Modular Power Conversion Solutions

for
Solar Power
&
Energy Storage

Utility-scale Inverters

Bi-directional PCS

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Modular
Power Conversion Solutions
for
Battery Energy Storage

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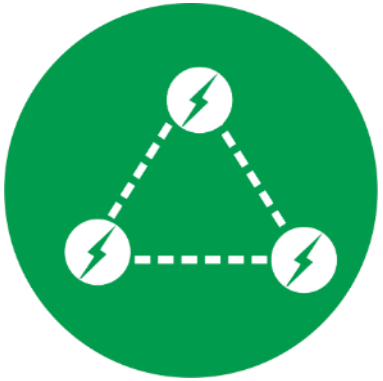
Grid-tied Mode

Off-grid Mode



Backup Mode

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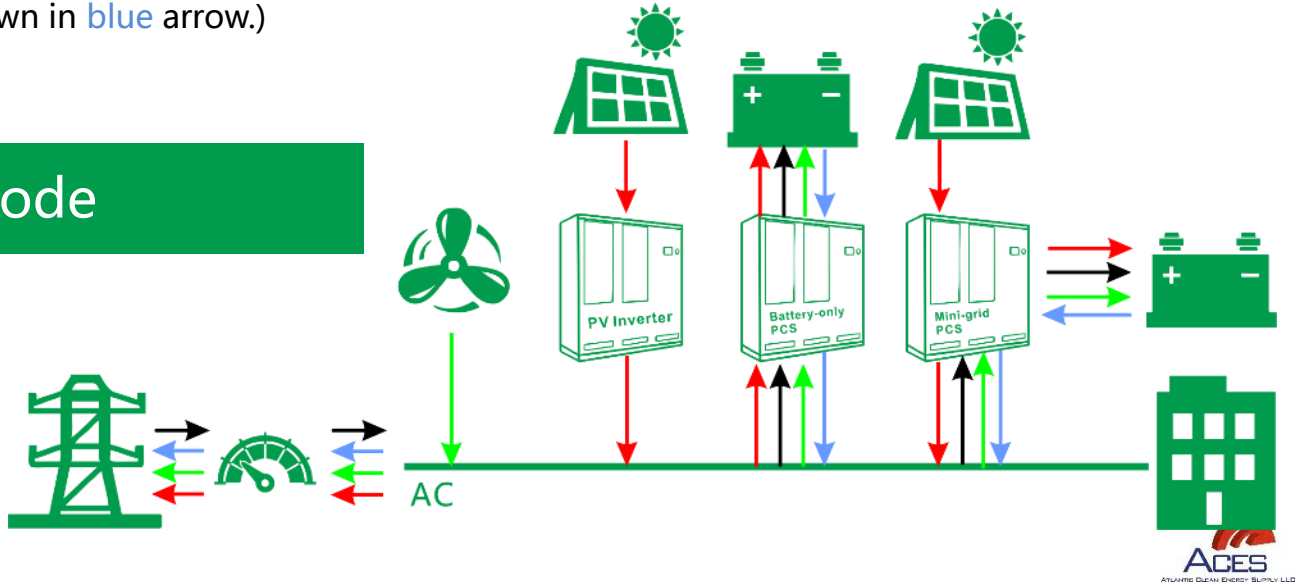
- ***Solar panels*** are connected to AC BUS line through PV Inverter and power the load or sell energy to utility or charge the battery through Battery-only PCS. Or connected to DC BUS line through Mini-grid PCS and charge the battery. Then it will power the load or sell energy to utility through Mini-grid PCS. (As shown in red arrow.)
- ***Wind turbine*** is connected to AC BUS line to power the load and/or sell to utility and/or charge the battery. (As shown in green arrow.)
- ***Grid*** is connected to AC BUS line to power the load and/or charge the battery when there is with grid or with incentive program. (As shown in black arrow.)
- ***Battery*** will be discharged to power the load when there is no renewable energy or sell to utility when there is demand from utility. (As shown in blue arrow.)

Grid-tied Mode

Energy Storage is used to sell back the energy to utility or support grid with frequency/load regulation.



Energy

- Sources Grid
- Capacity -

Load

- Type Commercial
- Average Load 1000W
- Peak Load 1000W
- Working condition 24hr x 7

Battery

- Type: EV battery Pack (LFP)
- Capacity: 40kWh x 40 +240kWh *12

PCS

- Capacity 1.5Mw
- Type 125kw Mini-grid PCS x 8
  4 DC connections per PCS

Name	State Grid Shanghai EV Battery Fast-switching System
Location	Shanghai, China
Date of Operating	Oct of 2013
Application	V2G, EV charging

On-grid Projects

Energy

- Sources Grid
- Capacity -

Load

- Type Commercial
- Average Load
- Peak Load
- Working condition

Battery

- Type: LFP
- Capacity: 1Mwh

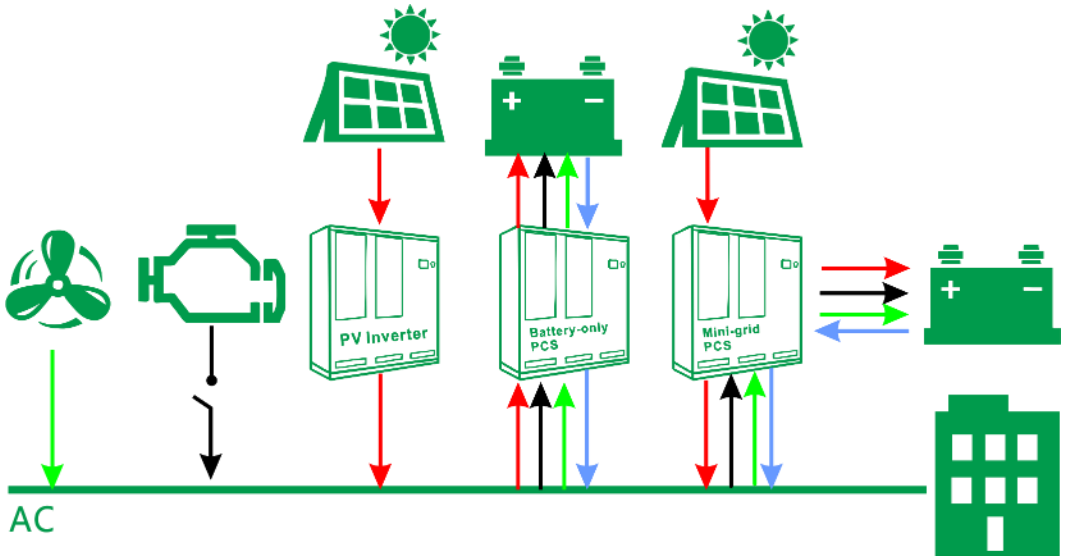
PCS

- Capacity 500Kw
- Type 500kw Battery-only PCS x 1

Name	Tianjin Port Container ESS
Location	Tianjin, China
Date of Operating	May of 2015
Application	Peak shaving

On-grid Projects

- ***Solar panels*** are connected to AC BUS line through PV Inverter and power the load or charge the battery through Battery-only PCS. Or connected to DC BUS line through Mini-grid PCS and charge the battery. Then it will power the load through Mini-grid PCS. (As shown in red arrow.)
- ***Wind turbine*** is connected to AC BUS line to power the load and/or charge the battery. (As shown in green arrow.)
- ***Diesel Gen Set*** is connected to AC BUS line as emergency power supply to power the load and/or charge the battery in accident or insufficient renewable energy. (As shown in black arrow.)
- ***Battery*** will be discharged to power the load when there is no renewable energy. (As shown in blue arrow.)



Energy Storage is used for main power for sites where without grid but with sufficient renewable energy.

Off-grid Mode

Energy

- Sources: PV + Wind
- Capacity: PV : 300kWp
Wind: 750kW x 2

Load

- Type: Residential / Commercial
- Average Load: 1000W
- Peak Load: 1000W
- Working condition: 24hr x 7

Battery

- Type: Lead Carbon + Super Capacitor
- Capacity: 4Mwh Lead Carbon
500Kw x 30s Super Capacitor

PCS

- Capacity: 2.5Mw
- Type: 500kw Battery-only PCS x 4
500kw Mini-grid PCS x 1

Name	Luxi Island Grid-tie Micro-grid
Location	Luxi Island, Zhejiang, China
Date of Installation	Jan of 2014
Application	Backup power/ Renewable Firming

Off-grid Projects

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Energy

- Sources: PV+ Diesel Gen Set
- Capacity: PV: 450kW
Diesel Gen Set: 100kW

Load

- Type: Residential
- Average Load: 100Kw
- Peak Load: 100Kw
- Working condition: Lighting/Home Appliance / Light Industry

Battery

- Type: Lead Acid
- Capacity: 2800Kwh

PCS

- Capacity: 150Kw+450Kw
- Type: 150kw Battery-only PCS x 1
450Kw Mini-grid PCS x 1

Name	Island PV-Diesel-Battery Micro-grid
Location	Semau & Salura, Indonesia
Date of Operating	Nov of 2013
Application	Off-grid Power

Off-grid Projects

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Energy

- Sources PV
- Capacity 80Kw x 25

Load

- Type Residential
- Average Load 10Kw x 25
- Peak Load 10Kw x 25
- Working condition Lighting/Home appliance

Battery

- Type: Lead Acid
- Capacity: 40Kwh x 25

PCS

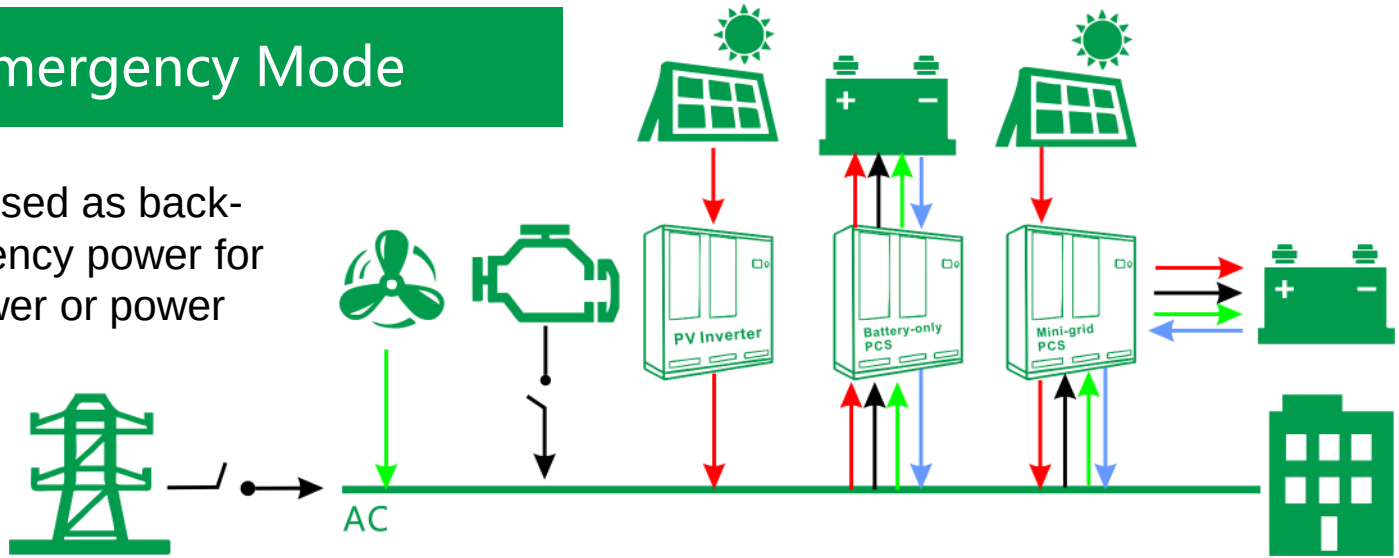
- Capacity 2Mwh
- Type 80kw Battery-only PCS x 25

Name	Qinghai Yushu Village Electricity
Location	Yushu, Qinghai, China
Date of Operating	Jun of 2015
Application	Off-grid Power

Off-grid Projects

Back-up / Emergency Mode

Energy Storage is used as back-up power or emergency power for inadequate grid power or power outage.



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- ***Wind turbine*** is connected to AC BUS line to power the load and/or charge the battery. (As shown in green arrow.)
- ***Diesel Gen Set*** is connected to AC BUS line as emergency power supply to power the load and/or charge the battery in accident or insufficient renewable energy. (As shown in black arrow.)
- ***Battery*** will be discharged to power the load when there is no grid. (As shown in blue arrow.)

Energy

- Sources: Grid + PV + Wind
- Capacity: PV 200kW
Wind 50kW

Load

- Type: Commercial
- Average Load: 100Kw
- Peak Load: 100Kw
- Working condition: 24 x 7

Battery

- Type: VRB
- Capacity: 200Kwh

PCS

- Capacity: 125Kw
- Type: 125kw Mini-grid PCS x 1

Name	Wuhan Future City Wind-PV-battery Micro-grid
Location	Wuhan, Hubei, China
Date of Operating	Mar of 2014
Application	Peak shaving

Backup/Emergency Projects

Commercial
30kW-150kW

Industrial
200-500kW

Utility
500kW-Mws

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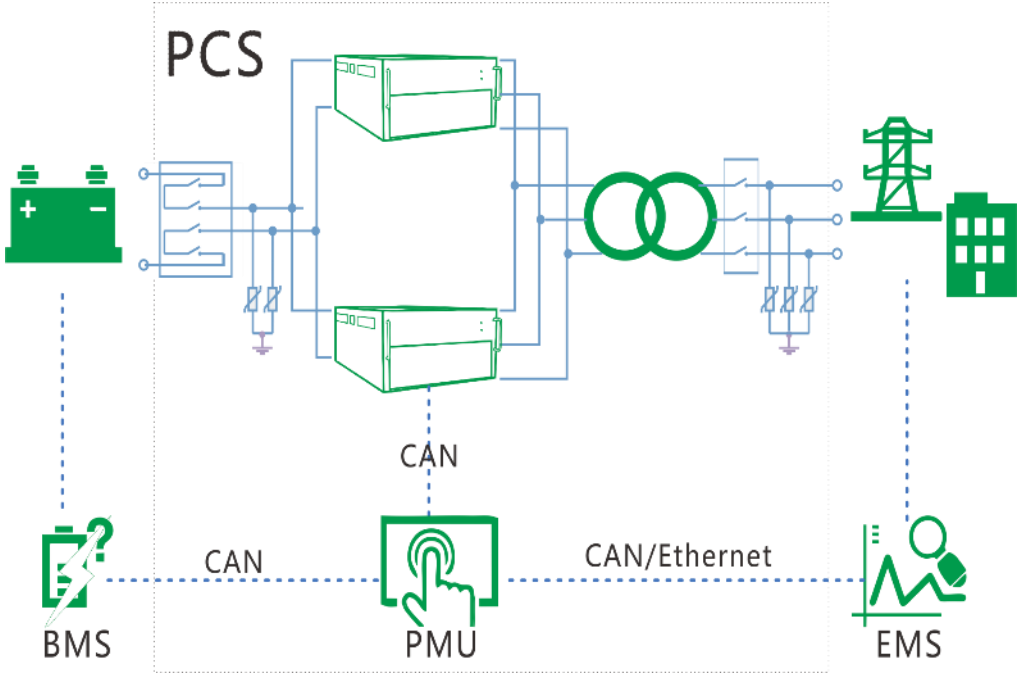
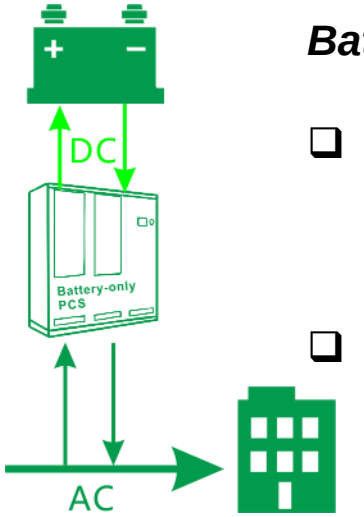
Parts of Battery Energy Storage



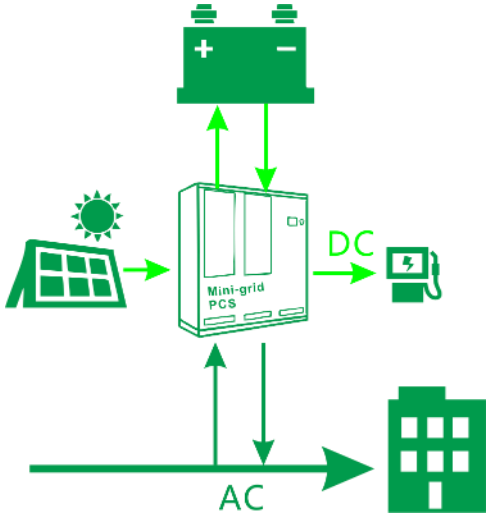
- **PCS** (Power Conversion System)
  - Power Module
  - PMU (Power Management Unit)
  - Switches/SPD/Transformer, etc.
- **BMS** (Battery Management/Monitoring System)
- **EMS** (Energy Management System)

Products Platform



Battery-only PCS

- ***Connections:***
  DC x 1
  AC x 1
- ***Application:***
  AC coupled with load and other energy input.

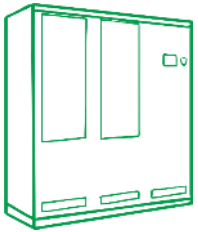


Mini-grid PCS

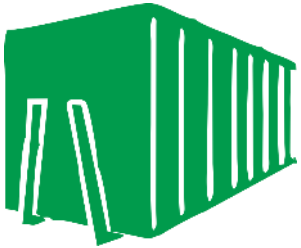
- ***Connections:***
  DC x 2 or 3
  AC x 1
- ***Application:***
  AC and/or DC coupled with PV / load. AC coupled with other energy input.

Our Solutions

Power Module + PMU



PCS Products



ESS Products

Power Module + PMU

- 50Kw DC-DC / DC-AC Bi-directional Module

- 30Kw DC-AC Bi-directional Module

- Power Management Unit

PCS Cabinet/Container

❑ 30-150kw

❑ 150-250kw

❑ 250-500kw

❑ 500k-2Mw

ESS Package/Container

- Cabinet

+

Battery Pack

- Container

- 20ft :
  100-300Kw PCS +
  300-400Kwh Battery

- 40ft :
  300-500Kw PCS +
  500-1000Kwh Battery

Technical Strength

Modular design

- Independent module, plug-and-play
- Easy-to-customize and reach high capacity per unit
- Stable & easy-to-maintenance
- Light weight, easy-to-ship and easy-to-install

3 level switch	Lower voltage-endurance, and switch loss of power components	High efficiency, more energy
High frequency	Small size e-cap and no big reactance	Smaller, lighter, easy-to-install
Multi-step voltage	Low harmonic & less THD.	Good power quality
Easy-to-design in modules	Easy-to-maintain for large power application	Improved stability.

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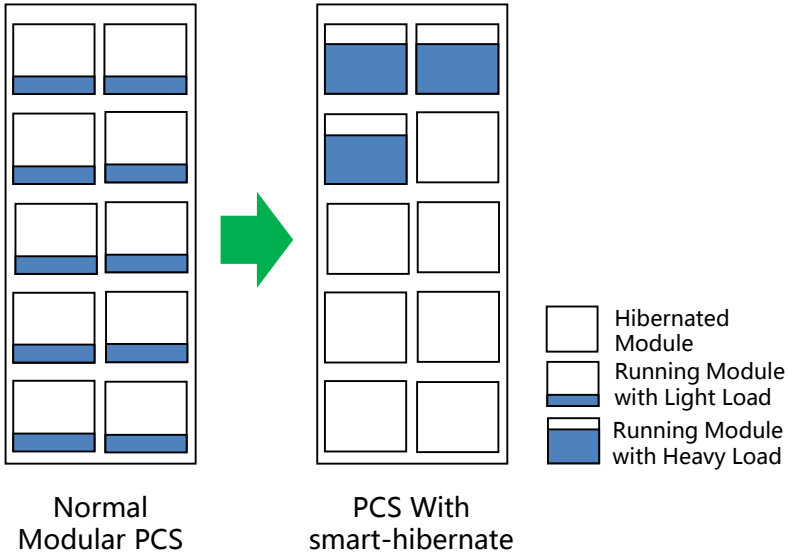
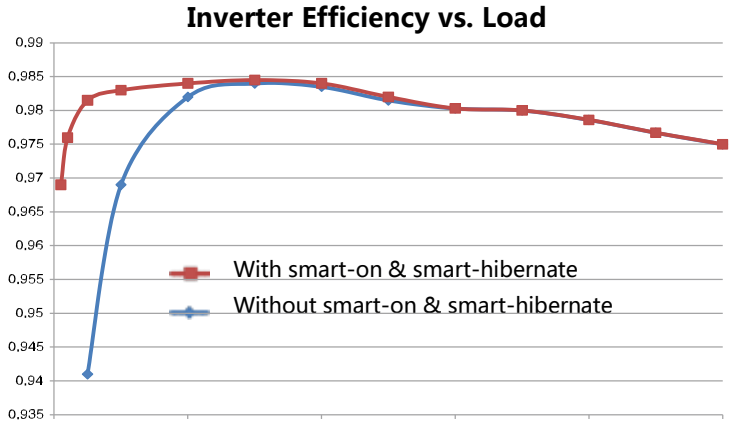
Smart-hibernate

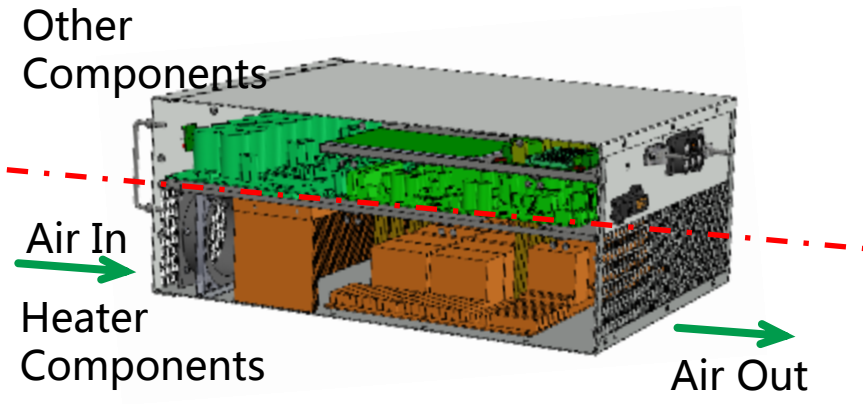
- Maintain higher efficiency for light load application.
- Improve energy generated by reducing no-load consumption
- Improve power quality of electricity generated
- Extend life time of inverter system by balancing working load and time between modules.





- Adapted for various environments.
- Improved stability by eliminating impacts on sensitive components of wind /dust and moisture.
- Improved cooling efficiency with independent wind-channel and straight-through wind cavity.

Separate the heater elements from other components



Independent wind-channel

Power monitoring & management system

- Various interface for information: Touchscreen, PC and remote.
- Real-time tracking on working status, voltage and current and other energy info.
- Data and curve are available to download and shared.
- Easy-to-customize, with sockets RS485/RJ45 and MODBUS comm. protocol.

Safe & Reliable

- Full protection:
  - AC voltage and frequency upper/lower limit.
  - Overcurrent/Undercurrent, Phase sequence error, Surge protection
  - DC: Overcurrent, Over-voltage/Under-voltage/Reverse power
  - Over-temperature, Over-load
  - Anti-islanding (On/Off)
  - Emergency Power Off(EPO) alarm & button
  - Fan and relay protection prevent damage on converter.

IEC 62109

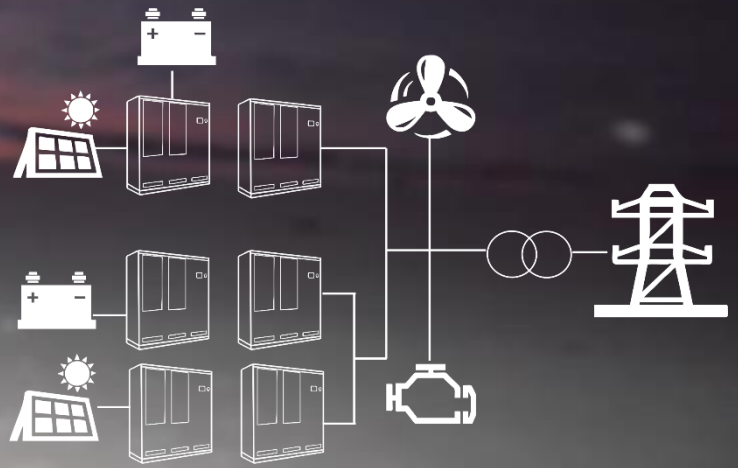
IEC 62477

IEC 61727

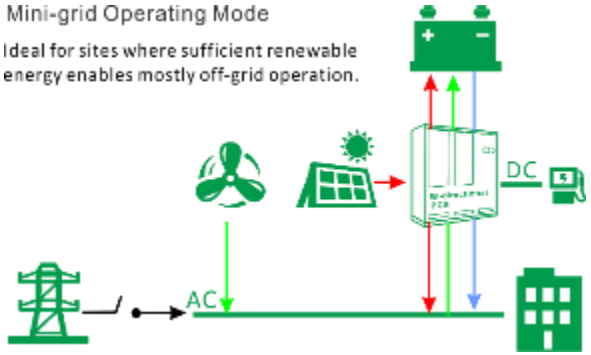
IEC 62116

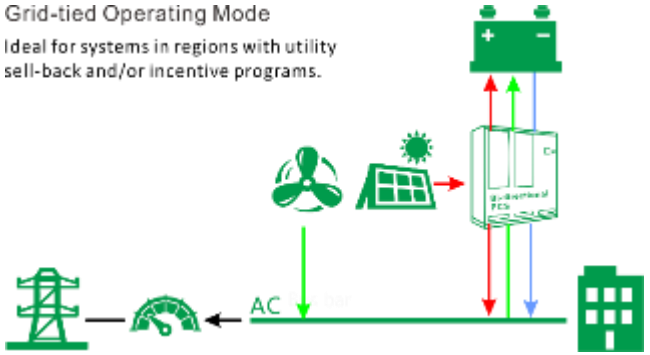
Commercial & Industrial Solution for Energy Storage

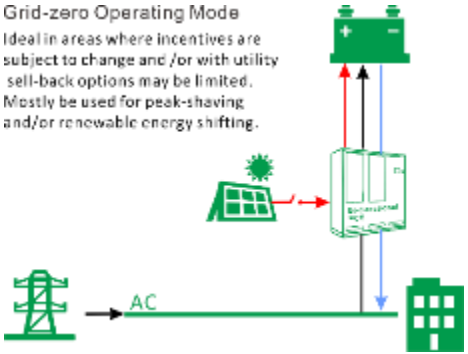
- Two series: Battery-only PCS & Mini-grid PCS
- Flexible control strategy for Energy-time-shift, Emergency-power-backup, Energy-shortage-support, Grid-optimize, Battery-generator
- Auto prompt switch between on-grid and off-grid status
- Modular design and simple structure.
- Easy-to-install, easy-to-maintain and easy-to-expand.
- High-voltage enables high efficiency, up to 95% with transformer.
- Customizable configuration optimized for cost and reliability.
- Active and reactive power management, improved power quality.

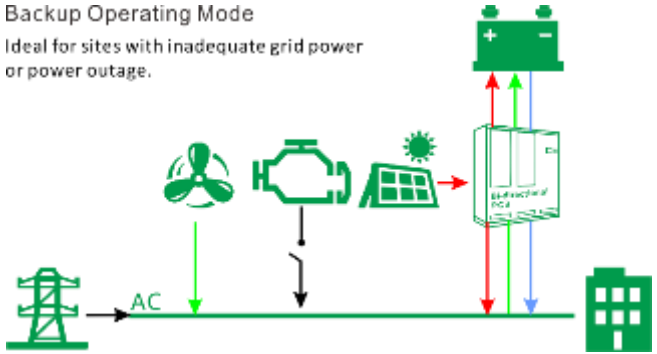


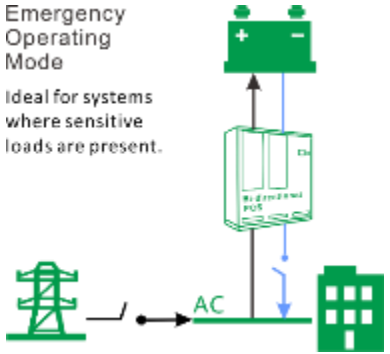
Various operating mode for different applications











Leading Technologies

- **Black start with load**. The PCS could restore the whole system with load automatically instead of switch off the load and on manually.

- **Multiple DC inputs with different voltage** for large scale ESS. More DC inputs with different rated voltage could be connected to the PCS to get better utilization of different class of batteries.

- **Off-grid parallel connection of multiple units** for large scale (MW) ESS. Auto-detection and operating as voltage or current source when more than one units are parallel connected to support large off-grid application.

Basic	
Response time (Charging/Discharging) (From 0 A to max current)	≤ 50ms
Switching time (Between on-grid and off-grid)	≤100ms(Customizable)
AC grid connection type	3P4W / 3P3W (With transformer)
Battery related	
DC voltage range	500-800V
DC voltage/current tolerance	≤1%(Effective)
Ripple coefficient of DC voltage/current	≤1%(Effective), ≤2.5%(Peak)
On-grid	
AC voltage	400V, -25% to +15% (Programmable)
AC frequency	50Hz, ±4.5Hz (Programmable)
Output THDi (@ Grid THDv <1% and over half load)	<5%
Power factor	-1 to +1 adjustable
Output DC component	< 0.5%
Grid charging/discharging method	Constant current and/or constant power, 3-steps charging (Fast-slow-trickle)
Off-grid	
AC voltage Rated	400V
AC frequency Rated	50Hz
DC voltage component	≤200mV
Output voltage tolerance	≤1%
Output frequency tolerance	≤0.1Hz
Output THDv (@ Lineal load)	≤2%
Voltage dynamic range (@ Resistance load: 0 to 100% to 0)	≤8%
Voltage dynamic recovery time (Normal mode, with full resistance load and recover to ±3% rated voltage)	≤20ms
Overload capability	@ 105% to 115% Load >10min @ 115% to 125% Load >1min @ 125% to 150% Load >200ms

System	
Protection	Over-temperature, Over-load, AC over/under voltage, AC phase reverse, EPO (Emergency power off), Fan/Relay failure, Programmable parameters: AC voltage/frequency upper and lower limit, EOD (End-of-discharging) voltage of battery.
Max. efficiency	Up to 97%(Without transformer) Up to 95.5%(With transformer)
Isolation	Power frequency
Cooling	Forced air-cooling
Noise	≤75dB
Communication protocol	Modbus TCP/IP
Communication socket	LAN / RJ485 / CAN
Working temperature	-20~50℃
Environmental protection rating	IP20

PWS1 Series Battery-only Bidirectional PCS

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Basic	
Response time (Charging/Discharging) (From 0 A to max current)	≤ 50ms
Switching time (Between on-grid and off-grid)	≤100ms(Customizable)
AC grid connection type	3P4W / 3P3W (With transformer)
Battery related	
DC voltage range	***250-750V***
DC voltage/current tolerance	≤1%(Effective)
Ripple coefficient of DC voltage/current	≤1%(Effective)
On-grid	
AC voltage	400V, -25% to +15% (Programmable)
AC frequency	50Hz, ±4.5Hz (Programmable)
Output THDi (@ Grid THDv <1% and over half load)	***<3%***
Power factor	-1 to +1 adjustable
Output DC component	< 0.5%
Grid charging/discharging method	Constant current and/or constant power, 3-steps charging (Fast-slow-trickle)
Off-grid	
AC voltage Rated	400V
AC frequency Rated	50Hz
DC voltage component	≤200mV
Output voltage tolerance	≤1%
Output frequency tolerance	≤0.1Hz
Output THDv (@ Lineal load)	≤2%
Voltage dynamic range (@ Resistance load: 0 to 100% to 0)	≤8%
Voltage dynamic recovery time (Normal mode, with full resistance load and recover to ±3% rated voltage)	≤20ms
Overload capability	@ 105% to 115% Load >10min @ 115% to 125% Load >1min @ 125% to 150% Load >200ms

System	
Protection	Over-temperature, Over-load, AC over/under voltage, AC phase reverse, EPO (Emergency power off), Fan/Relay failure,
	Programmable parameters: AC voltage/frequency upper and lower limit, EOD (End-of-discharging) voltage of battery.
Max. efficiency	***Up to 97.5%***
Isolation	***Non-isolated***
Cooling	Forced air-cooling
Noise	≤75dB
Communication protocol	Modbus TCP/IP
Communication socket	LAN / RJ485 / CAN
Working temperature	-20~50℃
Environmental protection rating	IP20

PWS2 Series Battery-only Bidirectional PCS

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Model List

	PWS2 -30K	PWS2 -60K	PWS2 -120K	PWS1 -50K	PWS1 -100K	PWS1 -150K	PWS1-250K	PWS1 - 500KTL	PWS1 500K-MW
									
Output									
Rated output power (KW)	30	60	120	50	100	150	250	500	500K-1MW
Rated Max. AC current (A)	44	88	176	72	144	216	360	720	720-1440
Rated Max. charging/ discharging current (A)	80	160	320	100	200	300	500	1000	1000-2000
Phisical									
Dimension (W / H / D) mm	800*1600*600			800*2160*800			1200*2160*800	1800*2160*800	Customizable
Weight (kg)	50	80	140	360	600	750	1050	950	

Battery related	
DC voltage range	250-520V
DC voltage tolerance	≤0.5%(Effective)
DC current tolerance	≤1%(Effective)
Ripple coefficient of DC voltage/current	≤1%(Effective)
PV related	
PV voltage range	500-900V
MPPT voltage range	520-850V
Max. PV current	≤260A
On-grid	
AC voltage	400V, -25% to +15% (Programmable)
AC frequency	50Hz, ±4.5Hz (Programmable)
Output THDi (@ Grid THDv <1% and over half load)	<5%
Power factor	-1 to +1 adjustable
Output DC component	< 0.5%
Grid charging/discharging method	Constant current and/or constant power, 3-steps charging (Fast-slow-trickle)
Off-grid	
AC voltage Rated	400V
AC frequency Rated	50Hz
DC voltage component	≤200mV
Output voltage tolerance	≤1%
Output frequency tolerance	≤0.1Hz
Output THDv (@ Lineal load)	≤2%
Voltage dynamic range (@ Resistance load: 0 to 100% to 0)	≤8%
Voltage dynamic recovery time (Normal mode, with full resistance load and recover to ±3% rated voltage)	≤20ms
Overload capability	@ 105% to 115% Load >10min @ 115% to 125% Load >1min @ 125% to 150% Load >200ms

Basic	
Response time (Charging/Discharging) (From 0 A to max current)	≤ 50ms
Switching time (Between on-grid and off-grid)	≤100ms(Customizable)
AC grid connection type	3P4W / 3P3W (With transformer)

System	
Protection	Over-temperature, Over-load, AC over/under voltage, AC phase reverse, EPO (Emergency power off), Fan/Relay failure,
	Programmable parameters: AC voltage/frequency upper and lower limit, EOD (End-of-discharging) voltage of battery.
Max. efficiency	Up to 97%(Without transformer) Up to 95.5%(With transformer)
Isolation	Power frequency
Cooling	Forced air-cooling
Noise	≤75dB
Communication protocol	Modbus TCP/IP
Communication socket	LAN / RJ485 / CAN
Working temperature	-20~50℃
Environmental protection rating	IP20

Mini-grid Bidirectional PCS

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Model List

	PWG2 -50K	PWG2 -100K	PWG2 -125K	PWG2 -150K	PWG2 -250K	PWG2- 500Kw to Mw
						
Rated power (KW)	50	100	125	150	250	**500Kw to Mw**
Maximum current (A)	130	260	325	390	750	Customizable
Dimension (W / H / D) mm	800*2160*800	1200*2160*800		1800*2060*800		

Location	Installation	Application	User/Project name	Cap(KW)
China	Sep-12	Off-grid power / Backup power	Shengshan Island Ocean renewable energy	100
Indonesia	Nov-13		Semau Island PV-Diesel-Battery Micro-grid	150
China	Jan-14		Luxi Island Grid-tie Micro-grid	2500
China	Jun-15		Qinghai Yushu Village Electricity	2000
China	Dec-13	Peak-shaving /Demand Charges	PV-Battery Electricity for Urumqi Municipal Building	50
China	Dec-13		Chenjiazhen Ind. Park	200
China	Mar-14		Wuhan Future City Wind-PV-battery Micro-grid	125
China	Apr-14		Nanning Electric Utility	150
China	May-14		Chery Automobile Recycling Burn-in & Energy Storage	200
China	May-14		Dynavolt Power Tech, Fujian	100
China	Dec-14		Anhui Hengrui New Energy	250
China	May-15		Tianjin Port Container ESS	500
China	Oct-12	Grid support /Renewable firming /Frequency regulation	China Aviation Lithium Battery Co.,	100
China	Oct-13		State Grid Shanghai EV Charger Station	1500
China	Mar-14		China Smart Construction Co. PV-diesel-battery Micro-grid	50
China	Sep-14		Shenzhen Polytechnic	50
China	Dec-14		Yunnan Honghe College	50

Energy Storage Track Records

ACES
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Thank You

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