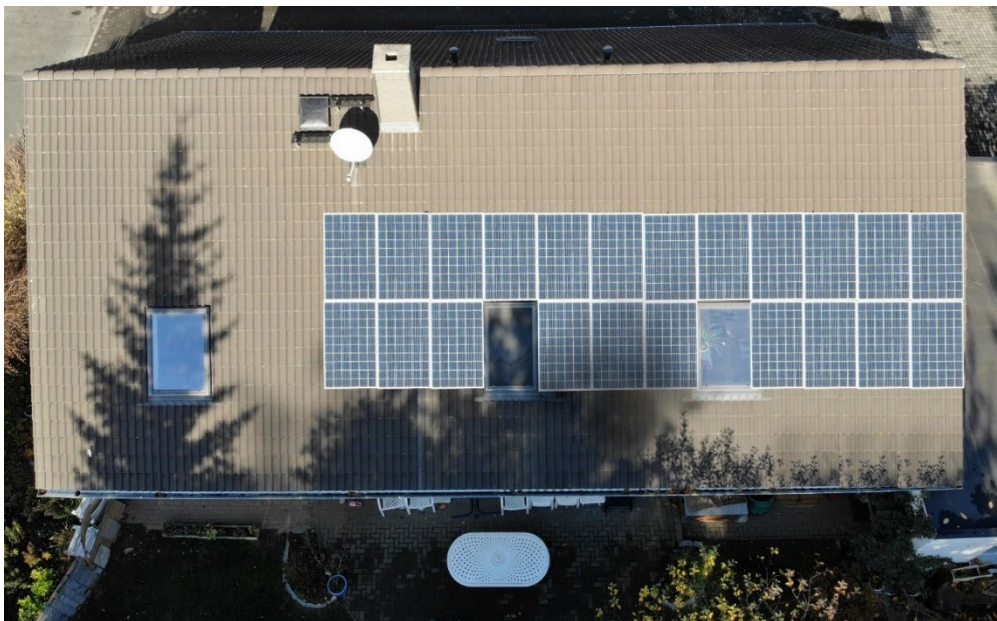


Optimizer Pairing with Inverter



Module Performance Monitoring in Physical View

Module Performance Monitoring in Physical View



- Physical layout view is only available to installer account users
- Real-time module performance view is under 'Plant Layout' tab of created site. Daily accumulated output energy of module is displayed and refreshes every 5 mins.
- Double click a module, following information of all modules can be monitored:

1. Real-time information

Cumulative energy, output power, output voltage, input voltage, input current are displayed in matrix.

2. Device Information

Optimizer SN and software version is displayed in matrix

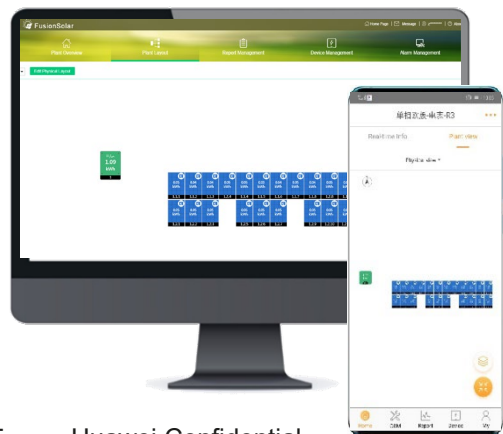
3. Fault information

Fault name, status, occurred time and recovery time of each problematic optimizer is displayed in matrix

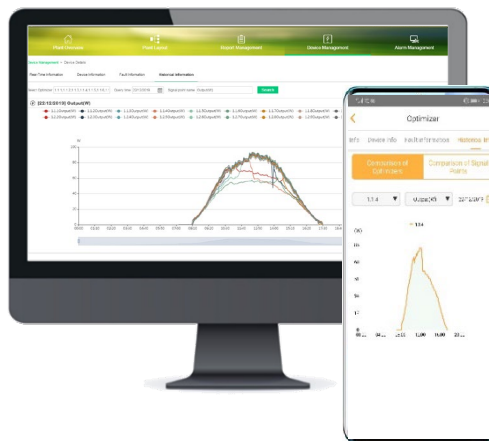
4. Historical Information

Optimizer and date can be selected to plot parameter curve of cumulative energy, output power, output voltage, output current, input voltage, input current, temperature.

Physical Layout



Historical Data



5s Module Physical Layout Creating



PV module physical view is created by Image Recognition

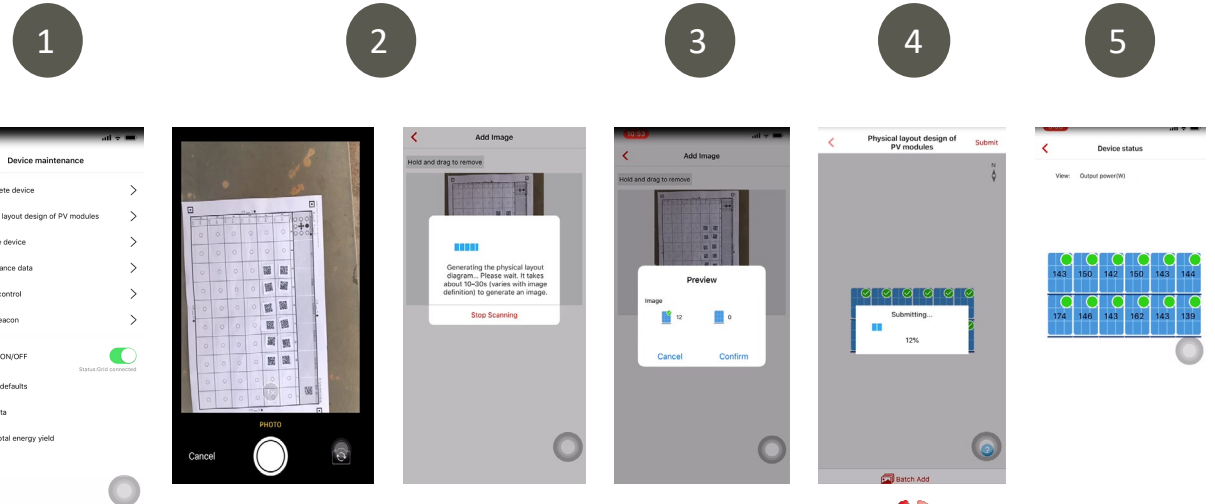
Step 1: In FusionSolar app commissioning tool, click 'Device management' -> 'Physical layout design of PV modules', Click 'Camera'

Step 2: Take Photo of created module physical layout template pasted with optimizer QR codes and wait for detecting of optimizer QR code completion.

Step 3: When all QR codes have been detected, check the number of them and then click 'Confirm'.

Step 4: Wait for detected information uploading to inverter.

Step 5: Module physical view creation is completed



FusionSolar Residential Smart String ESS Solution

Pre-sales Technical Training





Residential Smart String ESS Introduction

HUAWEI Smart String ESS Basic Specification

Safe Performance of Lithium Iron Phosphate Cell

Problems of New & Old Pack Mixing in Conventional Modular ESS

HUAWEI Smart String ESS Solution with Energy Optimizer

Black Start with Smart String ESS

ESS installation and Operating Mode

Smart String ESS Installation & Wiring

Smart String ESS Setting

ESS Control Mode - Maximization Self Consumption

ESS Control Mode – Time of Use

ESS Control Mode – Excessive PV Energy Fully fed to Grid

Residential PV + ESS Solution Application

SUN2000-2-6KTL-L1 PV + ESS Connects to Single/Three Phase Grid

SUN2000-2-6KTL-L1 AC Coupling to Single/Three Phase Grid

SUN2000-2-6KTL-L1 PV + ESS Operates in Off Grid

SUN2000-2-6KTL-L1 Multiple System Application

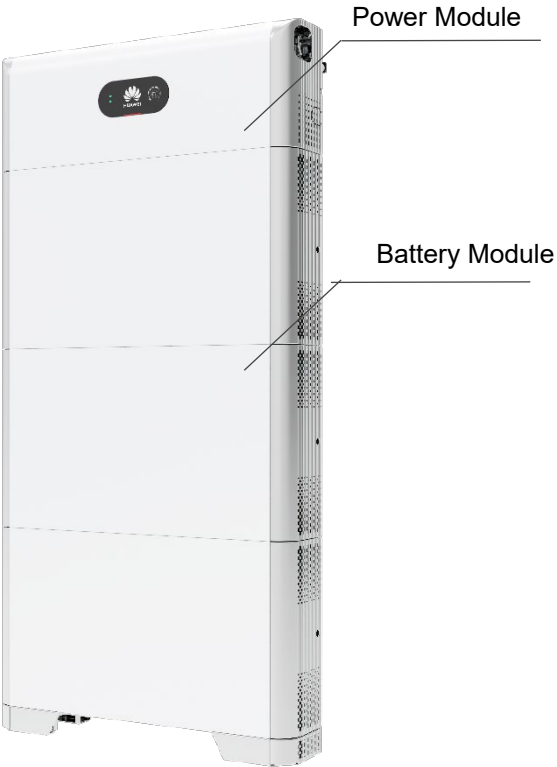
SUN2000-3-10KTL-M1 PV + ESS Connected to Three Phase Grid

SUN2000-3-10KTL-M1 AC Coupling to Three Phase Grid

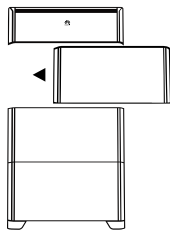
SUN2000-3-10KTL-M1 Multiple System Application

SUN2000-2-6KTL-L1 & 3-10KTL-M1 System Mixed Application

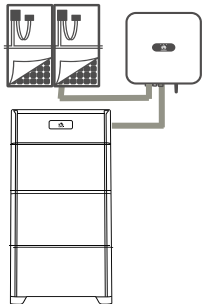
HUAWEI Smart String ESS Basic Specification



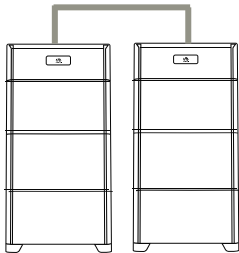
Up to three 5kWh Battery Module in one system



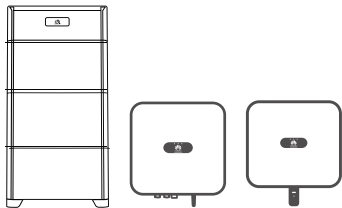
High voltage DC couple Solution



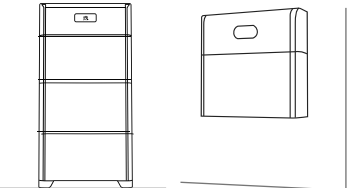
Up to 2 ESS operates in parallel, 5-30kWh



Compatible with both SUN2000-2-6KTL-L1 & SUN2000-3-10KTL-M0/M1



Standard floor stand / Optional wall mount installation
IP65, outdoor / indoor install



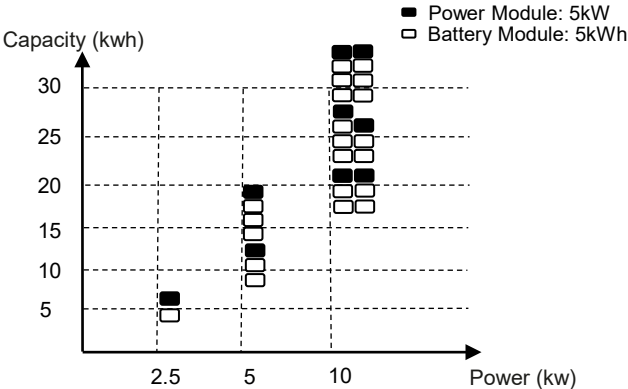
Lithium-iron phosphate (LiFePO4) cell



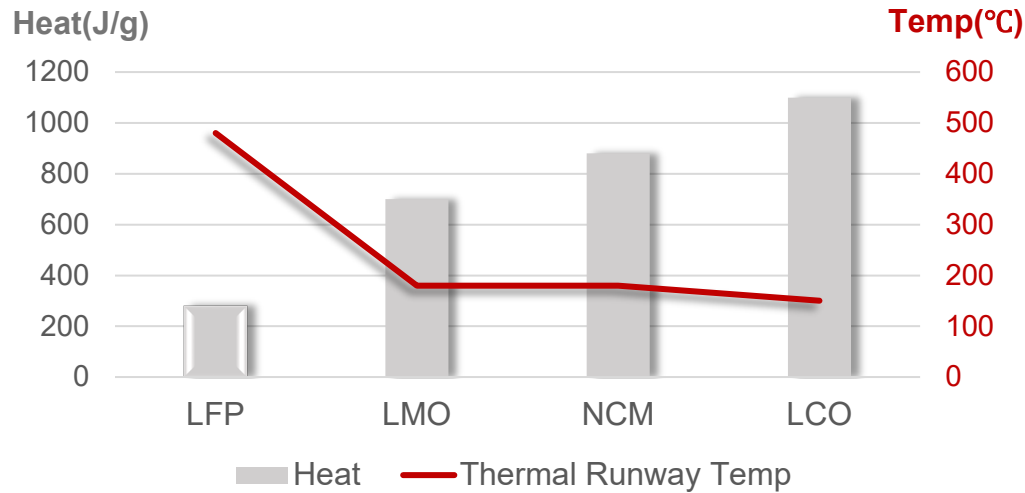
100% DoD
10 years warranty
≥4,500 cycles



Max 5KW charge/discharge power



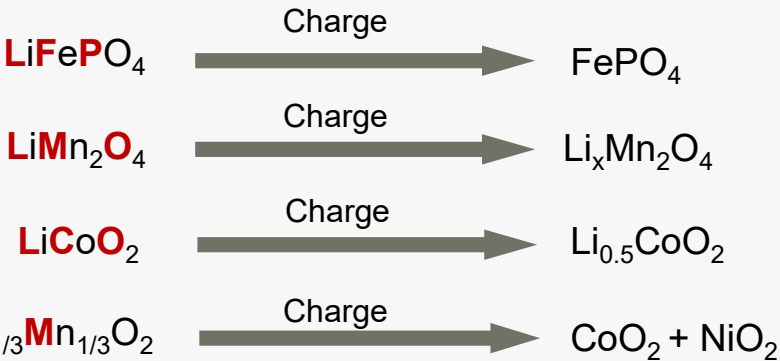
Safe Performance of Lithium Iron Phosphate Cell



Lithium iron phosphate cell inherently generates low heat and has high thermal runaway temperature

Chemistry reaction of LFP does not generate O₂, No explosion risk

Lithium iron phosphate (LFP)



Lithium manganese oxide (LMO)

Lithium cobalt oxide (LCO)

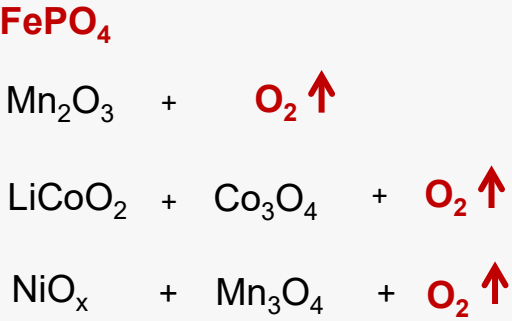
Li(NiCoMn)O₂ (NCM)

Thermal Runway @ 480°C

Thermal Runway @ 180°C

Thermal Runway @ 150°C

Thermal Runway @ 180°C



Normal Charge

Thermal Runway When Over Charge, Over Discharge, Over Temperature

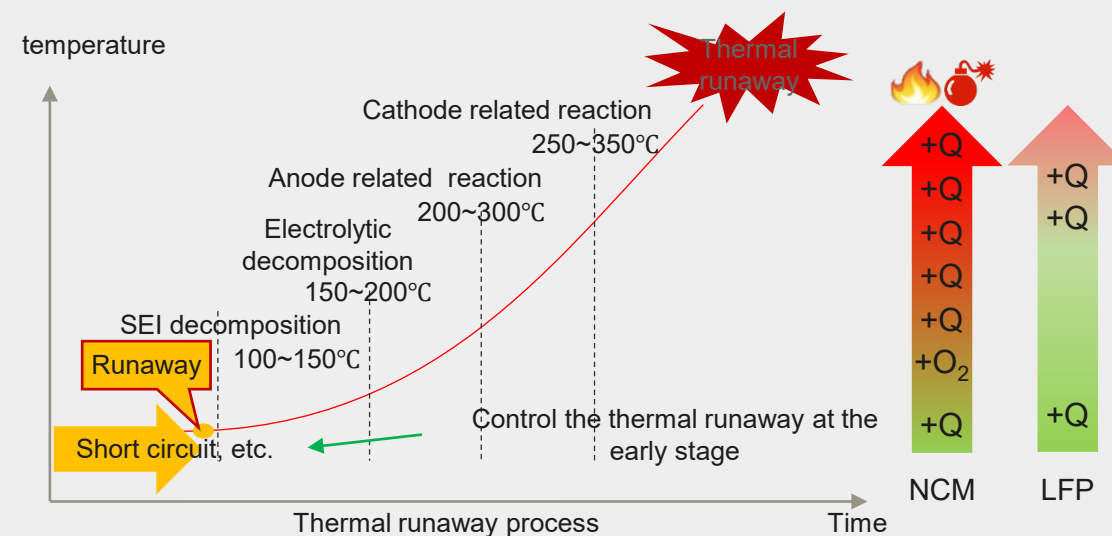
Safe Performance of Lithium Iron Phosphate Cell

Nail test: LFP-no fire no explosion; NCM-fire & explosion

Thermal runaway & quick heat lead to fire



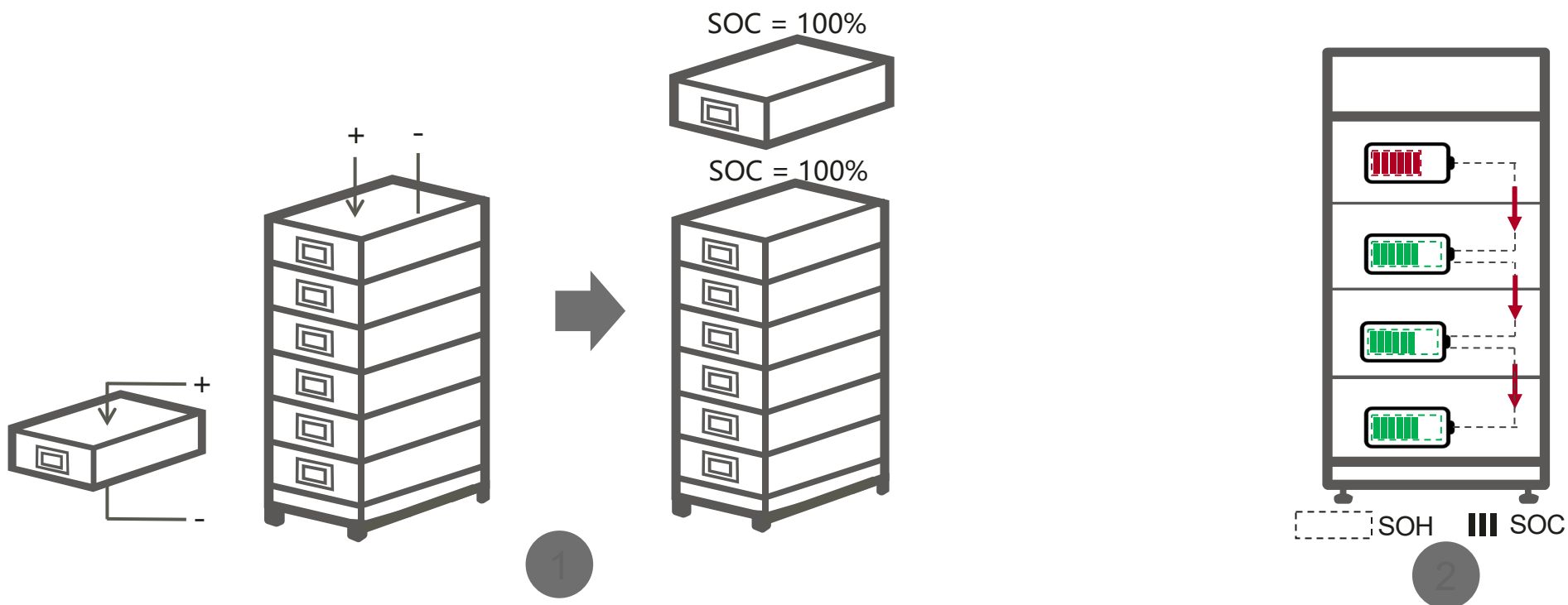
Temperature(°C)	Reaction type (with heat)	LFP	NCM
110~150	LiC ₆ with electrolyte	√	√
180~500	Li _{0.3} NiO ₂ with electrolyte	✗	√
220~500	Li _{0.45} CoO ₂ with electrolyte	✗	√
150~300	Li _{0.1} Mn ₂ O ₄ with electrolyte	✗	√
130~220	LiPF ₆ with solvent	√	√
240~350	LiPC ₆ with PVDF	√	√



Problems of New & Old Module Mixing in Conventional Modular ESS

ESS with Battery Modules Connected in Series

1. Before connect a new battery module to existing system, both of them have to be charged @100% SOC to synchronize charge and discharge status.
2. Internal resistance of old battery pack increases due to operating degradation, which results in ESS SOH decreases gradually. When old battery module mixed with new modules, charging will halt when old modules are fully charged but new modules not fully charged yet.

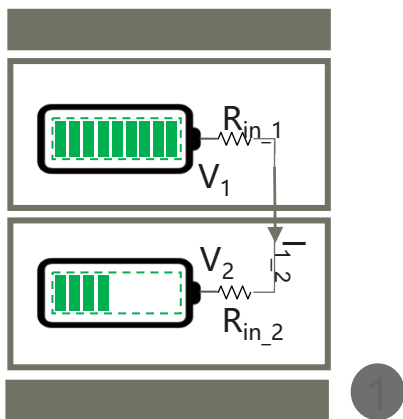


Problems of New & Old Module Mixing in Conventional Modular ESS

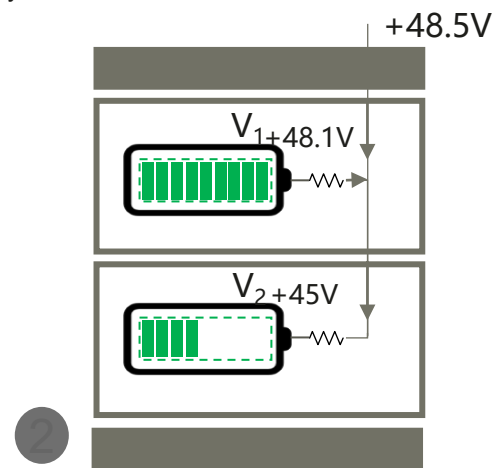
ESS with Battery Modules Connected in Parallel

1. **Circulating current** – The generation of circulating current generated by voltage mismatch among battery modules might cause fire hazard or energy loss.
2. **Over-charging** - It is not possible to charge each module to a fully charged state at the same time when resting voltages differ noticeably in each battery modules connected in parallel. The risk of over-charging and/or overheating batteries rises because the pack with lower SOC will drain more current when float charging is applied on all different batteries at the same time.

Assume $V_1 > V_2$ initially before two battery packs are connected in parallel. After they are connected in parallel, a circulating current is generated by voltage mismatch. The circulating current $I_{1,2}$ would be high if the terminal voltages V_1 and V_2 differ noticeably.



When charging batteries with V_1 and V_2 ($V_1=48.1V$, $V_2=45V$) connected in parallel, more current is drawn by battery with V_2 including circulating current from battery with V_1 . Sometimes the current will exceed the limit that the battery pack can safely handle.

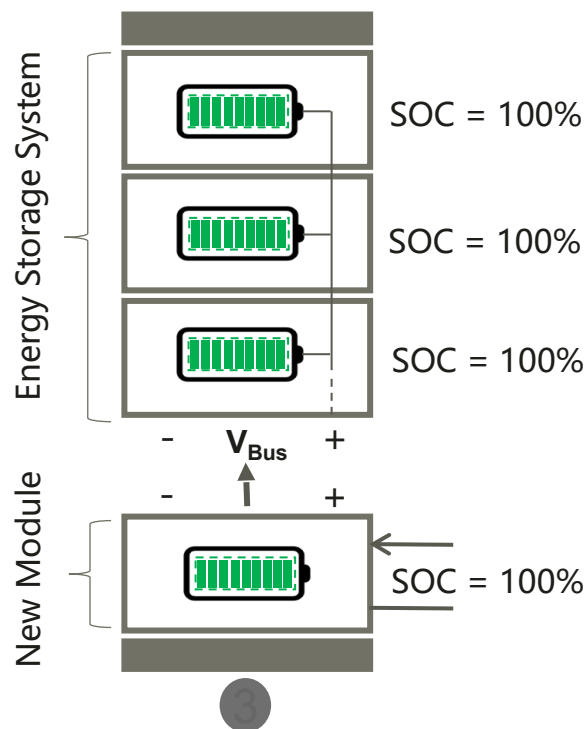


V_1 and V_2 will be self-balanced eventually after a certain amount of time so that no circulating current is generated. During this period, the energy loss occurs and fire is even caused by high circulating current without protection.

Problems of New & Old Module Mixing in Conventional Modular ESS

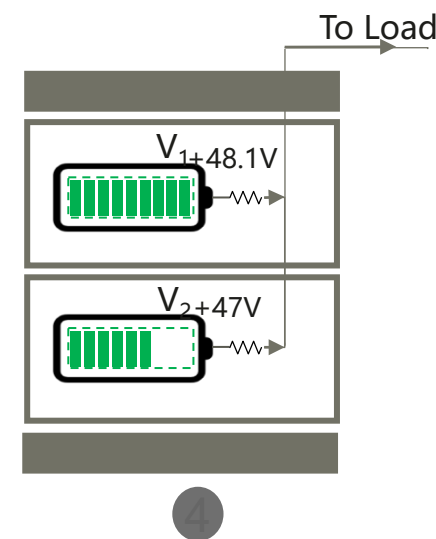
ESS with Battery Modules Connected in Parallel

- Before connecting a new battery module, it has to be recharged by a separate charging process until its voltage reaches the existing voltage of bank voltage of battery module connected in parallel in the system. This is to avoid the circulating current or excessive charge current to new battery module.
- Over-discharging** – The risk of over-discharging, overheating, and capacity loss increases because the battery pack with higher SOC and/or resting voltage will source more current to the load, especially when SOC and/or resting voltages differ noticeably in each battery pack

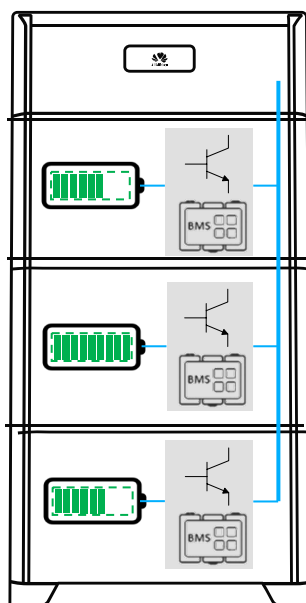


Over-discharge – In the worst case, a battery pack with relatively higher SOC than other battery packs might source all of the current to the load. This might lead to over-discharge of a single battery.

Degraded lifetime – High discharge current will lead to high temperature of the battery. One of the drawbacks resulting from high temperature is that batteries age much faster at high temperature. Another drawback is that high temperature might activate the protection circuit inside the battery and the battery will be disconnected.



HUAWEI Smart String ESS Solution with Energy Optimizer



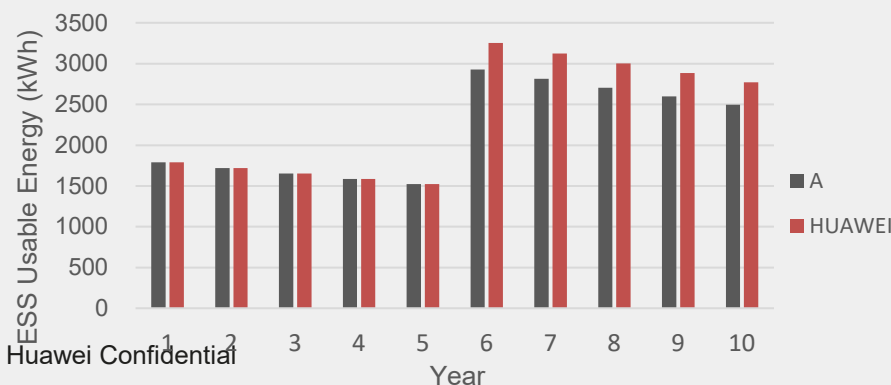
Energy Optimizer

Regulated the voltage of DC bus to which battery is connected in parallel to be stable.

Control the charge and discharge current of each battery module independently.

BMS is integrated to manage and supervise operating status and safety of performance.

- ✓ Avoid circulating current among battery modules connected in parallel
- ✓ Free of pre-charging when new modules mixed with existing system
- ✓ Charge and discharge of each module is optimized to maximize system usable energy and eliminate risk of over-charging & discharge, overheat.
- ✓ Faulty module is automatically isolated and can be positioned in management system.



Usable Energy Comparison Case

Assumption:

- 5kWh ESS expand to 10kWh ESS with new and old battery module mixed in one system @ 6th year along 10-year lifecycle.
- System executes a complete charge and discharge cycle per day.
- ESS retains 60% energy capacity @10th year

Comparison Conclusion:

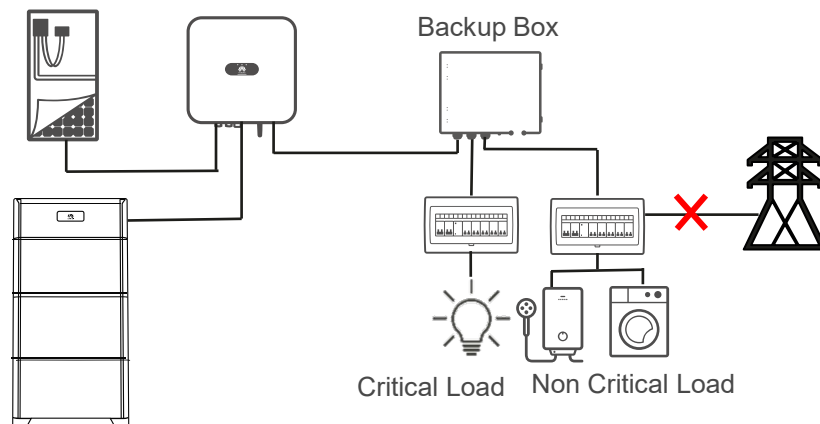
- HUAWEI smart string ESS with energy optimizer supplies **11%** more energy every year from 6th year.
- In total 10-year ESS lifecycle, HUAWEI smart string ESS supplies **7%** more energy.

Black Start with Smart String ESS

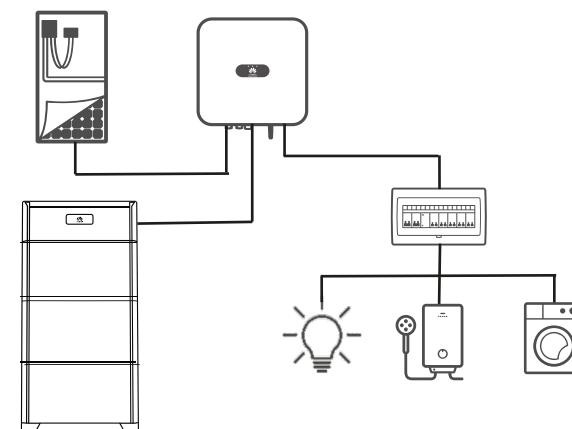
A **black start** is the process of restoring an electric power station or a part of an electric grid to operation without relying on the external electric power transmission network to recover from a total or partial shutdown.

When enough energy remains in the ESS, function of black start support activate inverter operating even without PV input. ESS energy capacity for black start is subjected to load and duration for emergent power supplement.

Black Start Button



Scenario 1: If system is shutdown during grid outage, it can be restored to operate in backup mode with ESS black start to supply power to critical load.



Scenario 2: If system is shutdown without AC grid, it can be restored to operate in off grid (No AC grid) mode with ESS black start.

- For example, under 5KW load with emergent power supplement duration to be 12-18 minutes, SOC of ESS is recommended to be at least 30% to start black start.
- When PV input activates smart energy center, without trigger black start button, ESS can be waken up by high DC voltage of smart energy center interface even if its energy has been exhausted.

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Black Start with Smart String ESS

ESS installation and Operating Mode

Smart String ESS Installation & Wiring

Smart String ESS Setting

ESS Control Mode - Maximization Self Consumption

ESS Control Mode – Time of Use

ESS Control Mode – Excessive PV Energy Fully fed to Grid

Residential PV + ESS Solution Application

SUN2000-2-6KTL-L1 PV + ESS Connects to Single/Three Phase Grid

SUN2000-2-6KTL-L1 AC Coupling to Single/Three Phase Grid

SUN2000-2-6KTL-L1 PV + ESS Operates in Off Grid

SUN2000-2-6KTL-L1 Multiple System Application

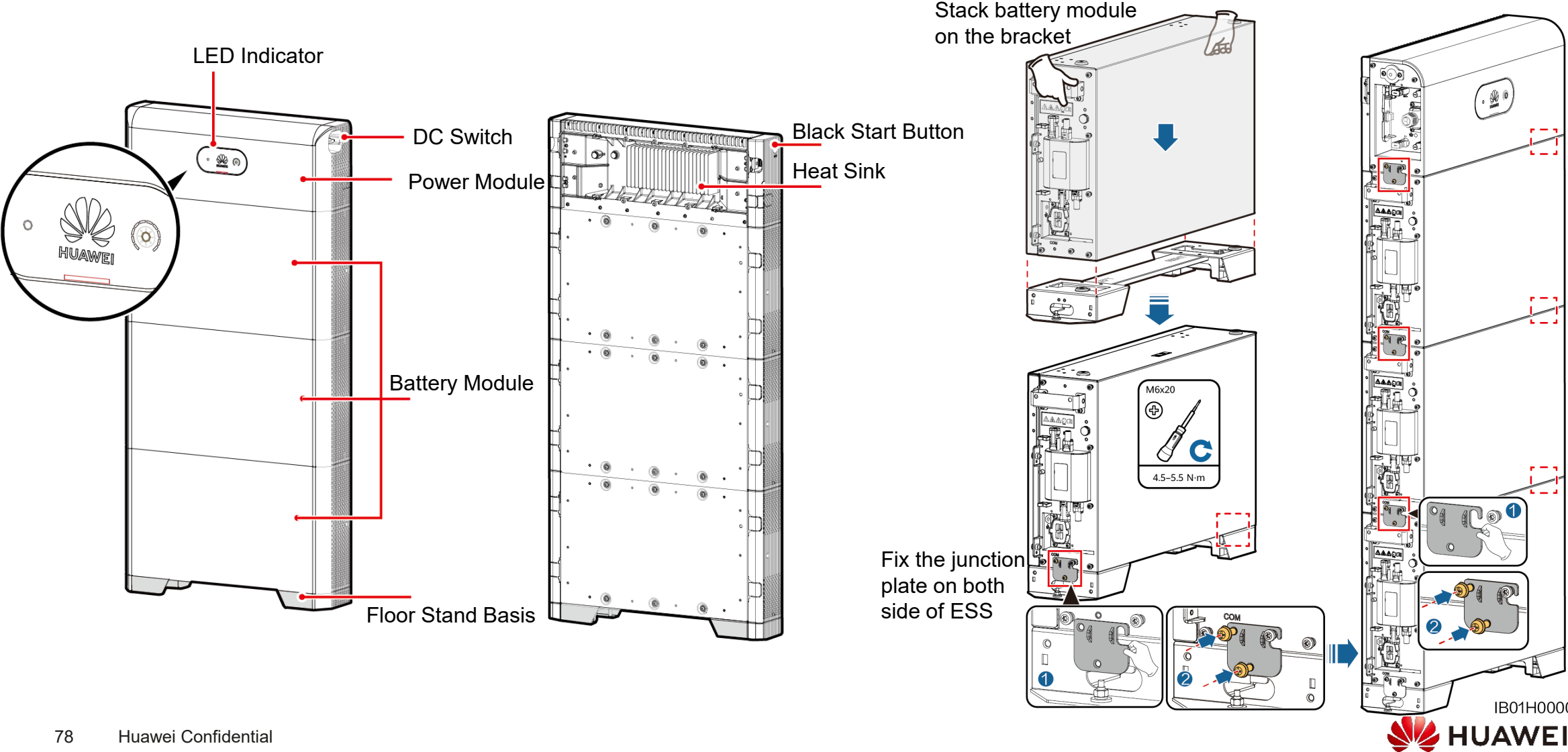
SUN2000-3-10KTL-M1 PV + ESS Connected to Three Phase Grid

SUN2000-3-10KTL-M1 AC Coupling to Three Phase Grid

SUN2000-3-10KTL-M1 Multiple System Application

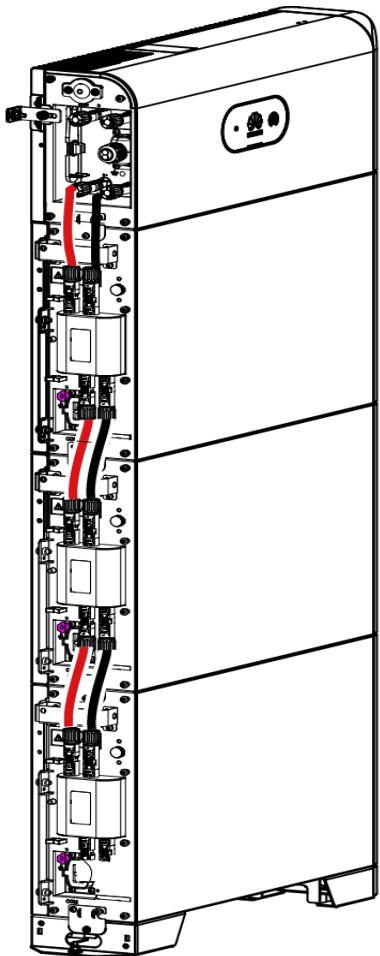
SUN2000-2-6KTL-L1 & 3-10KTL-M1 System Mixed Application

Smart String ESS Installation

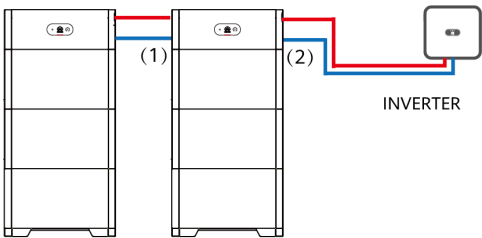
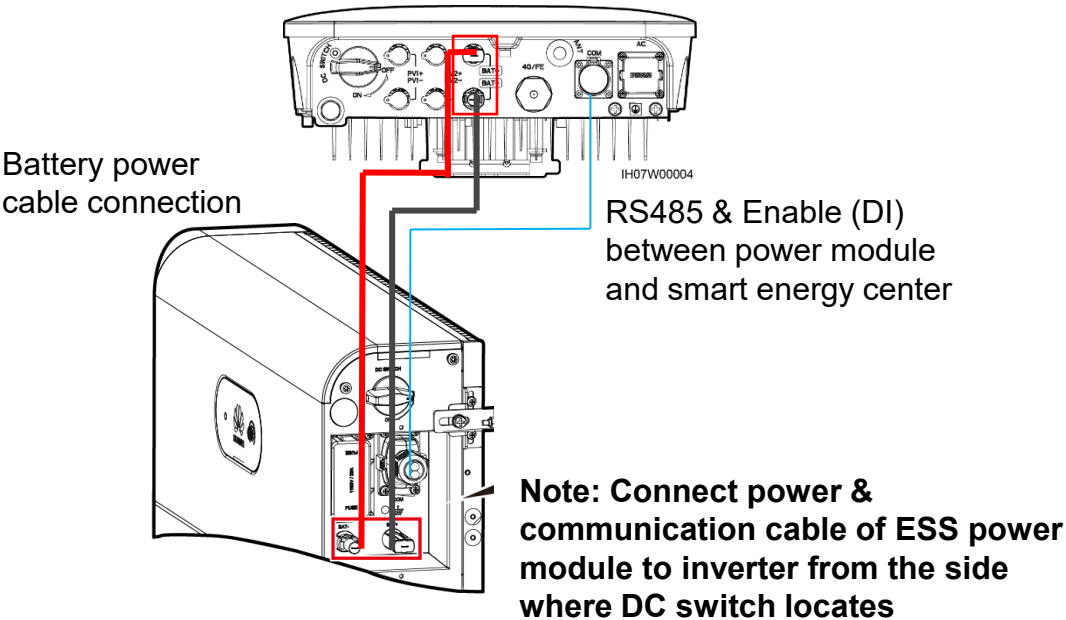
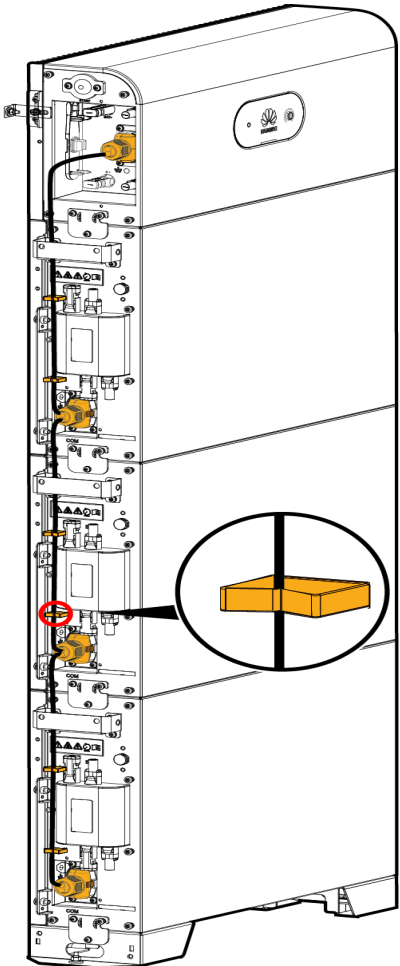


Smart String ESS Wiring

Connect power cable between ESS string terminal +/- of power module and battery modules



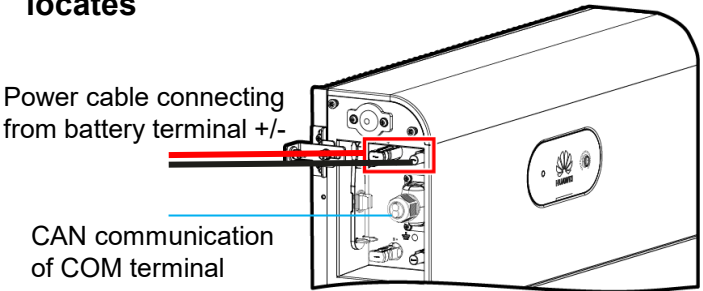
CAN communication connection between power module and battery in ESS



- (1) ESS extension CAN connection
- (2) RS485 connection between ESS and inverter

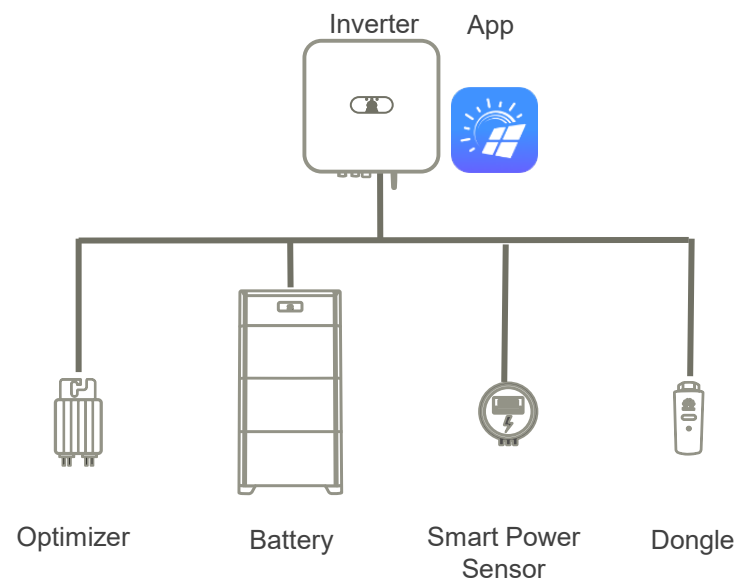
Power Cable COM Cable

Note: Extend ESS connection from the side where black start button locates



Smart String ESS Auto Detection

All inverter connected devices can be automatically detected in FusionSolar app



ESS Control Mode Setting Option

Quick settings

Device Mgmt. Communication networking

Basic parameters Energy storage control Completed

Working mode settings ? Time-of-use ^

Start date End date

00:00 00:01

Day >

Priority of excess PV energy ? Fed to grid v

Allowed charge power of grid 0.000kW

Previous Next

Maximum self-consumption

Using PV energy is prioritized over using grid energy, Storing PV energy is prioritized over feeding excess PV energy into grid

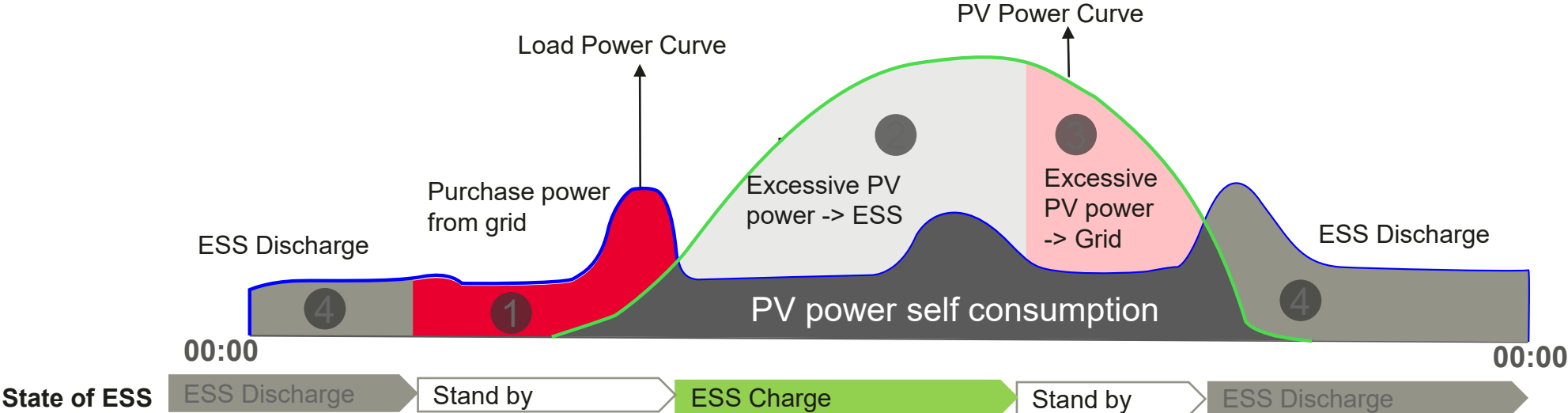
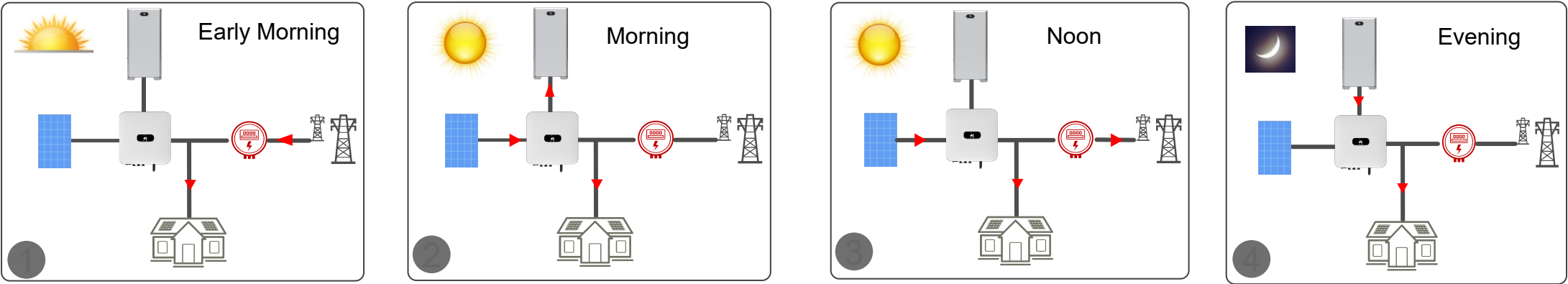
Fully fed to grid

Smart energy center feeds as much power as possible to the grid either with excessive PV power or ESS power.

TOU (Time of Use)

If electricity is more expensive at times of high demand (peak rate) than at times of low demand (off-peak rate), customers will automatically consume more when it is cheaper and save when it is expensive.

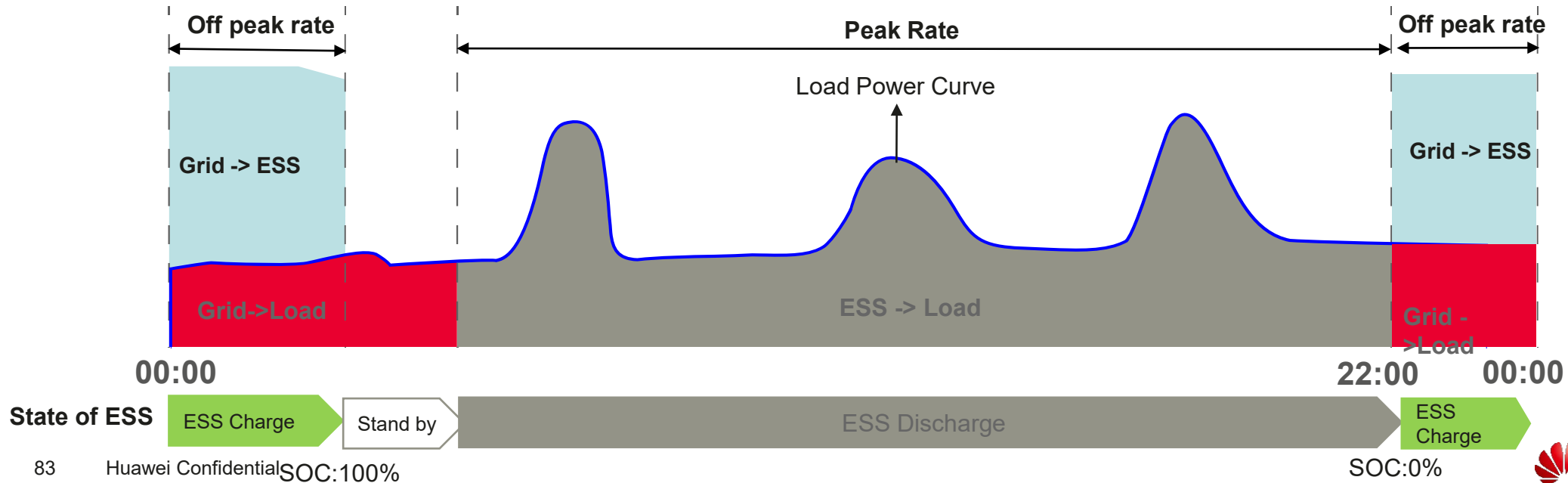
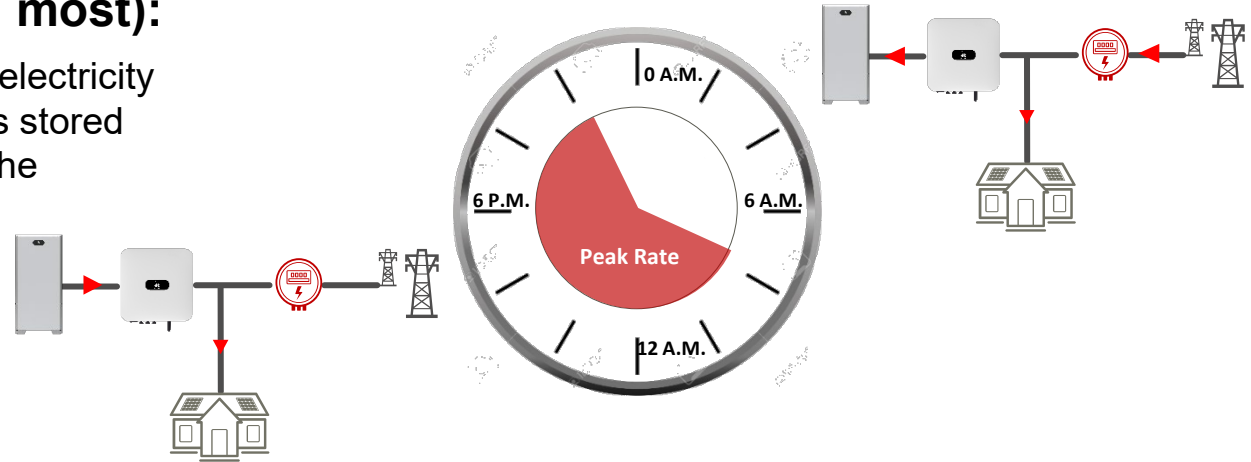
System Operating Control Mode - Maximization Self Consumption



System Operating Control Mode – Time of Use, No PV

Time-Of-Use (AC coupling system applied most):

Time of use storage operation mode enables you to store electricity in the battery at a cheap off-peak rate, and then to use this stored electricity to supply the household appliances at times of the expensive peak rate.



TOU (Time of Use) Control Mode Setting

Quick settings

Device Mgmt. Communication networking

Basic parameters Energy storage control Completed

Working mode settings Time-of-use

Start date End date Charge/Discharge

00:00 00:01 Charge power

Day

Priority of excess PV energy Fed to grid

Allowed charge power of grid

Fed to grid Charge

Previous Next

Specify day and period of ESS charge and discharge

Quick settings

Device Mgmt. Communication networking

Basic parameters Energy storage control Completed

Working mode settings Time-of-use

Start date End date Charge/Discharge

09:31 23:30 Discharge

Day everyday

23:56 23:59 Charge

Day Sunday Monday Saturday

23:31 23:55 Discharge

Day Sunday Monday Tuesday Wednesday Thursday Saturday

Priority of excess PV energy Fed to grid

Allowed charge power of grid 1.500kW

Previous Next

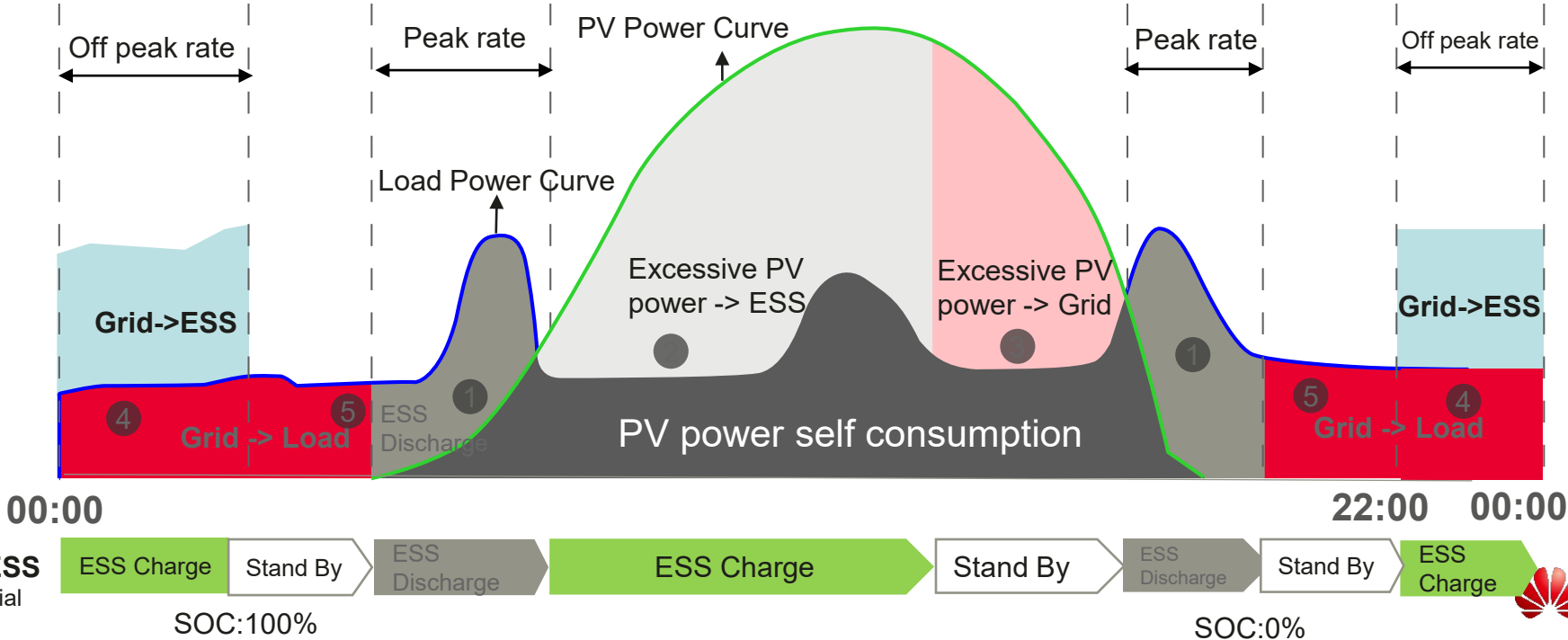
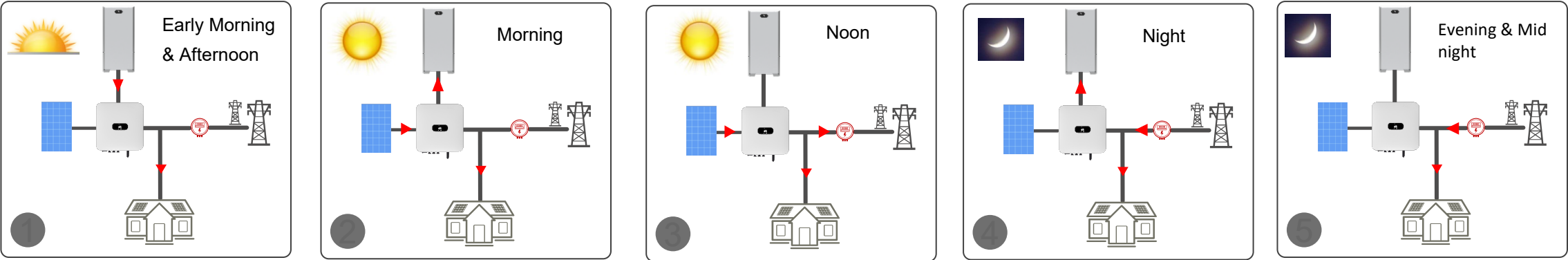
Excessive PV power fed to grid prior to charge ESS

PV power utilization priority: Self-consumption > Export to grid > ESS charge
Load is supplied with power in the priority of PV, ESS discharge and Grid. ESS charge power to grid is prohibited.

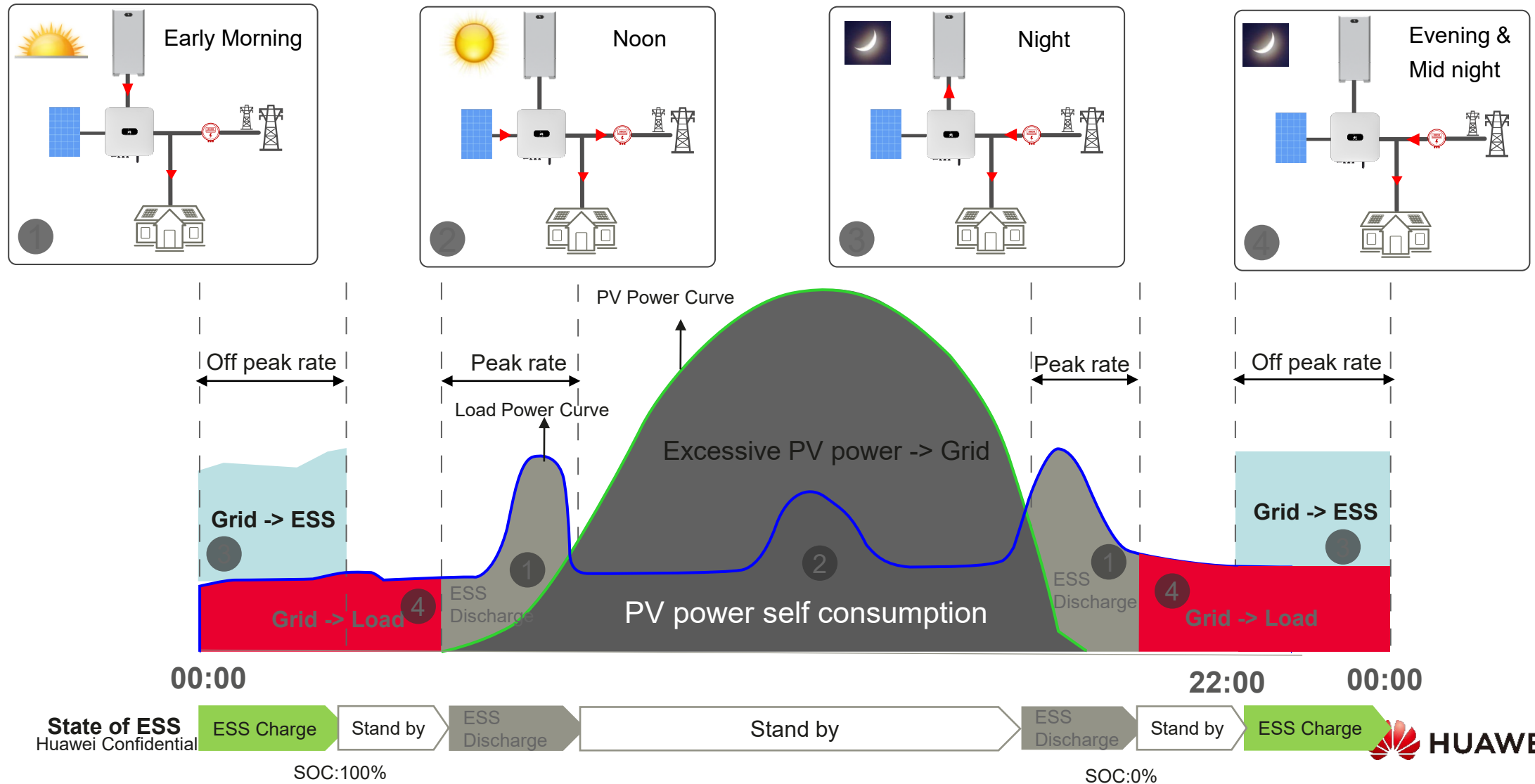
Excessive PV power charges ESS prior to being fed to grid

PV power utilization priority: Self-consumption > ESS charge > Export to grid
Load is supplied with power in the priority of PV, ESS discharge and Grid. ESS charge power to grid is prohibited.

System Operating Control Mode – Time of Use, ESS Charge Prior

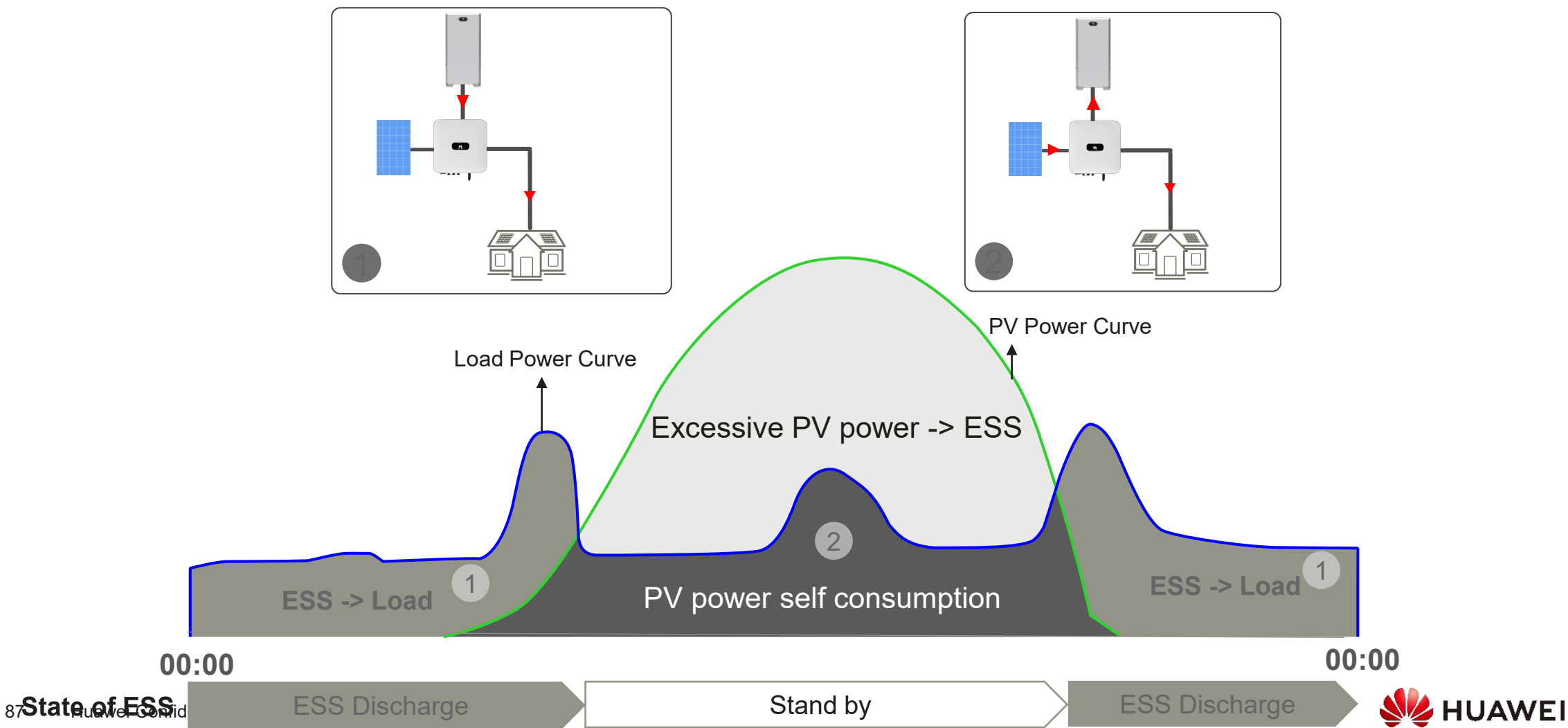


System Operating Control Mode – Time of Use, Grid Feed In Prior



System Operating Control Mode – Off Grid Operating Mode (No AC Grid)

Smart energy center operates in voltage source mode to supply stable voltage and frequency to the load. Excessive PV power is to charge ESS.



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SUN2000-2-6KTL-L1 AC Coupling to Single/Three Phase Grid

SUN2000-2-6KTL-L1 PV + ESS Operates in Off Grid

SUN2000-2-6KTL-L1 Multiple System Application

SUN2000-3-10KTL-M1 PV + ESS Connected to Three Phase Grid

SUN2000-3-10KTL-M1 AC Coupling to Three Phase Grid

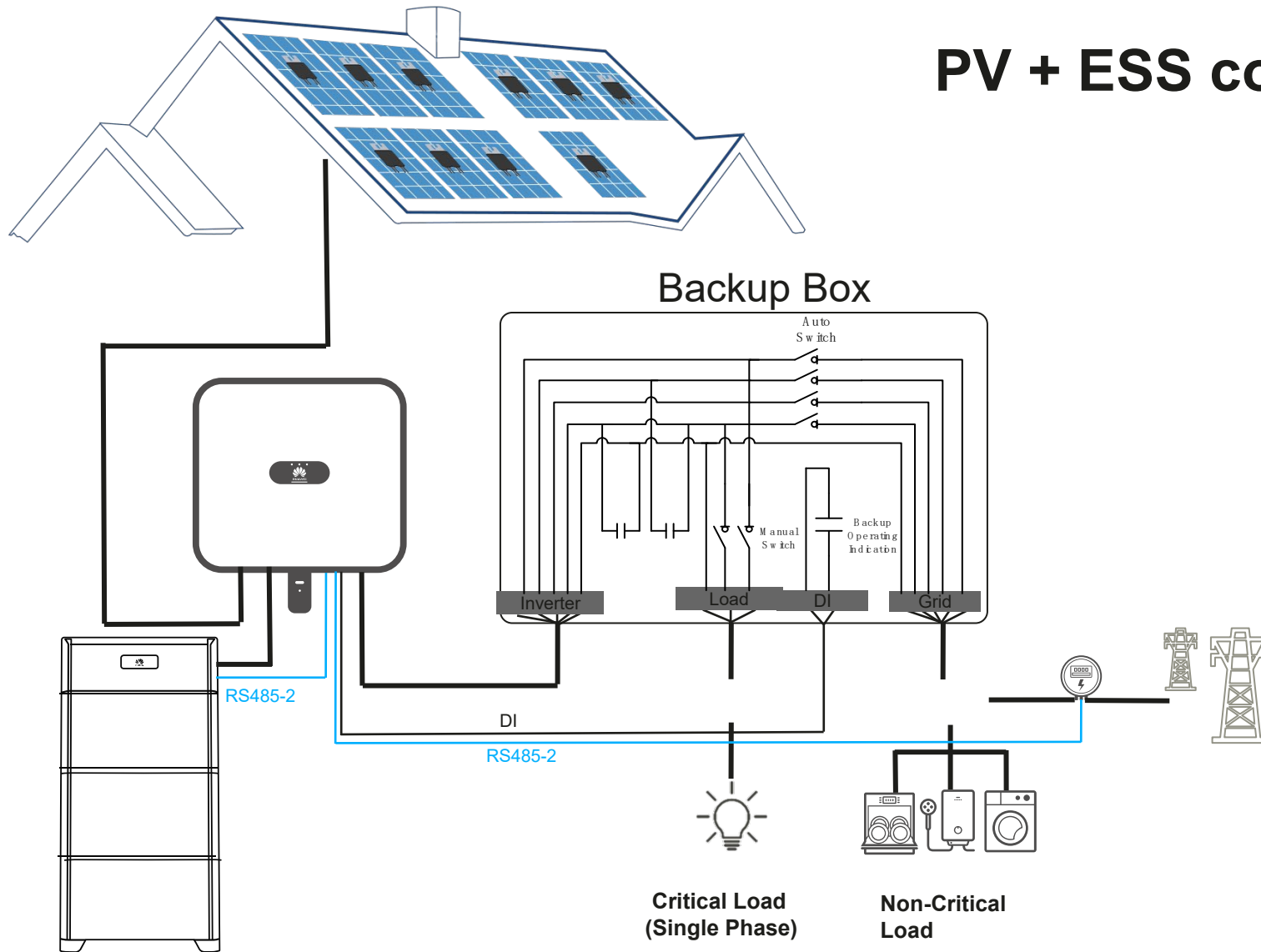
SUN2000-3-10KTL-M1 Multiple System Application

SUN2000-2-6KTL-L1 & 3-10KTL-M1 System Mixed Application

Smart Energy Center Application Solution Option (PV + Storage)	Backup	Off-Grid Operating (No AC Grid)	Export Control	Max self-consumption Mode	Time of Use Mode	Note
SUN2000-2-6KTL-L1 (PV connected) + LUNA2000 String Battery / LG Chem Battery	√	√ (Ready in 2020 Oct)	√	√	√	
SUN2000-2-6KTL-L1 (master inverter, PV + LUNA2000 String Battery / LG Chem Battery) + SUN2000-2-6KTL-L1 (slave inverter, PV + optional LUNA2000 String Battery / LG Chem Battery) + SUN2000-2-6KTL-L1 (slave inverter, PV + optional LUNA2000 String Battery / LG Chem Battery)	√	X	√	√	√	Max 3 SUN2000-2-6KTL-L1 connected in one RS485 bus. Master inverter is controlled by a smart dongle and connects to energy storage system. For the other slave inverter, storage system is optionally to connect,
SUN2000-2-6KTL-L1 (No PV) + LUNA2000 String Battery / LG Chem Battery	√	X	X	X	√	
SUN2000-3-10KTL-M1 (PV connected) + LUNA2000 String Battery	√	X	√	√	√	
SUN2000-3-10KTL-M1 (master inverter, PV + LUNA2000 String Battery) + SUN2000-3-10KTL-M1 (slave inverter, PV + optional LUNA2000 String Battery) + SUN2000-3-10KTL-M1 (slave inverter, PV + optional LUNA2000 String Battery)	√	X	√	√	√	Max 3 SUN2000-3-10KTL-M1 connected in one RS485 bus. Master inverter is controlled by a smart dongle and connects to energy storage system. For the other slave inverter, storage system is optionally to connect,
SUN2000-3-10KTL-M1 (No PV) + LUNA2000 String Battery	√	X	X	X	√	
SUN2000-2-6KTL-L1 (LUNA2000 String Battery / LG Chem Battery) + SUN2000-3-10KTL-M1 (LUNA2000 String Battery)	√	X	√	√	√	

SUN2000-3-10KTL-M1

PV + ESS connects to Three Phase Grid



- Only HUAWEI LUNA2000-5/10/15-S0 string battery is compatible with SUN2000-3-10KTL-M1 smart energy center;
- Battery communicates to smart energy center via RS485 at RS485-2 port.
- Smart power sensor DTSU666-H 250A/50mA is connected at the grid connection point for exported power measurement to calculate self-consumption rate and power export control.
- Three phase backup box Backup Box-B1 can be connected to smart energy center. User can determine critical single phase household load to connect to backup box.

On-grid mode: Smart energy center connects directly to the grid. Both critical load and non-critical load are connected to the grid and can be powered up.

Backup mode: When grid is outage, non-critical load is powered off. Switch in backup box automatically turns off and smart energy center turns into backup operating mode to output stable voltage and frequency to critical load until battery energy is exhausted and there is no stable PV power input.

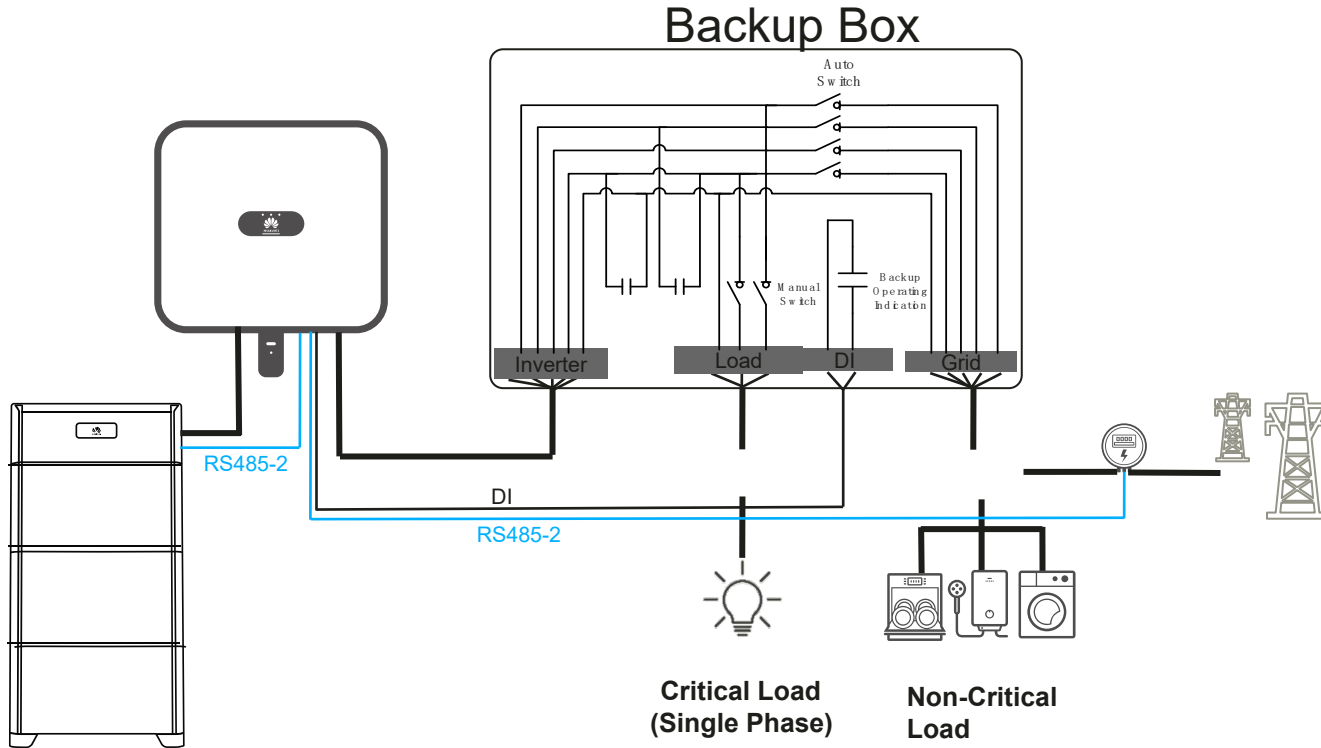
During daytime, both PV and battery supply power to critical load while during nighttime only battery discharges power to critical load.

- Both self-consumption maximization control mode and TOU control mode can be applied for system operating.



SUN2000-3-10KTL-M1

AC Coupling to Three Phase Grid



- Only HUAWEI LUNA2000-5/10/15-S0 string battery is compatible with SUN2000-3-10KTL-M1 smart energy center;
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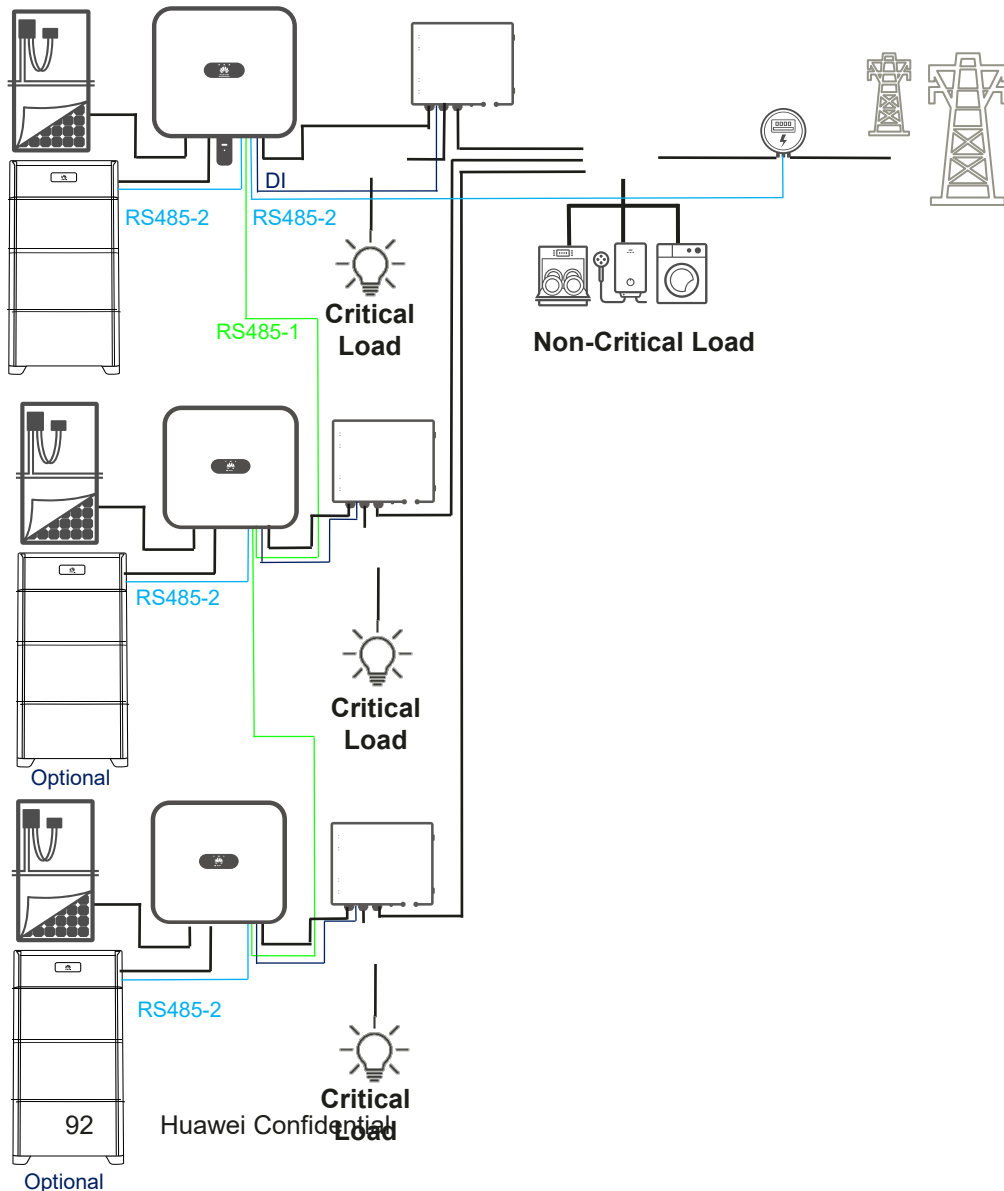
Backup mode: When grid is outage, non-critical load is powered off. Switch in backup box automatically turns off and smart energy center turns into backup operating mode to output stable voltage and frequency to critical load until battery energy is exhausted and there is no stable PV power input.

During daytime, both PV and battery supply power to critical load while during nighttime only battery discharges power to critical load.

- Only TOU control mode can be applied for system operating.
- Off grid (No AC grid) operating is not supported

SUN2000-3-10KTL-M1

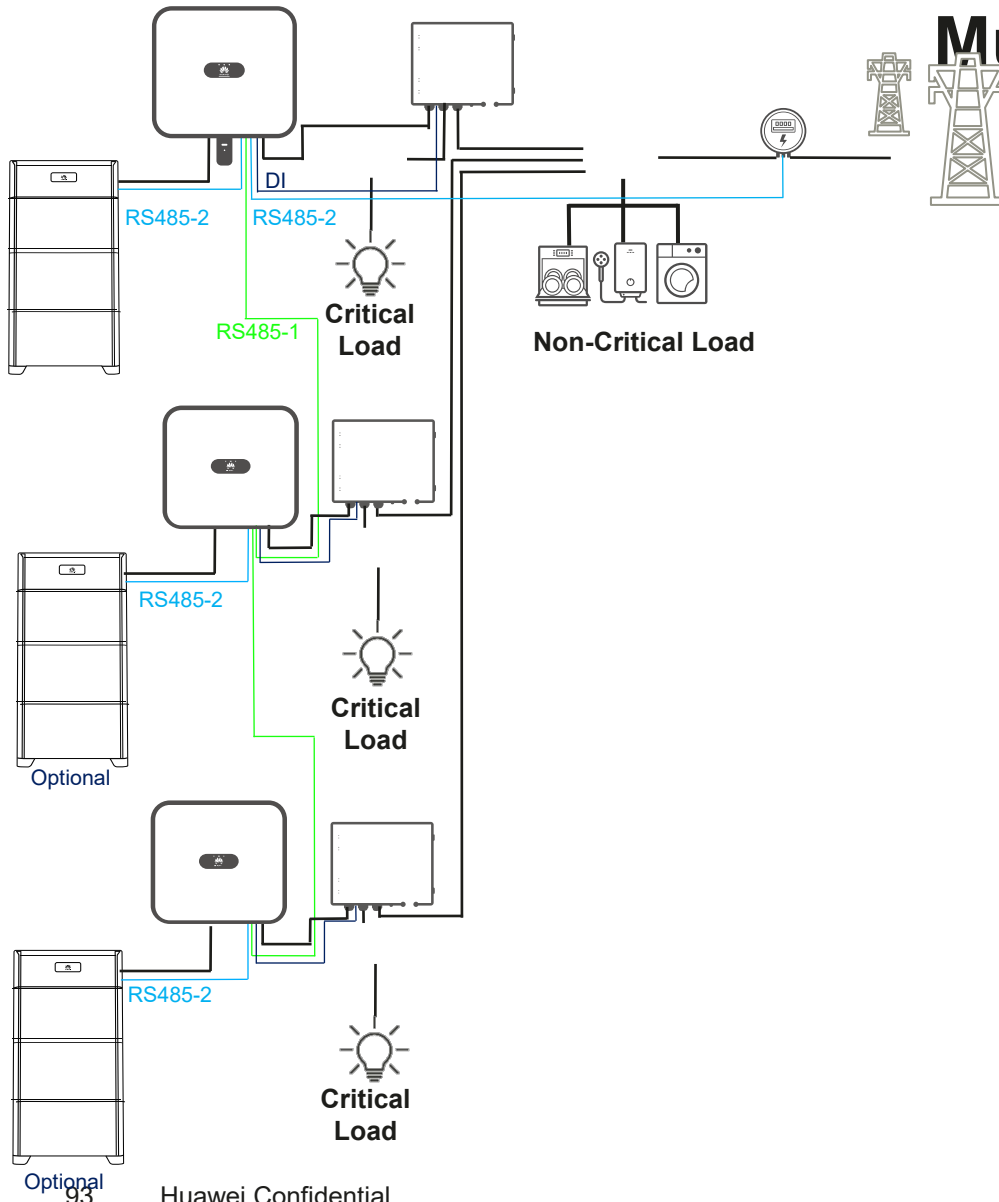
Multiple PV + ESS connects to Three Phase Grid



- Up to 3 smart energy centers can be connected in one RS485 bus
- Master smart energy center is connected to smart power sensor DTSU666-H 250A/50mA via RS485-1 port and a smart dangle via USB interface. The rest smart energy centers connected in the RS485 bus are slave ones.
- Only HUAWEI LUNA2000-5/10/15-S0 string battery is compatible with SUN2000-3-10KTL-M1 smart energy center. Master smart energy center has to be connected with a battery while slave ones are optionally to connect to batteries.
- Battery communicates to smart energy center via RS485 at RS485-2 port.
- Three phase backup box Backup Box-B1 can be connected to each smart energy center for single phase critical load supplied by backup power during electricity outage.
- DTSU666-H 250A/50mA smart power sensor is connected at grid connection point for power export measurement and control.
- Both self-consumption maximization control mode and TOU control mode can be applied for system operating.

SUN2000-3-10KTL-M1

Multiple ESS connects to Three Phase Grid



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- Only HUAWEI LUNA2000-5/10/15-S0 string battery is compatible with SUN2000-3-10KTL-M1 smart energy center. Master smart energy center has to be connected with a battery while slave ones are optionally to connect to batteries.
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- DTSU666-H 250A/50mA smart power sensor is connected at grid connection point for power export measurement and control.
- Only TOU control mode can be applied for system operating.

FAQ

Question / Comment	R&D Feedback
Please advise installation environment requirements for safety and maintenance.	DC switch of ESS is required to be turned off as well as for the switch of the inverter connected to ESS. ESS has grounding requirement. All above installation requirement is explicitly stated in quick guide of ESS. On the other side, energy optimize in each battery module isolate battery pack voltage to wiring terminal so as to ensure de-energized installation.
Does the Power Module contain a DC switch?	Yes, there is a DC switch to the right side of ESS when facing to its front
What kind of communications connector?	ESS communicate to inverter via RS485, ESS internal communication and extension communication is in CAN.
Please explain the inverter behavior when the battery runs empty	When the battery runs empty, the battery goes into standby mode. When PV power arises, inverter will charge the battery with it.
Backup mode: When the PV inverter is working in backup mode the inverter AC output must be grounded on the Neutral connector. This is called polarization of the grid and it allows external RCD's to work as intended when there is an insulation problem on the critical load. Obviously the grounding must be removed before the grid is (re) connected.	In backup mode, the inverter AC output is grounded on the Neutral connector(The ground position is in the backup box). When the grid reconnected, the inverter output connect the grid, The Neutral connector is automatically disconnected from the ground.
Same comment as Page 16, but in off-grid mode the inverter Neutral must be permanently grounded and an external RCD is mandatory.	Yes. In off-grid mode, the inverter Neutral must connect to ground. This requires an N-wire ground connection outside the inverter.
For Backup mode and Off-grid Mode: Some loads like refrigerators & freezers have very high peak starting current up to 6x or 10x nominal load current. Please provide specifications and allowed load characteristics for peak load, short overload and long overload.	5kWh ESS has peak power discharged @ 3.5 kW for 10 s 5kWh ESS has peak power discharged @ 7 kW for 10 s 5kWh ESS has peak power discharged @ 3.5 kW for 10 s
Very important to explain here that multiple SUN2000 inverters cannot be connected in parallel in off-grid or backup mode, because they are not synchronized.	YES
What is the max length of DC power cable connection between smart energy center and ESS?	10 m
Does customer need to prepare connection power cable between battery modules?	Customer needs to prepare following cable: 1. DC power cable and communication cable between smart energy center and ESS; 2. Power and communication cable between two ESS 3. PE grounding protection cable of ESS Power cable and communication cables for battery module connection are included in battery package.

Thank you.