BILLION

CASE STUDY

Innovative Solar Energy Storage
A Greener Future

Billion Solar Energy Storage Microgrid Solutions

Empowering Pacific Island Countries to Achieve Energy Revolution

The integrated solar storage system converts sunlight into electricity, stores excess energy, monitors power generation, and discharges electricity when needed, reducing dependence on the power grid.

- Enhance renewable energy usage
- On-grid operation
- Solar-Plus-Storage microgrid
- Stabilize self-sufficient power

Innovative Solar-Plus-Storage Systems for Sustainable Energy Use

As climate change intensifies and energy costs continue to rise, Pacific Island countries are facing severe energy supply challenges. Billion Group implemented innovative solar-plus-storage microgrid solutions in Palau, the Marshall Islands, and Tuvalu to achieve energy independence and low-carbon development, setting a successful benchmark for energy transition in island countries.

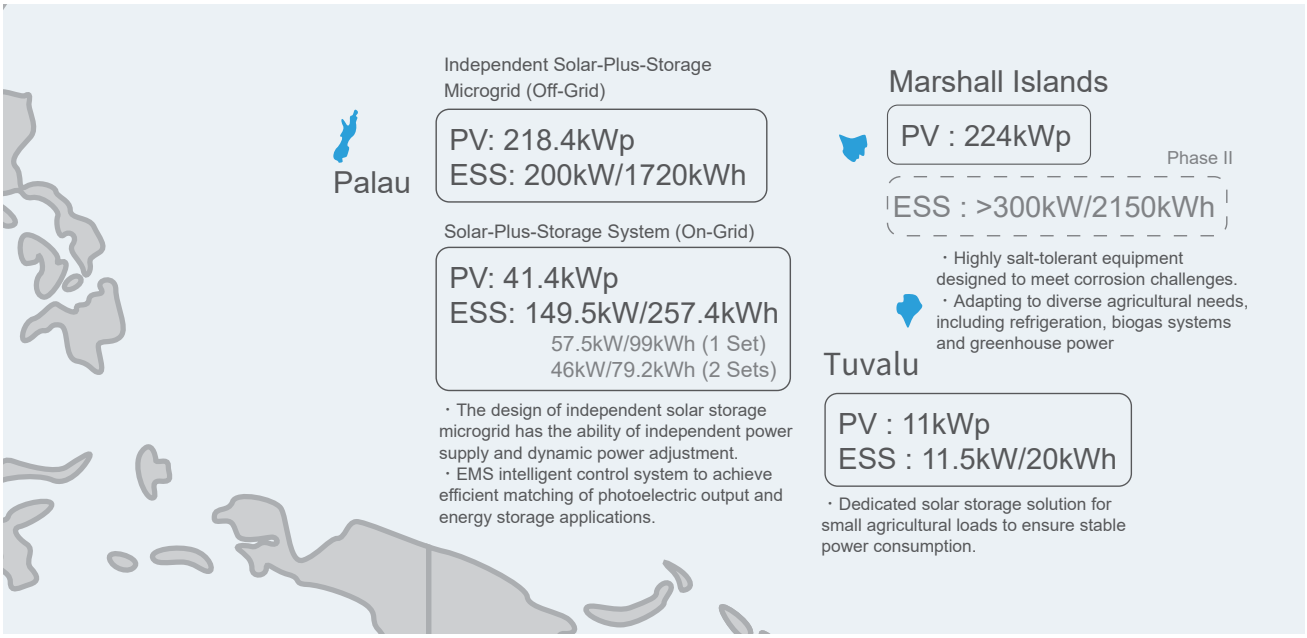
Challenges for Pacific Island Countries

Challenges	Solutions
Insufficient Infrastructure The dispersion of the islands makes it difficult to transmit power and deploy the system.	**Modularized Solar Energy Storage Systems** Modular systems tailored to remote islands' infrastructure conditions Introduce remote monitoring technology and localized installation design to reduce on-site manpower dependence.
High Energy Costs 97.5% reliance on imported diesel leads to high costs and significant carbon emissions.	**Solar-Plus-Storage Systems** Deploy efficient energy storage systems to reduce fuel use and ensure stable power supply. EMS intelligently regulates the matching of solar energy and storage, reduces the proportion of diesel and electricity used, and improves the energy efficiency of the system.
Extreme Climate Impacts Hurricanes, rainfall, and high temperatures threaten energy facilities. Saline environments can cause equipment corrosion and failures, increasing maintenance costs.	**High Equipment Durability** Corrosion-resistant materials (e.g. 304) and waterproof design improve the durability of the equipment. Strengthen infrastructure improves stability under extreme weather conditions.
Technical Constraints Lack of skilled engineering, procurement, and construction (EPC) teams, affecting the efficient implementation of the project. Insufficient infrastructure in remote areas limits the transportation and installation of large equipment.	**Technical Transfer and Training Plan** Develop remote management to support real-time operation and troubleshooting via cloud monitoring, reducing reliance on local teams. Equipment selection is based on high durability and the ability to adapt to extreme environments, reducing the need for maintenance and ensuring stable system operation.

"Billion and Billion Watts' engineering teams have the ability to plan independent microgrids, integrate photovoltaics and energy storage, and overcome the common mutual exclusion of photovoltaic and storage integration. The disturbance caused by the weather (sunshine) of solar photovoltaics will make the voltage source established by the off-grid operation of the PCS unstable, and the Billion' s PCS can respond in a very short time and solve the problem perfectly.
Additionally, the EMS controls the output power of PV inverters and adjusts it dynamically based on battery capacity. The EMS control will match the application of solar power generation and PCS to achieve optimal operation. Billion and Billion Watts' strength lies in tailoring solutions to customer requirements and applications, delivering the most comprehensive and well-considered plans."

— Mr. Alex Hsieh, Product Director of Billion Group

Overall Construction Scale



Highlights & Solutions

A. Integrated Solar-Plus-Storage System (On-Grid)

Dynamically adjust the power system at any time to optimize electricity costs and resource utilization

・**Efficient Power Storage:** Solar PV > Load, the load is powered by solar energy, with excess electricity charging the storage battery

・**Intelligent Backup:** Solar PV < Load, both solar power and the storage battery supply the load (the battery is prioritized, with grid power used only when the battery is insufficient).

・**Pure Energy Storage Power Supply:** Solar PV does not generate electricity and the battery capacity is sufficient, and the load is supplied by the energy storage battery.

・**Grid Support and Energy Storage Charging:** Solar PV does not generate electricity and the battery capacity is insufficient, and the grid powers the load and optionally charges the battery as per scheduled settings.

B. Independent Solar-Plus-Storage Microgrid (Off-Grid)

Delivers stable, self-sufficient power to the entire area.

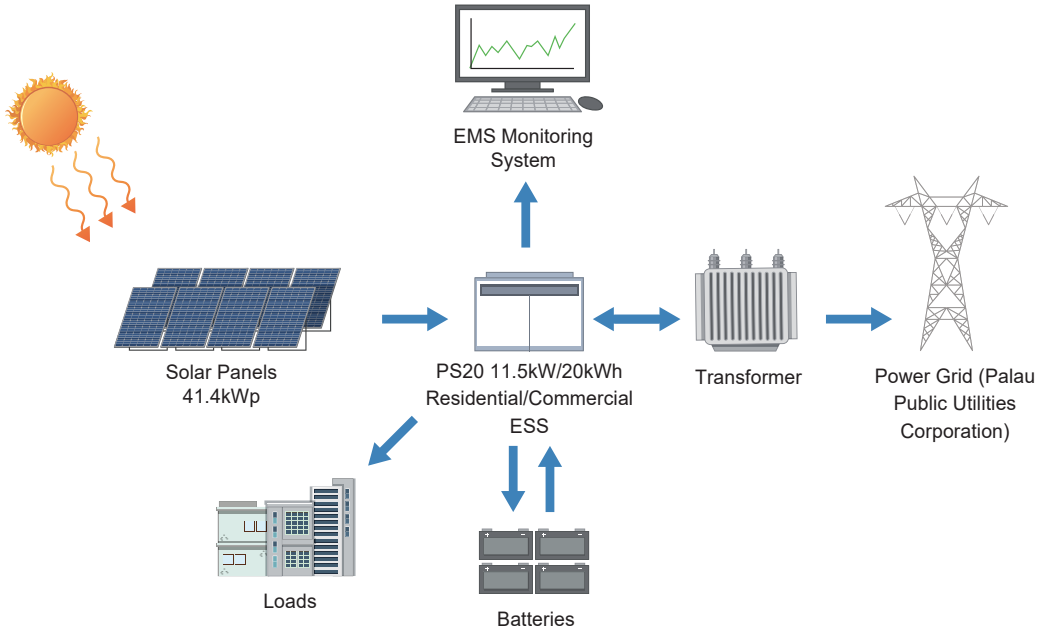
・**PCS Parallel Connection:** Through PCS parallel, the solar storage microgrid can be separated from the power company to build an independent power system to provide a stable supply for the load.

・**Dynamic Power Adjustment:** The EMS (Energy Management System) dynamically adjusts PV inverter output based on battery capacity. Excess energy is stored in the battery when generation exceeds load demand, and the storage system supplies power when generation is insufficient.

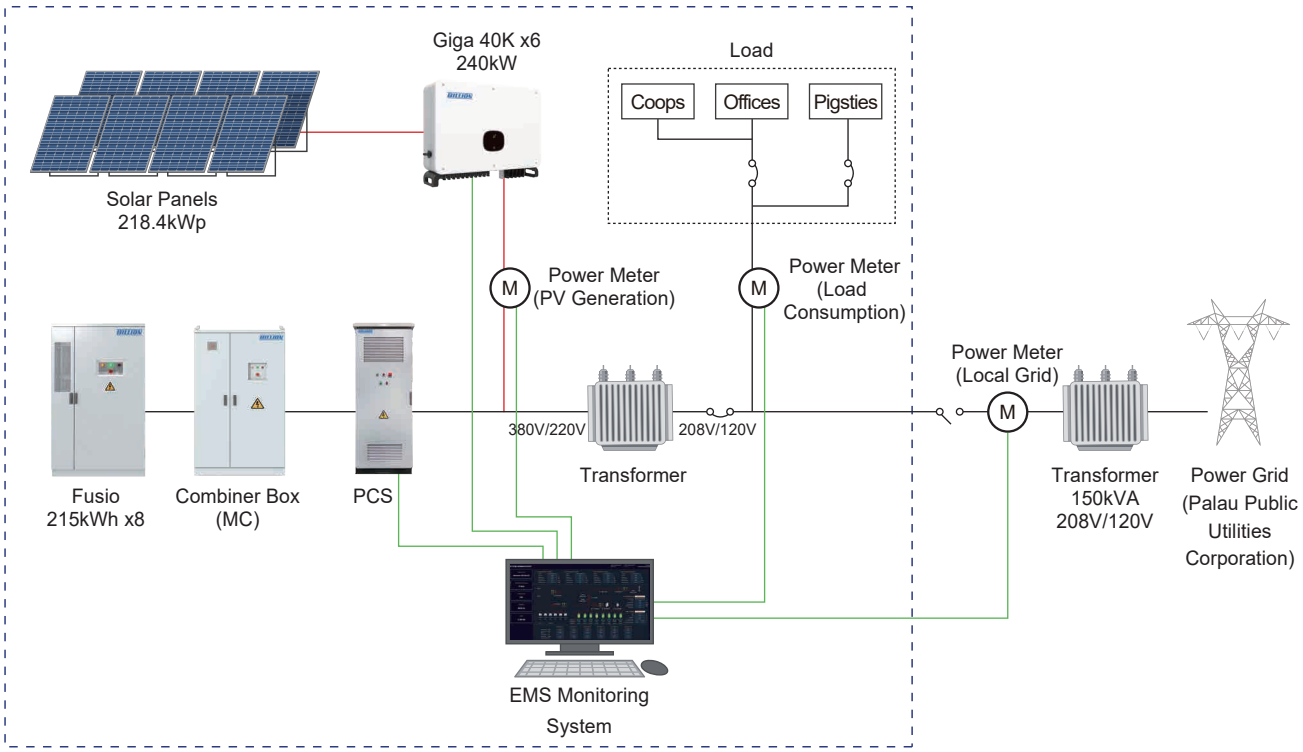
・**Maximize Power Generation Efficiency:** The built-in MPPT of PV inverters continuously tracks the maximum power point, ensuring optimal efficiency.

・**Bidirectional Charging and Discharging:** Supports DC & AC bidirectional charging and discharging, allowing excess power to be stored flexibly for stable supply during nighttime or low sunlight conditions.

Integrated Solar-Plus-Storage System



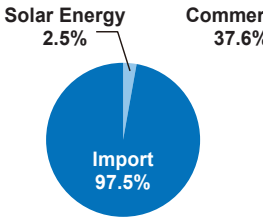
Independent Solar-Plus-Storage Microgrid



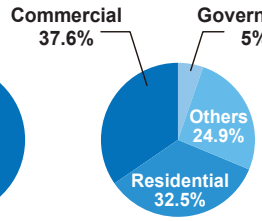
Success Story - Palau

Self-Sufficient Energy and Efficient Utilization

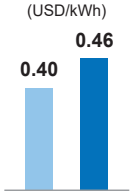
Palau has long relied on imported diesel for power generation, which has high electricity prices and serious carbon emissions. Agriculture, fishery facilities and residential electricity demand are diverse, and there is an urgent need for a stable and sustainable supply of green energy.



Energy Source Proportion



Electricity Consumption



Average electricity price

Why is Palau suitable for a solar-plus-storage microgrid solution?

Rich solar energy resources:
Long sunlight hours and rich solar energy make it ideal for solar power development.

Reduce reliance on imported fuel and lower power generation costs:
Imported fuel is costly, and solar-plus-storage can reduce fuel dependence. Solar power generation costs have been declining yearly, offering better cost-efficiency than fuel-based generation and enhancing energy independence.

Overcome geographical constraints and respond to disasters:
The island's terrain makes centralized large-scale power transmission challenging and costly. A solar-plus-storage microgrid system allows for distributed deployment with high flexibility and recoverability, making it an ideal choice for post-disaster power recovery.

The island climate enhances photovoltaic operation efficiency:
Frequent rainfall naturally cleans solar modules, significantly reducing maintenance and cleaning costs and optimizing site operation efficiency.

Energy Demand and Goal

Area	Area (m^2)	Monthly Avg. Electricity Usage (kWh)	Goal
Area A (demonstration farm)	88.78	2,000	Achieve over 50% green energy proportion
Area B (livestock house, office, and dormitory)	1,934.69	24,900	Achieve 100% green energy proportion
Area C (aquaculture center)	223	5,000	Achieve 50% green energy proportion

Applications of Equipment Requirements

Area	Equipment
Area A (demonstration farm)	Refrigerators, air pumps, electric fans, lights, etc.
Area B (livestock house, office, and dormitory)	Air conditioners, incubators, industrial fans, high-pressure sprayers, solid-liquid separators, submersible pumps, ceiling fans, freezers, refrigerators, heaters, lights, etc.
Area C (aquaculture center)	Blowers, water pumps, freezers, air conditioning for feed storage rooms, etc.

Challenges

Area A (demonstration farm)

・Structural Limitation: The existing structure of the agricultural machinery shed is simple, with the roof support mainly composed of wooden stakes and cement used only at the base for fixation. This design has high requirements for load-bearing capacity and is challenging to construction

・Power Demand and Configuration: The meter box in Area A is approximately 4.57 to 6.09 meters away from the agricultural shed, with primary power needs of 110V, while some large machinery requires 220V, which requires additional consideration of power distribution and stability.

・Insufficient Network Construction: No Wi-Fi and poor communication quality, which affects the real-time performance of equipment monitoring and energy management.

Area B (livestock house and dormitory)

・High Demand for Green Electricity: 24,900kWh of electricity per month, 218.4kWp of solar energy and 1720kWh of energy storage capacity need to be built.

・Insufficient Grid Capacity: The total capacity of the Palau power grid transformer is only 150kVA, which cannot carry the excess power of solar energy.

Area C (aquaculture center)

・Inadequate infrastructure: Buildings have not yet installed electricity meters, which affects power access and energy management system deployment.

Solutions

Area A (demonstration farm)

Supports the operation of agricultural equipment such as refrigerators, farm lighting and tools, and is suitable for small distributed load scenarios.

Solar-Plus-Storage System

Solar PV Capacity - 12.74kWp

Energy Storage Capacity - 79.2kWh

Equipment Used - PS20 Residential/Commercial Energy Storage System (4 Units)

Area B (livestock house and dormitory)

EMS intelligently controls the matching of solar storage and load, provides all-weather power supply for agricultural facilities, offices and dormitories, and supports independent off-grid operation in the whole area.

Independent Solar-Plus-Storage Microgrid System

Solar PV Capacity - 218.4 kWp

Energy Storage Capacity - 1720 kWh

Equipment Used - Giga 40K Inverters (6 Units), Fusio 215kWh Commercial & Industrial Energy Storage Cabinet (8 Units), BNP100K Power Conditioning Systems (2 Units)

Area C (aquaculture center)

Stable support for pumping, freezing and feed preservation equipment operation, green electricity coverage rate of 50%.

Solar-Plus-Storage System

Solar PV Capacity - 28.67kWp

Energy Storage Capacity - Area A: 178.2kWh

Equipment Used - PS20 Residential/Commercial Energy Storage System (9 Units)

Results

Palau’ s success story fully demonstrates the technical expertise and innovative strength of Billion Group in the field of photovoltaic storage microgrid, and successfully helps Palau achieve energy self-sufficiency and significant reduction of carbon emissions through customized green energy solutions. This not only meets the diverse electricity needs of local agriculture, fisheries and residents, but also provides a replicable demonstration of energy transition for other Pacific Island countries.

- Improve Area A/C energy efficiency
- Area B achieved 100% self-sufficient green electricity

- Reduce CO2 emissions by 800 tons per year
- Promote energy independence and carbon reduction goals

- Benchmark for renewable energy applications
- Provide replicable success stories

- Reduce the cost of imported fuel
- Enhance energy supply stability

Area A (demonstration farm)

Supports the operation of agricultural equipment such as refrigerators, farm lighting and tools, and is suitable for small distributed load scenarios.

PV 12.7 kWp

Energy Storage 46kW/79.2kWh

Area B (livestock house and dormitory)

EMS intelligently controls the matching of solar storage and load, provides all-weather power supply for agricultural facilities, offices and dormitories, and supports independent off-grid operation in the whole area.

PV 218.4 kWp

Energy Storage 200kW/1720kWh

Area C (aquaculture center)

Stable support for pumping, freezing and feed preservation equipment operation, green electricity coverage rate of 50%.

PV 28.6 kWp

Energy Storage 103.5kW/178.2kWh

Success Story - Tuvalu

Creating Self-Sufficient Energy Solutions for Smallholdings

Tuvalu, one of the smallest and most fragmented countries in the Pacific Islands faces multiple challenges of extreme weather, poor infrastructure and high electricity costs. Billion Group provided flexible and efficient solar-plus-storage solutions to ensure reliable energy for smallholding loads and residents' urgent power needs.

Project Background

Tuvalu has long relied on diesel power generation, but the geographic dispersal of the islands and resource transport limitations have resulted in high generation costs and significant carbon emissions. As part of the Pacific Islands Green Energy Plan, Tuvalu urgently needed a cost-effective, low-carbon, and efficient energy solution to address infrastructure constraints and improve energy sustainability.

Electricity Demand and Construction Goals

Location	Area (m^2)	Monthly Avg. Electricity Usage (kWh)	Goal
Funafuti Farm	825	550	Build green energy, achieving over 100% renewable energy proportion

Demand	Equipment
Smallholding loads and emergency power needs, ensuring 24-hour electricity supply	Refrigerated cabinets, water pumps, fans, lights, etc.

Challenges

Limited Power Sources

・As a small island country, Tuvalu heavily depends on diesel power generation, resulting in high fuel costs and unstable supply.

・Long-term power outages and unstable power supply have affected the daily lives and business activities of local residents.

Environmental Challenges

・Island regions face extreme climate challenges, which place stringent demands on the stability and durability of the power system.

・Need to build energy solutions that are durable and efficient.

Energy Transition Needs

・Unstable power supply for agricultural facilities affects critical needs like irrigation, refrigeration, and lighting.

・Lack of energy storage to provide stable power at night or in severe weather.

・The local government is committed to reducing carbon emissions and promoting the integration of renewable energy and storage technologies.

Solutions

Solar-Plus-Storage System

Solar PV Capacity - 10.92kWp

Energy Storage Capacity - 19.8kWh

Equipment Used - PS20 Residential/Commercial Energy Storage System (1 Unit)

Implementing Energy Storage Solutions

The integrated solar-plus-storage system combines solar power generation with energy storage technology to deliver stable, efficient, and all-weather energy supply:

・Stable Power Supply: Provides continuous and stable electricity, addressing frequent power outages.

・Efficient Management: Optimizes energy distribution and real-time monitoring through the smart energy management system.

・Environmental Adaptability: Durable design and high safety to adapt to the extreme climatic conditions of Tuvalu.

・Scalability: Supports flexible expansion to meet future energy demand growth.

High Performance and Safety Assurance

・The ESS uses LiFePO4 batteries, offering high safety and long lifespan.

・Supports IP65 protection standards, ensuring stable operation under severe climate conditions.

Energy Conservation and Emissions Reduction

・Reduce reliance on diesel power generation and reduce carbon emissions while increasing local energy independence.

Results

Satisfy the energy needs of smallholdings loads and emergency power demands, ensuring 24-hour power supply.

The implementation of the solar-plus-storage solution successfully addressed Tuvalu’ s energy supply issues, achieving both economic and environmental benefits. It not only improved local living standards but also set a benchmark for sustainable energy transitions, serving as a model for other small island countries.

Enhance Energy Management Capabilities

・Smart monitoring and remote management

・Significantly reduce operational and maintenance costs

Promote Sustainable Development

・Reduce carbon emissions

・Support clean energy transition in Tuvalu

Stabilize Power Supply

・Improve local power stability

・Greatly alleviate the inconvenience caused by power outagestransition in Tuvalu

Reduce Energy Cost

・Substantially reduce reliance on diesel power generation

・Lower imported fuel expenses

PV 10.92 kWp

Energy Storage 11.5kW/19.8kWh

Success Story - Marshall Islands

Efficient Green Energy Transition in Saline Environment

Located in the middle of the Pacific Ocean, the Marshall Islands has long relied on imported diesel power generation, with high energy costs and unstable supply. Faced with extreme weather and saline environmental challenges, transitioning to renewable energy and utilizing solar power as an alternative has become the key to achieving sustainable development.

Project Background

Tuvalu has long relied on diesel power generation, but the geographic dispersal of the islands and resource transport limitations have resulted in high generation costs and significant carbon emissions. As part of the Pacific Islands Green Energy Plan, Tuvalu urgently needed a cost-effective, low-carbon, and efficient energy solution to address infrastructure constraints and improve energy sustainability.

Electricity Demand and Construction Goals

Location	Area (㎡)	Monthly Avg. Electricity Usage (kWh)	Goal
Laura Farm	1,808	6,900	Build green energy, with total solar capacity of at least 55kW

Demand	Equipment
Pure solar power generation design to meet the needs of greenhouse air conditioning, refrigeration and daily lighting demand	Ventilation equipment, biogas equipment, solid-liquid separation tank, indoor greenhouse air conditioning, office air conditioning lighting

Challenges

High Energy Costs and Unstable Supply

・Reliance on imported diesel power results in high energy costs and extreme sensitivity to international fuel price fluctuations, increasing supply uncertainty.

・Unstable power supply significantly impacts the daily needs of local residents and businesses, limiting economic growth opportunities.

Saline Environment and Extreme Climate Impacts

・High salinity and humidity cause threats to the durability of equipment materials, leading to corrosion, frequent failures, reduced system lifespan, and decreased operational efficiency.

・Frequent maintenance and replacement of equipment significantly increase costs, creating challenges for long-term project sustainability.

Insufficient Infrastructure and Lack of Technical Support

・Lack of professional construction and high-salinity-resistant materials makes it difficult for existing infrastructure to support energy upgrades and stable supply needs.

・Insufficient technical support hinders the modernization of energy systems, further challenging the sustainability of local energy supply.

Solutions

Solar PV System
Solar PV Capacity - 223.86kWp
Equipment Used - Giga 40K Inverters (6 Units)

Solar-Plus-Storage System
Energy Storage Capacity - >300kW/2150kWh
Equipment Used-
Fusio 215kWh Commercial & Industrial Energy Storage Cabinet (10 Units),
BNP100K Power Conditioning Systems (3 Units)

2025 Phase II Scheduled Plan

Due to the insufficient feeder capacity of the local power grid, it is recommended to adopt a self-generation and self-consumption operational model for the solar power plant. This should be complemented with a commercial and industrial energy storage system to enhance energy supply stability and improve the overall operational efficiency of the system.

Implementing Solar Energy Storage Systems

・Utilize solar energy as the main source, significantly reducing dependence on imported diesel and lowering energy costs.
・Provide stable and reliable energy supply for high salinity and high humidity environments.

Efficient Inverters and ESS Equipment for Small-Scale Power Systems Needs

・Supports multi-MPPT and intelligent air-cooling technology, compatible with bifacial modules to enhance energy utilization.
・IP65 protection to adapt to severe environments, ensuring stable operation.

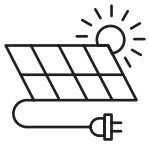
Sustainable Energy Solution

・Supports efficient energy transition, helping local economic growth and infrastructure upgrades.
・Superior conversion efficiency and flexible monitoring function enhance system performance and energy reliability.

Results

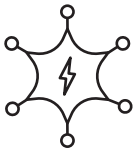
Pure solar power generation design to meet the needs of greenhouse air conditioning, refrigeration and daily lighting

The implementation of solar photovoltaic solutions significantly improved local energy efficiency and supply stability while reducing dependence on imported fuels. At the same time, the system is designed with environmental sustainability, reducing carbon emissions and achieving renewable energy transition goals. Furthermore, it supports agricultural and infrastructure upgrades, effectively promoting local economic activities and providing a reliable solution to energy challenges in high-salinity environments.



Improve Energy Efficiency
· Increase the proportion of local renewable energy
· Reduce dependence on imported diesel

Reduce Environmental Impact
· Reduce carbon emissions
· Achieve green energy transition goals



Stabilize Power Supply
· Enhance energy stability
· Effectively address unstable power supply issues

Support Agriculture and Economic Development
· Support infrastructure upgrades
· Facilitate local economic activities

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