



# Hybrid Power Plants for independent power supply

GE Power Generation

GE GERMANY

**€ 56 million**

Investments in developing business in Germany

**Over 130 years**

in Germany

**Since 1990**

service expertise in Germany

**450**

new jobs in research and development

**> 7.000**

employees

BELECTRIC

**3.000**

PV-systems installed on buildings to date by BELECTRIC

**With over 100**

active patents, proving BELECTRIC's strength as an innovator

**> 1 GWp**

PV-systems installed as first company worldwide

**200,000**

hours working time by engineers and technicians from BELECTRIC each year in developing our products, projects and innovations

KOFLER ENERGIES

**230**

engineers throughout Germany

**€ 170 million**

revenues

**100**

decentralized energy supply projects in industrial, commercial, hotel, leisure and sports, as well as in residential construction

**11,300 t of CO<sup>2</sup>**

saved per year through sustainable solutions and intelligent energy management

# Our pioneering spirit transforms ideas into reality

The way we deal with our ever-increasing need for power is one of the major challenges for the 21<sup>st</sup> century. Industry, utilities, municipalities and private individuals are all looking for tailor-made solutions that will enable them to achieve economic and ecologic targets, while at the same time ensuring increasingly independent, decentralized, grid-connected power supply. The future lies in environmentally compliant on-site power generation systems that can be interconnected to respond flexibly to operating demands and therefore remain commercially viable. In other words, the future lies in hybrid systems.

Awareness of the need for a new energy system is particularly recognized among Germany's industrial and business sectors. This has prompted them to take action. Power is increasingly generated close to the consumer and at the same time the power feed-in is metered and billed by the transmission grid operators. This results in varying levels of loads in the distribution grids.

However, for many this still does not go far enough, as they would prefer to be able to cover as much of their energy needs as possible independently. The primary concern here is not always to get the best possible prices. More and more businesses are equally motivated by a desire to achieve low-level CO<sub>2</sub> emissions and to consolidate unlimited availability and stability and the wish to improve their public image. The question is how to unite all of these diverse aims and motives. We believe our hybrid power plant concept is the answer. We combine photovoltaic technology that is tailored to your needs with flexible combined heat and power generation and innovative battery storage solutions. An energy management system enables the best possible demand-specific control of the solution and creates the necessary conditions for connecting to energy marketing systems.

## THE ADVANTAGE FOR OUR CUSTOMERS

Industry and commerce, the building sector, municipalities and energy cooperatives can profit as the various parts of their generation assets are amortized, thanks to the ever-increasing energy cost advantages in comparison to an external purchase of power.

In addition, surplus power generation can be marketed directly and can lead to an improved CO<sub>2</sub> footprint. The private and commercial real estate sector is becoming increasingly attractive, facilitating new, innovative business models, such as tenant's sub-metered power supply. Our hybrid concept is particularly suited to municipalities and energy cooperatives. As well as the advantages already mentioned, by bringing together combined heat and power generation, solar, storage technology and energy management, our hybrid concept offers good predictability and therefore allows to ideally integrate on-site power supply for private and macroeconomic benefit.

For power supply companies or contractors the hybrid power plant is also an excellent way to generate income that is no longer available from commodity business or the centralized power generation assets by offering decentralized generation capacity to municipalities and industrial enterprises. In this case, the utility handles the planning, construction and operation of the hybrid power plant itself. Municipalities and businesses will become de facto plant operators through a lease or rental agreement, enabling them to benefit from economically generated power without having to carry high investment costs.

## THE RETURN ON INVESTMENT

Naturally, the individual layout of the system means that the economic benefits of a hybrid power plant cannot be presented in general terms. Nonetheless, the logic of the concept is also convincing economically. After the completion of the amortization period, generation costs from solar energy are practically nil. Combined heat and power generation plants are highly efficient and cost-effective, particularly in the context of corresponding heating requirements. Any surplus power generated can be stored when trading prices are low and then used by the company to meet its own demand at a later point in time. If the market conditions are favorable, the surplus power can be sold on the energy markets either directly or through a virtual power plant network.



# The idea behind the hybrid power plant

**THE CHALLENGE**

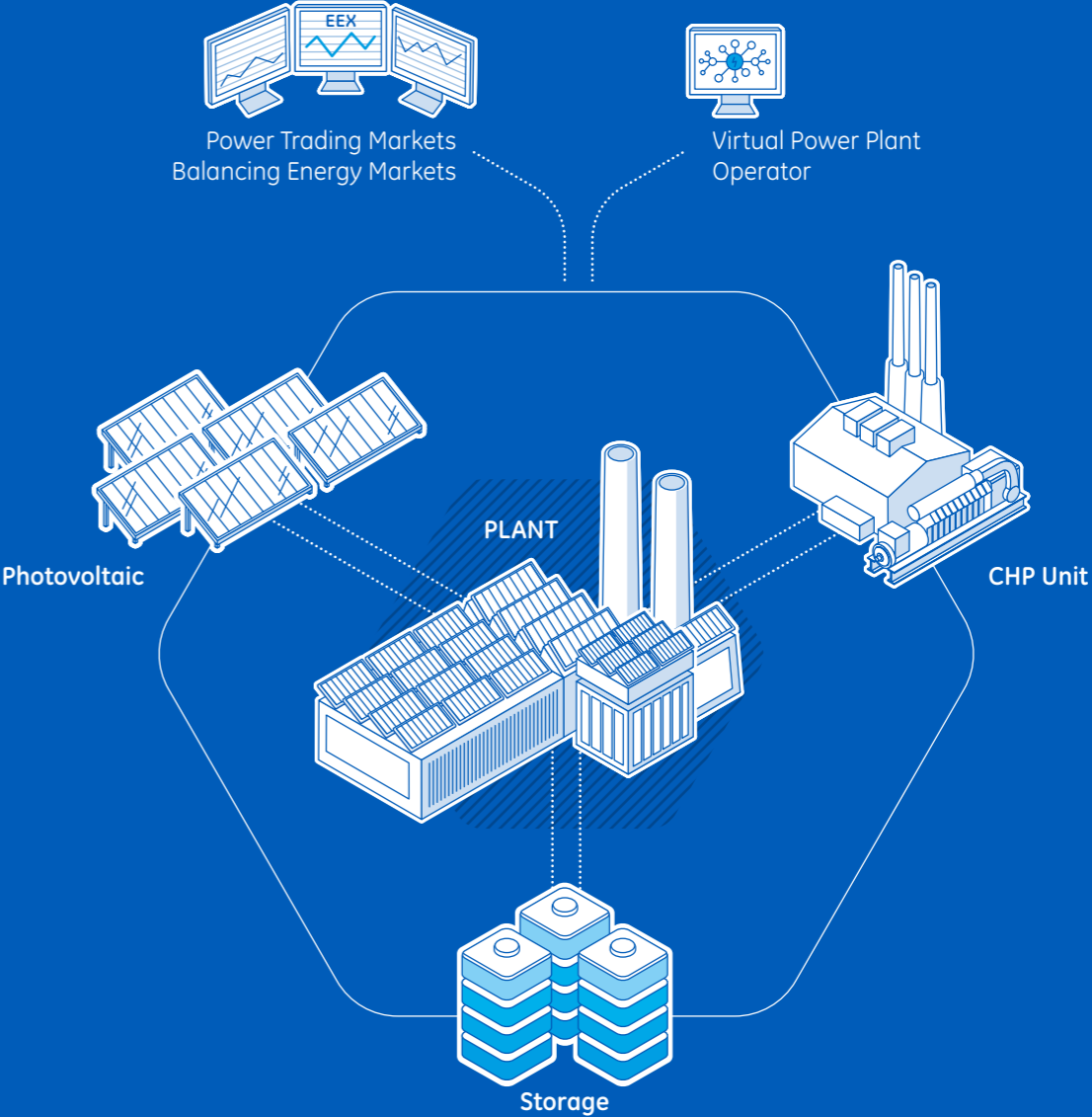
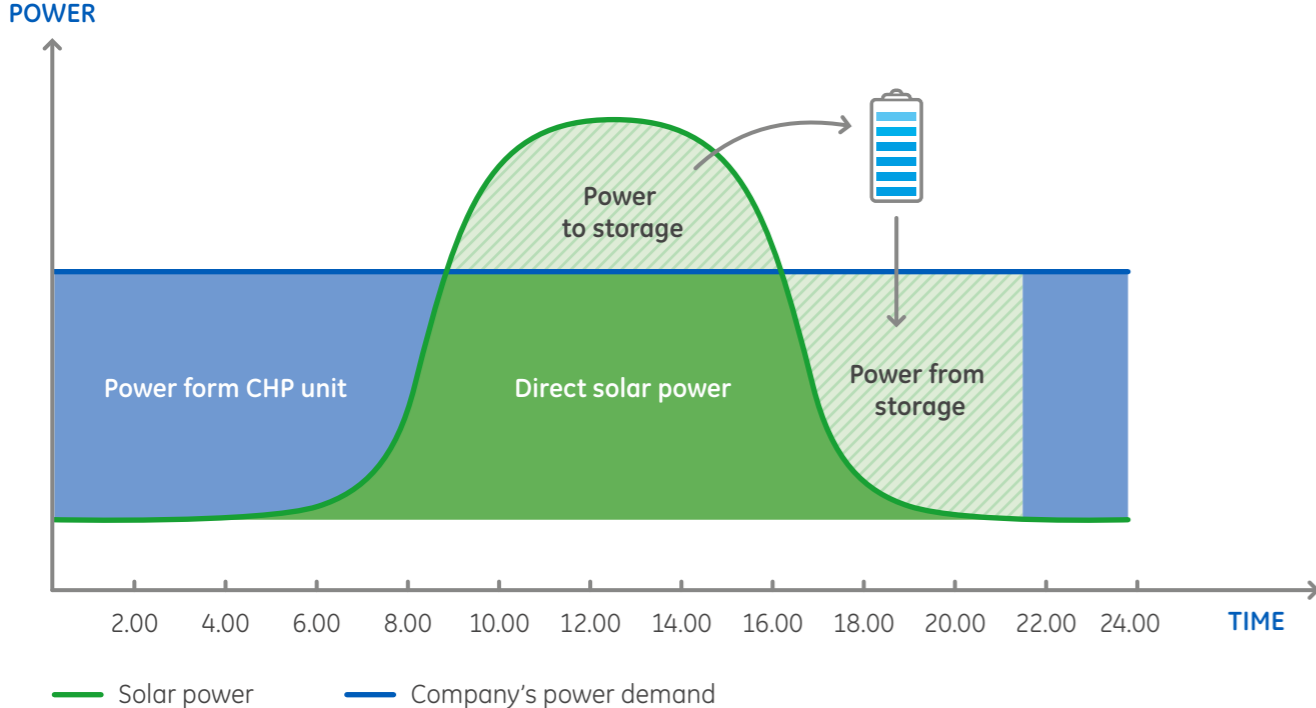
The increased integration of renewable power generation technologies is of vital importance in preserving natural resources and reducing CO<sub>2</sub> emissions.

The major problem is that power generated from renewable energies is extremely volatile, so that it is unsuitable as the sole source of electricity for industrial enterprises or complex consumer systems. In order to avoid endangering the security of supply, a certain proportion of controllable and planable generation capacities must be retained in the system. It needs to be possible to regulate this controllable output as flexibly as possible to the volatile supply from renewable energies. Thus, CHP plants that can also cover heating needs are often the ideal alternative for industrials and medium-sized enterprises. An energy management system monitors and controls the entire energy process in order to coordinate supply and demand as effectively as possible. A battery system and a heat

buffer operate like interim storage units for balancing the two generating systems optimally in terms of demand and general commercial conditions.

**THE PRINCIPLE BEHIND THE HYBRID PLANT FROM GE**

The flexible photovoltaic systems from BELECTRIC cover the renewable generation share in the general system. Besides controllable power supply a CHP plant, consisting of one or more GE Jenbacher gas engines, also supplies heat for the production process or to cover heating requirements. In addition, this unit can be used to provide refrigeration. Surplus generated electricity is being stored in a battery. When the sun is not shining and no heat is required, power can be drawn from the battery. Combined appropriately, the entire plant offers a very high level of independency and good security of supply, as well as the option of selling surplus energy at a profit.



**RENEWABLE POWER GENERATION WITH PHOTOVOLTAIC TECHNOLOGY**

Industrial and commercial businesses will find that the roofs of their buildings are ideal for power generation. The BELECTRIC Plan-Tec-System enables solar modules to be installed on flat roofs without requiring large amounts of ballast. The wind- and drag-resistant design minimizes the net weight of the system, while the modular construction means it can be extended as required. 1,000 m<sup>2</sup> of photovoltaic cells can reduce CO<sub>2</sub> emissions by around 69 tons per year.

**CONTROLLABLE POWER GENERATION WITH COMBINED HEAT AND POWER GENERATION**

GE Jenbacher gas engines can be perfectly combined with renewable energies. In combined heat and power generation technology, the heat generated from operating the gas engines is put to economic use. The simultaneously generated power is used to cover internal demand. The combined process thus permits an overall efficiency achievement of up to 90 percent. Savings of around 40 percent of primary energy can be achieved compared with conventional power generation.

**STORAGE TECHNOLOGY WITH AN ASSURED FUTURE**

By its nature, renewable energies sometimes produce too much power and sometimes not enough. This volatility can be resolved using a battery. Excess power generated is being stored for use at a time when power is needed. The storage solution is a reliable technology with sealed lead acid batteries manufactured by EnerSys, combined with an inverter and battery management system from GE.

**INTELLIGENT MANAGEMENT**

Our individually configured energy management system offers the option of monitoring the entire energy-related process in the system and of regulating by intervening when required. At the same time, it provides the basic information for the interface with your power trading system or the operator of an external integrator in a virtual power plant network.

# Controllable power generation

Combined heat and power generation plants with GE Jenbacher gas engines generate power and heat on a decentralized basis – just where it is needed. Heat storage solutions are being used to maximize the operating time of CHP plants. This increases in particular the power yield of the plant. We can use Jenbacher gas engines to equip combined heat and power plants in a range from approximately 300 kW up to 10 MW. Because biogas can also be used in the gas turbines, it is also possible to operate controllable power generation with a renewable energy source.

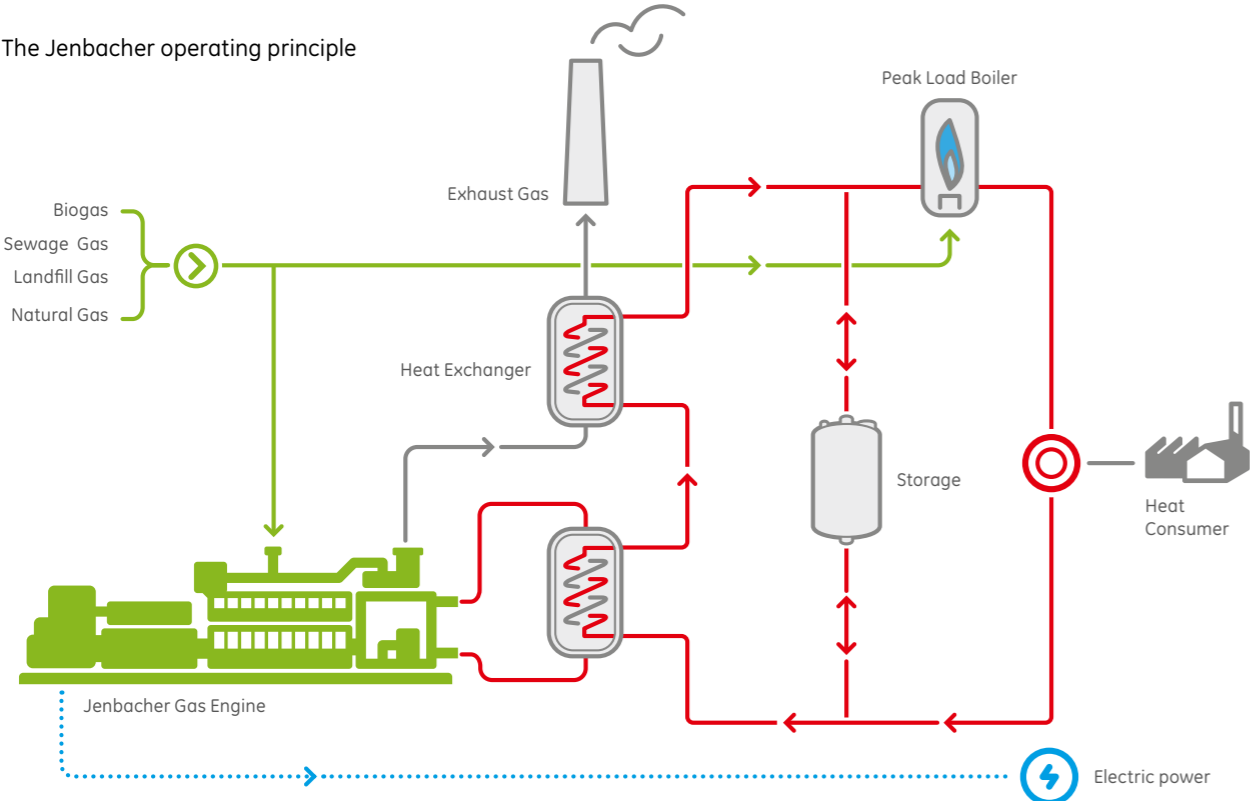
### EFFICIENCY LEVELS OF UP TO 90 PERCENT

In combined heat and power generation technology, the waste heat generated from operating the gas engines or turbines is put to economic use. The simultaneously generated power is used to cover internal demand and/or fed into the public power grid.

The thermal energy can be used to produce hot water and steam or different kinds of process heat (or cooling). Compared to competitive technologies the investment costs are relatively low.

### BENEFITS AT A GLANCE

- High level of electrical efficiency of up to 44 percent
- Overall efficiency (thermal and electrical) of over 90 percent
- Minimal NO<sub>x</sub> emissions thanks to patented LEANOX® lean mix combustion
- Maximum operational safety and availability
- High power density
- Designed to also use biogas and landfill gas



### UNCHALLENGED FLEXIBILITY

Jenbacher gas engines from GE can be operated using natural gas as well as various biogases and special gases from the agricultural, mining, industrial or waste management sectors. Depending on the customer's requirements, the gas is transformed into power, heat and/or cold.

**Series 2**  
Electric output: 300–330 kW

**Series 3**  
Electric output: 637–1,063 kW

**Series 4**  
Electric output: 844–1,562 kW

**Series 6**  
Electric output: 2,004–4,491 kW

**Series 9**  
Electric output: 9,500 kW





# Renewable power generation

## THE BEST OF DESIGN

The proven BELECTRIC system design, which is characterized by the intelligent combination of high quality components, is the ideal solution for the installation of solar modules on flat roofs with only low ballast levels. Internally developed products and cooperation with well-known manufacturers and institutes make it possible to operate solar rooftop systems reliably and with a higher-than-average yield for decades, even in extreme weather conditions.

The electric energy generated by the photovoltaic modules is transported to the inverter via the BELECTRIC DC voltage grid. The patented cabling system, using spliced cabling technology, can be used to establish an extremely long-lasting connection and reduces energy loss caused by transfer resistance and line resistance.

The used inverters feature pioneering technologies. Designed specifically with the relevant PV system in mind, they are extremely robust and efficient thanks to their improved MPP tracking and extensive remote monitoring options. The system technology is installed for convenient access, enabling a fast and simple response when service is required.

BELECTRIC uses the latest thin-layer technologies in all photovoltaic roof systems. Thin-layer modules are real allrounders and supply solar power even in poor light conditions, for example when the sky is clouded.

## THE BEST OF PLANNING

Every large photovoltaic system is individually planned with all local conditions in mind. Whether the flat roof is covered with a plastic membrane, bitumen or gravel, whether it features a pitched design using trapezoidal sheets or a corrugated structure, we have the ideal solution.

The latest 3-D-CAD applications mean that substructures from BELECTRIC can be tailored precisely to every roof. A structural inspection of the roof surface and an analysis of local wind and snow levels will ensure that the substructure and the photovoltaic modules will withstand all weather conditions. Only material of highest quality is used – from screws to module rails. This ensures a long product lifetime and thus safeguards the solar investment.

## THE BEST OF CONTROL

The photovoltaic system is monitored remotely in realtime, ensuring access to data at all times. Recording and analysis applications make it possible to keep a close eye on system performance and all parameters. This data allows system failures to be avoided and increases operational safety. This data base allows system failures to be avoided and increases operational safety. All key performance indicators and the latest CO<sub>2</sub> readings can be displayed at all times.





# 3.0 MegaWattBlock®

## THE SOLAR POWER PLANT WITH THE LOWEST POWER GENERATION COSTS WORLDWIDE

BELECTRIC sets new standards in renewable power generation with the 3.0 MegaWattBlock. The new power plant unit was developed with the vision of achieving the lowest power generation costs in photovoltaic technology and offering reproducibility in a standard power plant product. After a year and a half of development, this goal has finally been reached. The product design has been completely revised. As well as leading technology components from GE and First Solar, the proven BELECTRIC network stabilizer is also used in the 3.0 MegaWattBlock. The power plant block allows a solar power plant to be scaled in increments of 3 MWp.

- New triple support substructure
- Stable PV performance using thin-film technology from First Solar
- Efficient 1,500 DC Volt technology
- Efficient, grid stabilizing Power Conditioning Unit (PCU) with inverter technology from General Electric
- Performance ratio over 83 percent

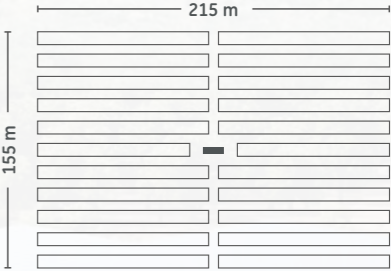
## IDEAL GRID STABILIZATION

The BELECTRIC Power Conditioning Unit (PCU) uses an intelligent power plant management system, a modern inverter station and a transformer unit. The inverter station was specially optimized for the use of thin-film module technology and features very high levels of system efficiency. This unit enables power to be directly fed into the medium voltage grid (20 kV).

Grid services: The active reactive power control of the PCU makes it possible to significantly increase grid stability by day and night without sunlight. The active reactive power control operates independently of sunlight by day and night.

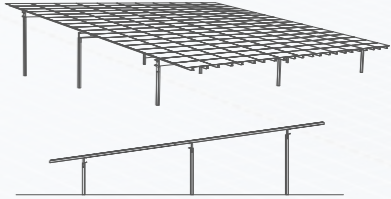


## THE 3.0 MEGAWATTBLOCK SOLAR POWER PLANT



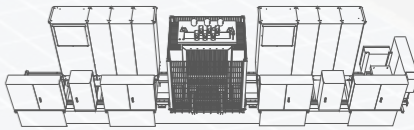
### 3.0 MegaWattBlock Design

Because space is used to maximum efficiency of 900 kWp/ha, the power plant requires an area of only 33.325 m<sup>2</sup>



### Optimized Substructure

The 3-support principle from BELECTRIC ensures rapid installation and reduced shading with 18 solar modules in each row



### Power Conditioning Unit (PCU) SKID System

Turn-key 1,500 Volt central inverter technology with intelligent power plant management and transformer unit



# Extensive range of services

BELECTRIC and GE offer you an extensive range of services: these are provided for the entire hybrid system, for power generation and storage, for converter technologies and for energy management. Below you can find an overview of our key services.

### FINANCIAL ENERGY SERVICES

Technology that no one can afford is of no use to anyone. That's why financing of our solutions is a natural part of our service offering. As a company that places a great deal of emphasis on our vision of the future, we also provide a range of convincing implementation concepts.

Because we dedicate a great deal of energy to ensuring progress together, we have created a separate division to deal with the financial side of the business.

We are big enough to be able to offer financing from a single source. If a project requires it, we also cooperate with specialists. We think in terms of liquidity and balance sheets.

We can handle sales and project financing. We can also support our customers with dedicated local teams. They know the regions they operate in. They are also experts in the fields for which finance is available.

We form teams of structuring specialists and risk experts. From project development and construction to day-to-day operations, you can rest assured that your financing is in safe hands – our hands. Development loans from federal or regional government, European institutions, financial advisory bodies, hedge funds as well as equity and credit capital are all familiar territory for us. We also ensure that they are equally familiar to our customers.

### SERVICE FOR CONTROLLABLE POWER GENERATION

- Optimal and flexible support
- Remote data monitoring enables online access to the system, minimizing downtimes, increasing availability and keeping repairs as low as possible
- All maintenance, upgrading and revision tasks are provided at site

### SERVICE FOR RENEWABLE POWER GENERATION

- Visual inspection of all system parts for mechanical damage
- Examination of protective systems according to the current VDE-/IBE regulations
- Functional check of all safety and protection equipment
- Functional check of all metering and metering data transmission equipment
- Cleaning of the modules
- Detailed maintenance reports



IN SAFE HANDS

THE HIGHLY QUALIFIED AND EXPERIENCED BELECTRIC TEAM HANDLES THE MAINTENANCE AND REPAIR OF ALL THE COMPONENTS REQUIRED FOR OPERATION, INCLUDING REGULAR VISUAL AND FUNCTIONAL INSPECTIONS.

# Be prepared

Another frequent problem: electric power is available, just at the wrong time. This is because renewable energy sources do not always supply power when it is needed. However, for reasons of grid stability, a highly volatile power supply that is not synchronized with demand can cause problems. It can often even be necessary to deny surplus electric power access to the grid. The obvious solution is to store this electricity. However this is still relatively expensive – at present at least.

Our storage solution is an established technology with sealed lead acid batteries manufactured by EnerSys, combined with an inverter and battery management system from GE. This makes decentralized energy management significantly easier.

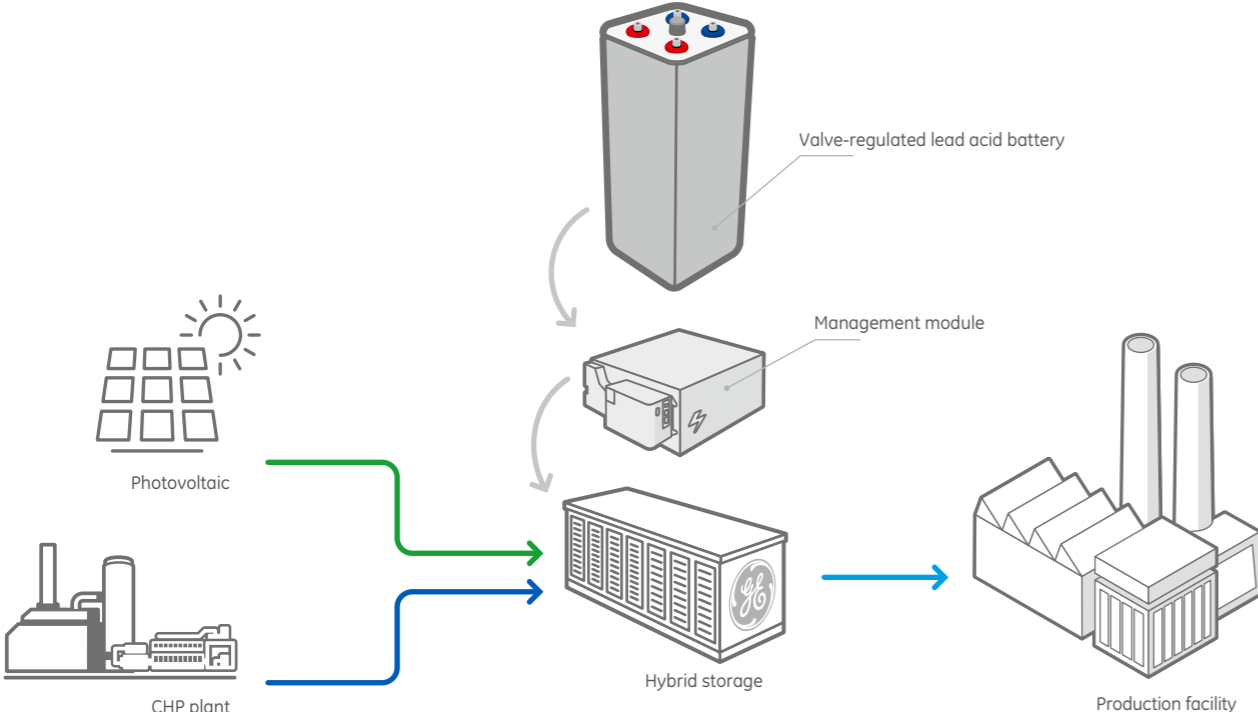
The valve-regulated lead acid batteries are based on a gel and tube technology. They are highly reliable and exceed the standard DIN values. In addition, they offer excellent durability in the trickle charge mode and feature high cycle stability. They are therefore - scout's honor - always prepared.

### CERTAINLY IDEAL

The sealed hybrid storage battery already has advantages with regards to its transport demands, as due to the applicable packing requirements, the transport does not fall under the ADR ordinance on the transport of dangerous goods (European agreement concerning the international carriage of dangerous goods by road). The battery can therefore in compliance with ADR be transported without extra effort both before installation and later disposal.

Sealed lead acid batteries are non-spillable. Therefore, in accordance with the relevant battery compartment standard DIN EN 50272-2 no retention pond or specific ground are necessary. The batteries are low-maintenance, no water, as is often the case, needs to be refilled.

And finally: Also the recycling has been practice-proven for decades. In the industrial sector a recycling rate of more than 99 percent is being achieved.



### THE BENEFITS OF THE STORAGE BATTERIES



#### Safe and environmentally friendly

The sealed lead acid batteries are non-spillable. The recycling has been practice-proven for decades. The recycling rate is almost 100 percent



#### Reliable technology

The batteries provide reliable services in the industry with high cycle stability and smooth recharging after deep discharge



#### Flexible solution

Capacity of 215 Ah to 3,170 Ah, low investment costs



#### High durability

The design life is 20 years at 20 °C



# An intelligent approach to system management

## ALL IN ONE, ONE FOR ALL

The management system records, converts, transfers and processes data. This data provides a reliable basis for optimized operational management. It can be used to control and manage different power generation systems, power storage and currents.

Because power consumption and currents are recorded and documented, the power management system also provides the basis for investment decisions and for improving energy efficiency. The centerpiece of the system and the location of its intelligence is a high-performance CPU.

Contractors like Kofler Energies offer customized solutions for the operational management. These contracting services enable customers to exploit their efficiency potential and to save resources which they need for their core business.

## 1.

### THE KEY CHARACTERISTICS

- Complete planning and implementation
- Use of proven components
- Redundant solutions
- Transfer in real time
- Easy adjustment and expansion
- Can be retrofitted to any power distributor/UPS
- Power Management

## 2.

### TECHNICAL BENEFITS

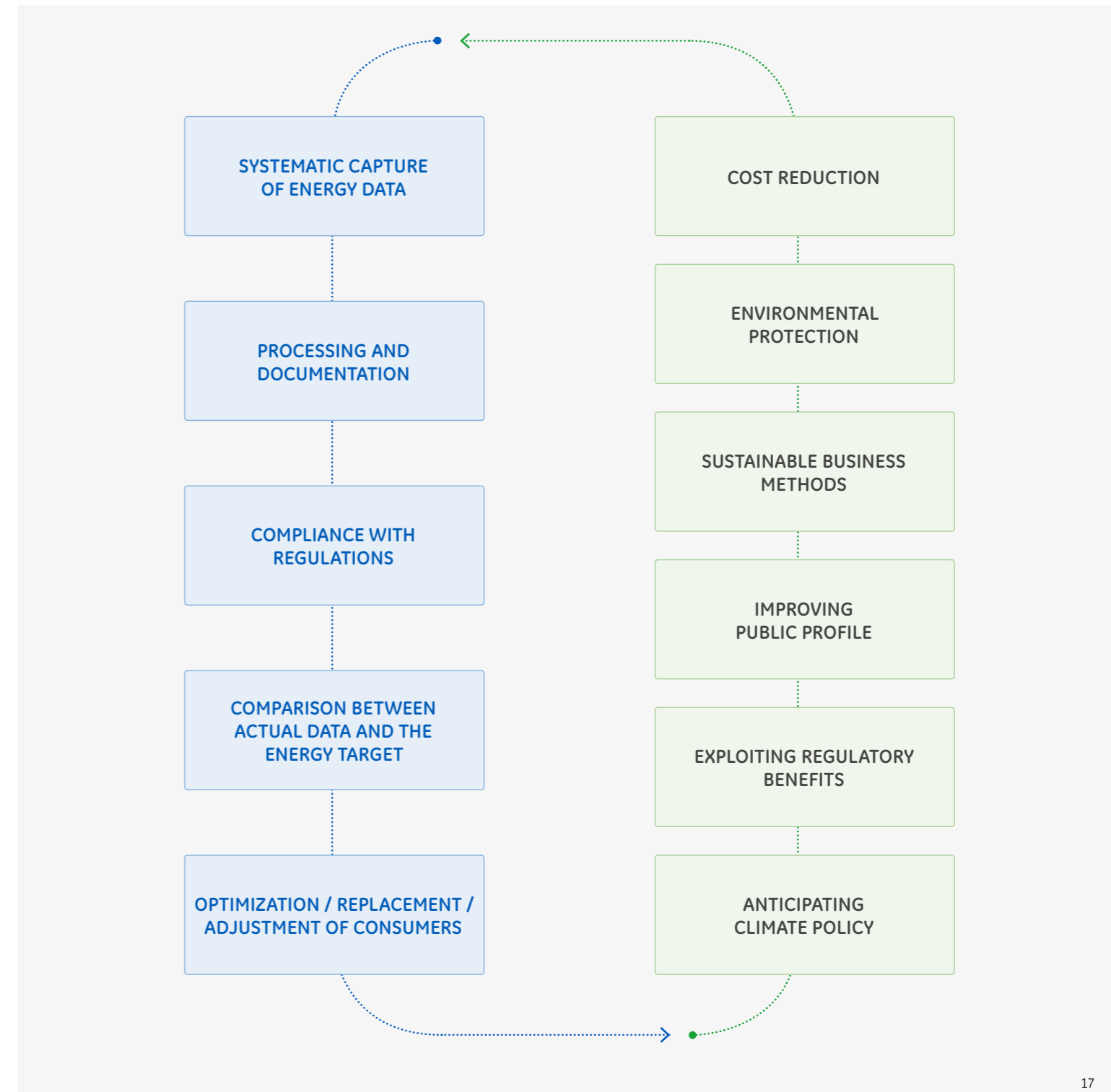
- Reliable recording of operating states
- Overview of the entire system as a block diagram
- Maintenance management
- Increasing system availability
- Easy operation
- Load control
- Archiving of data (reporting)
- Alarming
- Control of assets
- Logging
- Mobile communication connection

## 3.

### ECONOMIC BENEFITS

- Transparent power costs
- Configured reporting system for evaluation purposes
- Automatic documentation of system states and savings
- Effective plant operation
- Effective workforce management
- Remote access means no time is wasted on travel to the plant
- Local inspections reduce fast and effective error detection and troubleshooting
- Scalability

## THE PRINCIPLE BEHIND THE ENERGY MANAGEMENT SYSTEM



# A joint approach towards an independent future

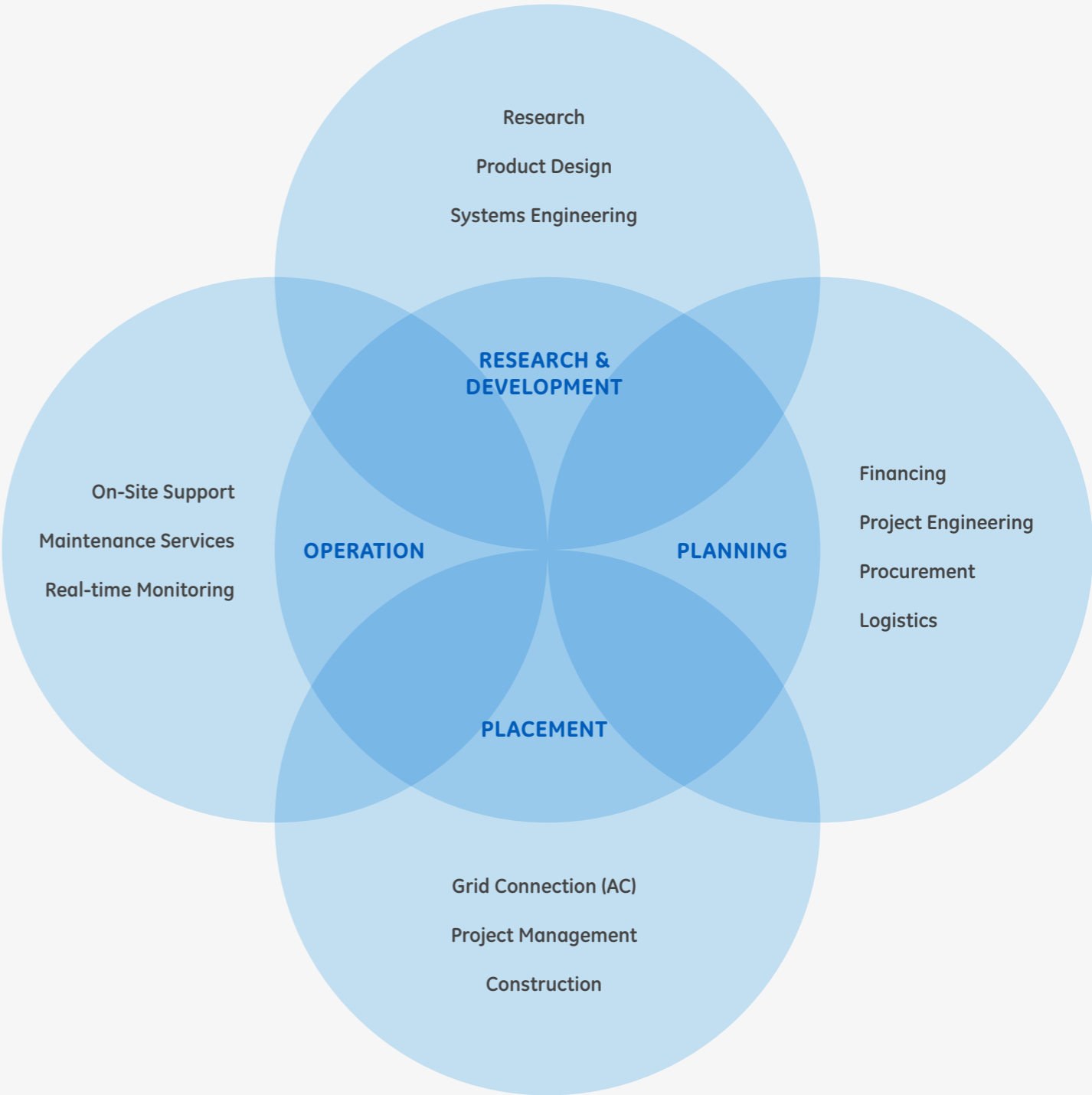
## THE FIRST STEP IS THE ONE THAT COUNTS

At present there is no single optimum route when building and operating a hybrid power plant. That is why we are planning to cooperate with our customers more closely and in greater partnership than ever before.

We are aware that we need to think in several different directions. Experiences gathered constantly need to be reconsidered in order to avoid moving in circles. We do not intend following in other people's footsteps, because this is not the way to discover new things and navigate new territories.

We are ready for the path ahead. That path involves the greatest possible independency in power generation, which has the added benefit that power can continue to be generated long after investments have been redeemed. The share of renewable energy is then practically on your doorstep. This is a fascinating outlook. What's more? We will also continue to analyze and reduce CO<sub>2</sub> emissions. This will involve new technologies, new software tools and upgrades.

Things are going to be exciting. We are looking for partners and customers who share our pioneering spirit.





[ge.com/de](http://ge.com/de)



GE imagination at work

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