

Solar Solutions BROCHURE

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SOLAR SOLUTIONS

AT A GLANCE



FROM THE SUN TO THE GRID



The principle behind photovoltaics is as clear as day: When sunlight falls on the solar cell, a voltage is created between its positively and negatively doped layers. If a load is connected to this cell, then direct current begins to flow. For this power to be used privately or put on the public grid, then the direct current must first be converted to alternating current. A solar inverter performs this DC to AC conversion.

Solar inverters also perform other important tasks: They monitor and control the entire system and store data about the amount of current produced, which can be displayed and analysed. Inverters also monitor the power grid continuously to ensure that important safety criteria are met.

Size matters for photovoltaic systems that are coupled to a power grid: For small- and medium-sized systems, the choice is string inverters. String inverters are linked to multiple solar modules connected in series. For larger systems, generator connection boxes consolidate multiple lines into a single central inverter. Central inverters are used in large photovoltaic power stations that produce anywhere from hundreds of kilowatts to several megawatts at peak production.

As for central inverters, AEG Power Solutions has developed the Protect PV central inverters line. Each individual inverter can provide 250, 560, 690 und 880 kVA of power, and the number of inverters can be scaled up to meet requirements. System owners typically use fallow open spaces for the module trusses and store additional equipment in containers or housings.

For a turn-key solution, AEG Power Solutions also offers the TKS-C series, consisting of two central inverters, a high-performance medium-voltage system and an on-site monitoring and control system.

Photovoltaic power stations with higher power outputs require more modules in order to use the inverters to full capacity. Approximately 4500 to 5000 solar modules are needed to produces one megawatt of power using a TKS-C 1000. These modules occupy a surface area of around 9,850 square metres which is approximately one and a half soccer fields.

For further information
please refer to our website:

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www.aegps.com

AEG
POWER SOLUTIONS



COMPANY PROFILE

AEG POWER SOLUTIONS

For more than 125 years, AEG Power Solutions (AEG PS) has been a global provider of electrical power systems and solutions for industrial power supplies. It offers one of the most comprehensive product and service portfolios in the fields of power conversion and power control.

The two complementary operating business segments Renewable Energy Solutions (RES) and Energy Efficiency Solutions (EES) serve customers worldwide. The RES product and service portfolio consists of systems and solutions for solar power plants including solar inverters, monitoring and control systems and power controllers. The EES product and service portfolio includes high performance uninterruptible power supplies (USPs), industrial power controllers and DC converters.

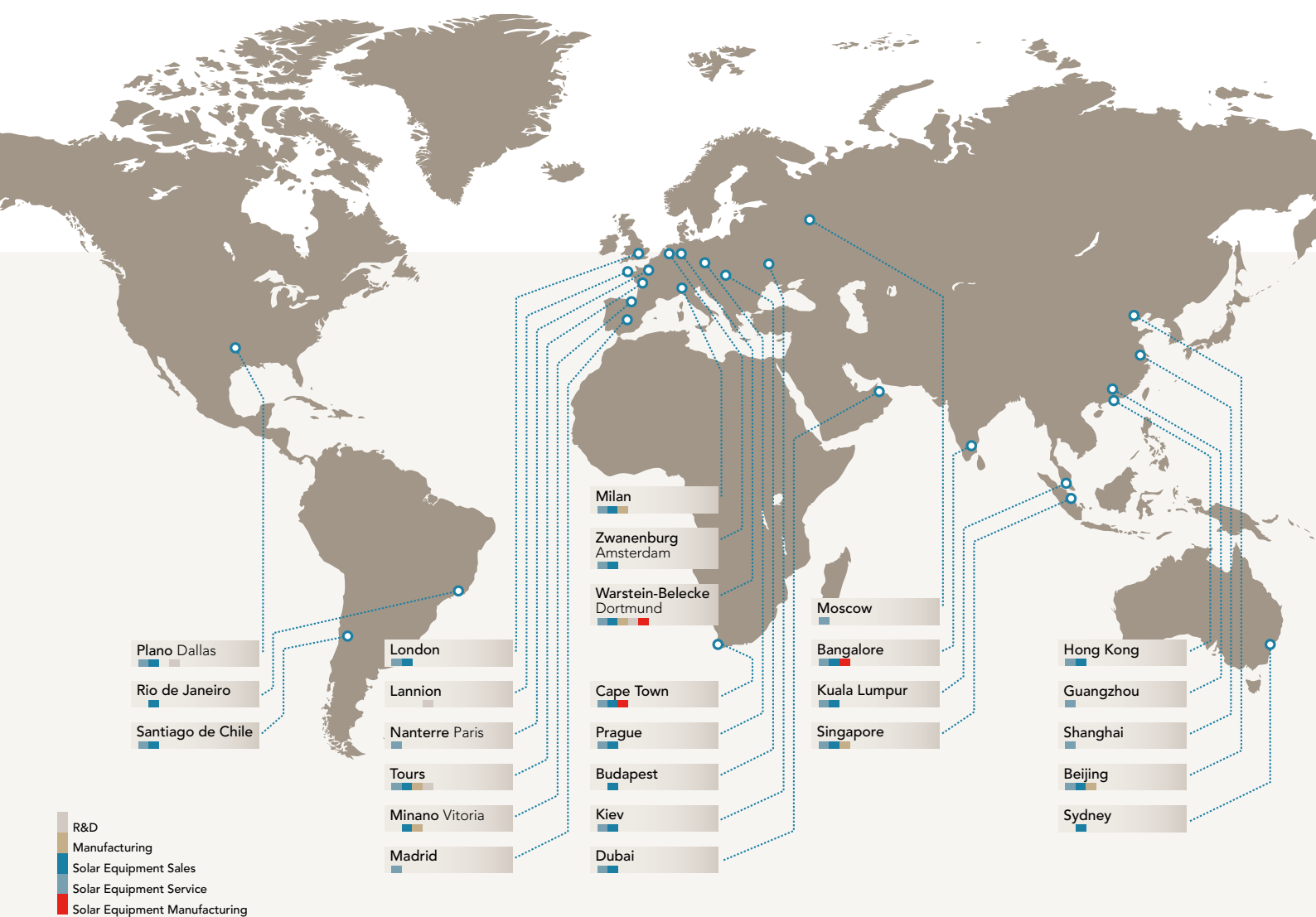
Thanks to its distinctive expertise, bridging both AC and DC power technologies and spanning the worlds of both conventional and renewable energy, the company creates innovative solutions for smart grids.

Photovoltaics play an important role as a renewable energy source. AEG PS offers complete solutions both for utility-scale solar power plants as well as for installations in the kW range.

The center of every PV installation is the inverter, which is also AEG PS' core competence. Since the inverter is the interface between the solar panels and the public grid, it is critical to have the highest efficiency rates and superior control intelligence. AEG PS' solutions guarantee maximum energy yield and

our intelligent software helps stabilize and support grid behavior which is becoming extremely important. Amongst our technological innovations, we also offer additional modules, such as high efficiency DC/DC converters and as grid management with intelligent monitoring and control systems. AEG PS provides professional, reliable power supply solutions, focusing on contributing solutions to the global "smart grid" project.

WITH GLOBAL REACH LOCAL PRESENCE



AEG PS CENTRAL INVERTERS

QUALITY FOR DECADES

In industrial applications quality plays a decisive role. System design and integration is not an empty phrase for AEG PS. Its central inverters named the Protect PV.250, PV.560, PV.690 and PV.880 stand for innovation and quality for utility-scale solar power plants.

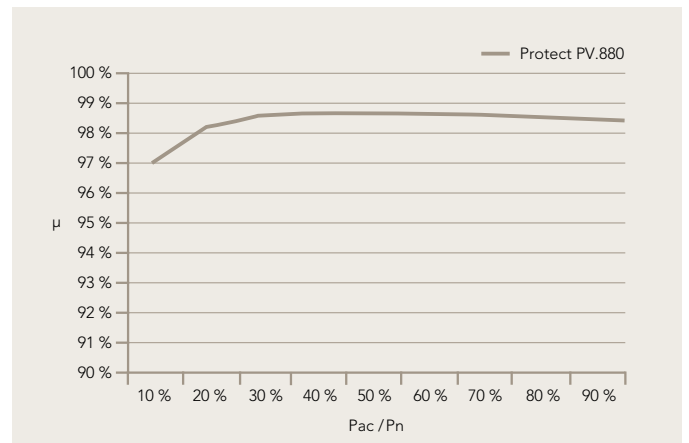
A few key figures illustrate the abilities of these devices. For the PV.880, the DC input has an operating range of 486 – 1000 V with a maximum DC current of 1440 A; the rated power at the inverter output contactor with a power factor of 0.9 inductive to 0.9 capacitive, which puts it above the average. The Protect PV.880 is connected to medium-voltage transformers (e.g., 10 and 20 kV), generally with a power factor of >0.99. The devices are designed for installation anywhere in world. They conform to numerous standards, among them UL-1741 for the U.S. market.

The central inverters set new standards: The following data was determined for the high conversion efficiency of the Protect PV.880 central inverter power stack by Fraunhofer ISE.

The control circuitry is fully digital and communication-enabled, so parameters can also be monitored and controlled remotely via the Internet. AEG PS products include such features as low-loss chokes, high-quality components and double-coating of all PCBs. This forms the basis for decades of reliable operation.



PV.880 Central inverter from AEG PS



OUTDOOR
SOLUTIONS

FOR HARSH ENVIRONMENTS

The TKS-C (Turnkey Solution Container) is a fully integrated solution that has been developed specifically for use in photovoltaic power plants. It comprises

- up to two solar central inverters,
- medium-voltage switchgear,
- a medium-voltage transformer,
- measuring and monitoring components, and
- data communication capabilities.

The container is split into two areas: the inverter compartment and the medium-voltage compartment containing the switchgear and transformer. AEG PS has developed two separate cooling circuits for the inverter cubicle; the cooling air from these is purified by filters. The features that really make the TKS-C concrete solution stand out are not only its ability to be put into operation rapidly, but also its durability, thermal and sound insulation, and superior fire protection properties.

Straightforward installation in utility-scale projects

The TKS-C is a turnkey system. It is connected to the PV panels on one side, to the transfer station on the other side, and can be put into operation



TKS-C – ready-to-use inverter and transformer station

immediately. The TKS-C is also delivered to the installation site fully equipped and tested. This means that there is no need for on-site integration work – saving constructors considerable time and costs.

Efficiency, adaptability

The TKS-C system includes tried-and-tested high-performance central inverters from AEG Power Solutions' Protect PV product range. These are able to reach proven peak efficiency levels of more than 98%. The maximum efficiency that the inverters offer is also accompanied by superior availability. The innovative FPGA circuit ensures flexible, precise and rapid control, while the ability to

assign parameters freely and flexibly enables compatibility with all grid standards. Not only this, but the system also offers an unrivalled thermal operating range of -20 °C to +40 °C. The TKS-C container solution is used in PV systems across the world and consistently proves an outstanding choice thanks to the long service life it offers in harsh environments.

THE PV.MH
SYSTEM

COMPACT AND RELIABLE AT ANY LOCATION



PV.MH: Weather-proof and compact inverter system

The PV.Metal Housing is a light, compact outdoor solution, consisting of a metal housing that protects against corrosion and either a PV.560, PV.690 or PV.880 solar central inverter. The system distinguishes itself by its light weight and small dimensions, which makes it a practical solution in almost all locations worldwide.

The PV.MH can be moved by forklift and sited on ready-made foundations. Transformer and switchgear are placed in a separate compact station, which can connect two PV.MH units to a medium voltage line. The inverter and housing are delivered assembled as one unit. DC input and AC

output cables are connected to the transformer station by prefabricated channels in the concrete pad. The central inverter is accessible by two front doors, the main circuit breaker by a side door.

THE PV.OUTDOOR SYSTEM

COMPACT AND RELIABLE AT ANY LOCATION

The Protect PV.Outdoor System consists of a durable, external, weatherproof metal housing and an integrated, high-efficiency, solar central inverter, either the PV.690 or the PV.880.

The design offers many advantages during transport, installation and service thanks to its light weight and its small dimensions.

The PV.Outdoor offers ease of use and maintenance as is standard for all AEG PS products. In addition, AEG Power Solutions has developed a unique cooling system that provides optimal air circulation within the inverter. The enclosure

consists of double-walled aluminum with a stainless steel plinth for mounting onto a concrete foundation. Additional components, such as transformers and medium-voltage switchgear, are part of the separate compact station, which can combine output from two PV.Outdoor systems.

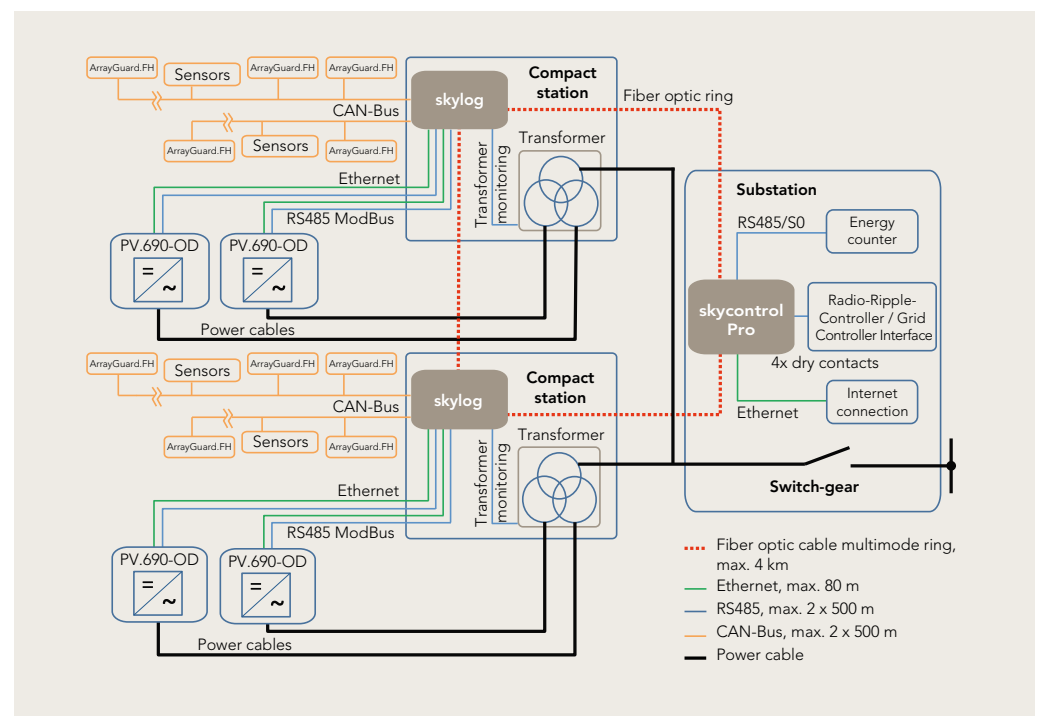
Ethernet and fiber optic communication channels connected to open standards such as ModBus or Ethernet form the foundation for communications in PV power plants using AEG PS solar central inverters. A powerful and proven online communications platform allows owners and operators to



PV.Outdoor system for central inverter

view the current and historical system status instantaneously.

The following chart shows the installation layout of the PV.Outdoor and PV.Metal Housing solutions.



PV.Outdoor and PV.Metal Housing installation layout

THE INTELLIGENT COMBINER BOX

FOR SOLAR POWER PLANTS

ArrayGuard® FH solar combiner boxes, which collect the current in the field, are the central point for metering the performance of the solar array. They detect any error arising over time.

The data collected and forwarded to the central inverter (i.e., PV.250 - PV.880) enables the operator to control the PV MW power plant. Being a substantial part of the monitoring system for utility-scale PV power plants, the CAN-Bus enabled string current monitoring system ArrayGuard® FH keeps energy yields high in the long run.

The ArrayGuard® FH:

- Combines up to 24 PV generator strings
- Detects failures and decreased yields early
- Several strings connected to one measurement channel
- Highly precise and widely temperature independent values acquired by Shunt measurement:
 - string currents (eight measurement channels)
 - system voltage
 - internal cabinet temperature
- Data transfer to local data logger via CAN fieldbus
- Fuses on each single PV string
- Options of fuse protection:
 - Fuses on PV+ or
 - Fuses on PV+ and PV-
- Fuse holders for easy-to-handle fuse replacement
- Connection of PV string cables by push-in-type through terminals
- DC main cable screw connection, no cable lug required
- Integrated DC overvoltage protector with monitored status signalling contact
- No external power supply required, power is supplied through the data bus
- Reliable throughout a long outdoor lifetime



ArrayGuard® FH

PV.LOG,
PV.SERV

CENTRALIZED DATA COLLECTION IN PV POWER STATIONS

The data loggers in the PV product range act as a cache for medium and large-scale photovoltaic systems. They continuously collect all important data from the inverters, from the combiner boxes, from the weather sensors and from the energy meter. They provide access to the current status of the entire system. Depending on their configuration, they are equipped with an integrated DSL router and / or data server as a mirror.

An Ethernet switch with fiber optic connections is included in all data loggers. These connections enable a redundant and potential-free ring network structure between the containers in PV power stations.

All in-house photovoltaic products from AEG Power Solutions are part of the monitoring network, including the:

- Protect PV Central Inverters
- RS485 String Inverter interface
- Combiner Boxes ArrayGuard®, ArrayGuard® FH

The data logger can also monitor the following skyCONNi weather sensors:

- for radiation measurement
- for wind measurement
- for precipitation and wind direction measurement
- EnergyGuard interface for energy meters



PV.LoG



PV.Serv

	PV.LoG	PV.LoG+	PV.Serv-	PV.Serv
KEY FEATURES				
DSL Router (Annex A / B)	-	x	-	x
Microspace Data Server	-	-	x	x
STANDARD				
Industrial PC			x	
DC-UPS 24 VDC			x	
CAN Bus overvoltage protection			x	
Ethernet Switch with Fiber Optic Connections			x	
24 VDC fuseblock			x	
Internal temperature sensor PT1000			x	
External temperature sensor PT1000			x	
OPTIONS				
Cabinet lighting			o	
Fan assembly			o	
Interface for active power regulation			o	
EnergyGuard interface			o	
String inverter interface			o	
As wall-mounted cabinet available			o	

x included, - not included, o optional

CONTROL SOFTWARE PVGUARD

EVERYTHING UNDER CONTROL

The PVGuard software has been developed for application in operation management of large PV power plants. The high-performance IPC in the data logger saves data over several years and in high-resolution quality. It can be used to carry out comparative calculations throughout the life of PV power plants. Performance comparisons can also be made between various plants and individual components. In this way, faults in the plant become apparent to the plant manager at an early stage. The system documents these faults so that warranty claims can be verified and one can keep a check on service works as well as other possibilities.

Front end

PVGuard generates an overview of the most important and informative data of the PV power plant. This page can also be customized, for example, by adding general information about the plant.

Overview for analysis

The overview displays a comprehensive plant representation of all devices installed in the PV power plant.

Zoom function

- Data resolution in one minute mean values
- Mathematical functions

Value Representation

- Identification and analysis of defects in modules
- Exact display of each measured value
- Storage of user-defined views
- Professional Diagram Viewer

Export and Print Functions

- Graphics can be exported in PDF, SVG and PNG formats
- Display of tables in MS-Excel-compatible formats and HTML
- Print option for diagrams

Error Configuration and Alarm Handling

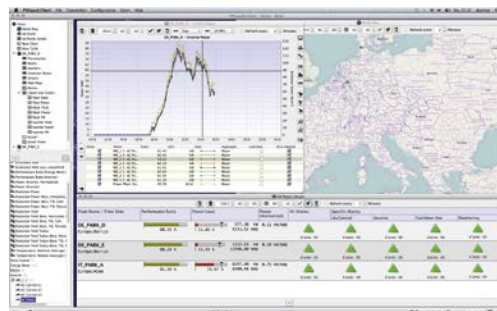
- Configurable value margins and tolerances
- Alarm notification by email
- Alarm history including the timestamps of the first and the most recent occurrence as well as error description
- Multi-stage alarm acknowledgement

Plant Map

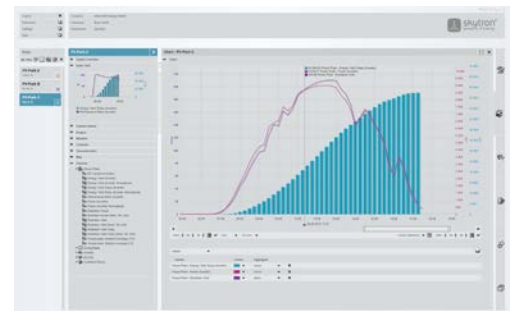
- Quick Navigation with Minimap
- Real layout of the PV power plant including location of inverters, combiner boxes and sensing devices
- Access to detailed views of devices
- Colored marking of different fault categories and alarm conditions

Web Interface

Tool to monitor relevant measuring data and calculations from the monitoring system



Overview



Plant chart

CHALLENGES, SOLUTIONS

ENERGY STORAGE



Battery Energy Storage System
Containerized Solution

Energy storage challenges

Electrical power generated from any source eventually needs to meet the challenge of how to store excess energy from energy generated when demand is low for use at an unspecified future point in time. This is a particular problem with power generated from renewable energy sources such as solar or wind. Put simply, when there is no sun or wind, there is no power available to be generated.

In order to bridge the gap between exploiting power availability at times that cannot be readily predicted and delivering sufficient power at times of demand, AEG Power Solutions has developed a Battery Energy Storage System solution.

The right solution – today

The combination of cuttingedge power electronics with the latest applications in battery technology gives AEG Power Solutions an advantage over other solutions currently on the market. The Battery Energy Storage System compensates for power variations in milliseconds and ensures that the operation of the grid remains stable at all times. When combined with renewable energy sources, a self-sufficient, localized solution is provided, that reduces the need to expand grids even further.

Energy storage solutions

On-grid

The Battery Energy Storage System is designed specifically for facilitating the transition to new ways of generating and distributing electricity.

For on-grid projects, AEG Power Solutions is focusing most of its efforts to begin dealing with the changes anticipated in global energy markets. With the decommissioning of all German nuclear power plants scheduled for 2022 and the goal of having 80 % of Germany's electricity generated through renewable energy by 2050, AEG PS is gaining a lot of experience of on-grid connection within its domestic market. The great danger of largescale disruption to power generation and supply offers a new challenge for AEG PS to work together hand in hand with both small and large energy providers to help stabilize the grid.

The Battery Energy Storage System not only helps to stabilize the frequency, it can also regulate the voltage through reactive power compensation/ supply and provide balancing power, with virtually no delay, until the power plants for primary balancing power have been started.

Tried and proven technology

Using their tried and proven technologies, that are currently employed throughout the grid network, AEG Power Solutions is well-placed to deliver smart solutions for connecting the Battery Energy Storage System technology to any grid for use in many areas, for example in:

- Peak shaving
- Peak demand shifting
- Frequency regulation
- Load leveling



Typical on-grid connection of the Battery Energy Storage System

ADVANTAGES, SOLUTIONS

ENERGY STORAGE

Off-grid

The Battery Energy Storage System for off-grid are designed primarily for use in "sun-belt" countries with extremely high solar radiation. AEG PS' solutions focus on combined PV / Battery Energy Storage System turnkey projects for the provision of basic levels of electrification and for fossil fuel efficiency measures in remote areas.

Turnkey modularity

The components of the Battery Energy Storage System is combined within a fully integrated, turnkey containerized solution developed specifically for the customers requirements.

TKS-SC container solutions

A completely integrated solution, the container includes metering and monitoring components as well as

communications infrastructure.

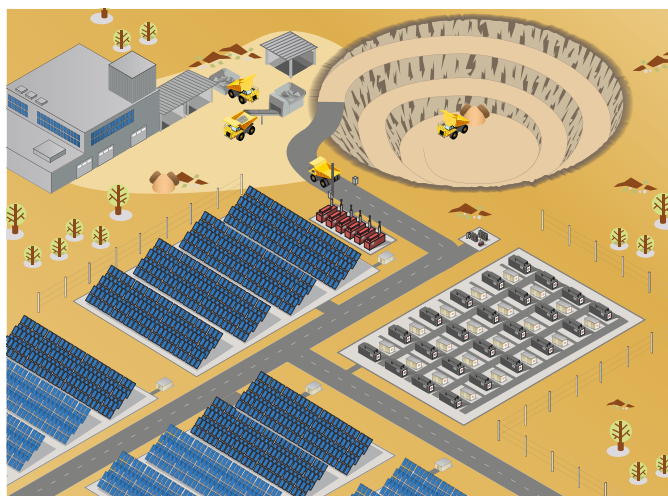
The single source solution ensures smooth battery storage operations, in close cooperation with the grid operator. The container station comprises a pair of Protect SC.250 and SC.500 converters along with a medium-voltage transformer and switchgear.

Protect SC.250/500 central converters

Battery Energy Storage System is based on the highly successful Protect PV range solar inverter, which delivers solutions for utility-scale applications. A power stack with advanced design measuring and control technology, which provides an outstanding converter efficiency factor and forms the heart of the Battery Energy Storage System. The total concept is flexible and adjustable to many requirements and is applicable for almost all grid codes worldwide.

The advantages

- Many decades of experience in the world of UPS and power electronics, batteries (the science of charging and discharging) and international grid connection compliance
- AEG Power Solutions already has all of the necessary grid compliance certification to connect any solution to the local grid
- Highly reliable, tried and field tested systems. The converter technology is based on the highly successful PV central inverter range
- Modular concept – allows for straightforward development of solutions tailored to the needs of the customer in terms of both available battery capacity and converter power throughput
- A wide range of DC input voltages allows the customer to select the best battery technology for the particular application, environmental and cost parameters
- Truly global service and support network
- Completely integrated turnkey solutions available to customers



Typical industrial off-grid application of the Battery Energy Storage System

PROTECT PV, TKS-C AND OUTDOOR SOLUTIONS

PV CARE SERVICES

As a world class system provider, you can rely on a global network of 22 Service Centers supported by over 150 field engineers. From the power solar system selection to your process installation and commissioning, our certified experts go beyond your expectations by offering service excellence that will maximize your solar farm efficiency and long-term revenues. The reliability of your installed power solution is supported by a Global Service Team renowned for its short response times and trouble shooting efficiency.

PV Care Preventive Maintenance

Scheduled and recurring preventive maintenance performed by accredited service experts is known to be the most cost effective approach to secure the full performance of your PV inverter at all times. Through product services such as PV Care Solo, PV Care Safe, PV Care Premium, your AEG PS Service Team provides the ultimate peace of mind, assuring complete cost control, security and maximum yields from your PV installation.

PV Care Start Commissioning

Benefit from the equipment manufacturer's warranty by having your system



commissioned by the most experienced service experts. While being commissioned in compliance with the latest local and international norms, your system is carefully checked and further optimized to meet your onsite power needs. You can also rely on a team of certified specialists to provide full operating training and hands-on advice.

PV Care Solo

PV Care Solo is a one time technical expert visit to your Protect PV central inverters, container and outdoor solutions. Featured with key functionality assessments and onsite numerical diagnostics, our service engineer experts implement the necessary measures to keep your system operating smoothly.

PV Care Safe

PV Care Safe is an annual scheduled onsite preventive maintenance developed to secure the functional reliability of your PV inverter. It can be deployed for periods of five to ten years or ten to twenty years with annual renewal. With functionality assessments and onsite numerical diagnostics, our service engineer experts implement the necessary measures to keep your system operating at peak performance.

PV Care Premium

PV Care Premium provides you with peace of mind at a fixed rate. PV Care Premium can be deployed for periods of ten to twenty years with annual renewal. Our service engineering team performs annual maintenance services of your systems, replaces and installs inverter and communication parts at no additional cost.

PROTECT PV, TKS-C AND OUTDOOR SOLUTIONS

PV CARE SERVICES

	PV Care Solo	PV Care Safe	PV Care Premium
Service Description	Technical Expertise	Annually scheduled on-site preventive maintenance	Annually scheduled on-site preventive maintenance including spare parts and installation visits
CONTRACT PERIOD			
5 years		■	■
10 years		■	■
10 to 20 years (with annual renewal)		■	■
REMOTE MONITORING			
24 / 7 remote operation management access			
Onsite functional assessment	■	■	■
PROTECT PV CENTRAL INVERTER			
Visual inspection	■	■	■
Functional assessments	■	■	■
Organic and inorganic contaminants removal with filter replacement	■	■	■
Computerized numerical diagnostic	■	■	■
Temperature analysis	■	■	■
Firmware update	■	■	■
Maintenance protocol registration Functional walk through	■	■	■
Parameters adjustment and optimization	■	■	■
TRANSFORMER AND DISTRIBUTION			
Functional assessments	■	■	■
ONSITE LABOURS & SPARE PARTS			
Includes spare parts			■
Includes on-site service engineers for defective parts replacement ¹			■
RESPONSE TIME AND AVAILABILITY			
24-hour onsite response time ²			■

¹ Excludes unrelated failures or acts of God.

² Based upon solar plant location. Exclude weekends and public holidays.

Remark: Standard maintenance encompasses monitoring (sensors, auxiliary voltage, router updates), AC/DC distribution (switches), inverters (functioning, monitoring, mechanics, cleaning) and medium voltage (switchgears and transformers).



Solar Park in Eastern Europe with AEG PS products



AEG Power Solutions

Approach your local AEG Power Solutions representative for further support.

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