



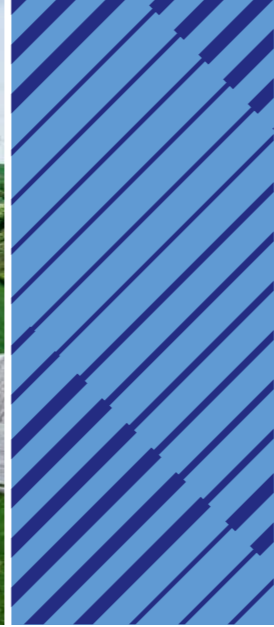
Power Generation

GRID-SCALE ENERGY STORAGE SOLUTIONS

The future of renewable energy for utility services



A Rolls-Royce
solution



MAXIMUM SYSTEM RELIABILITY AND SCALABILITY

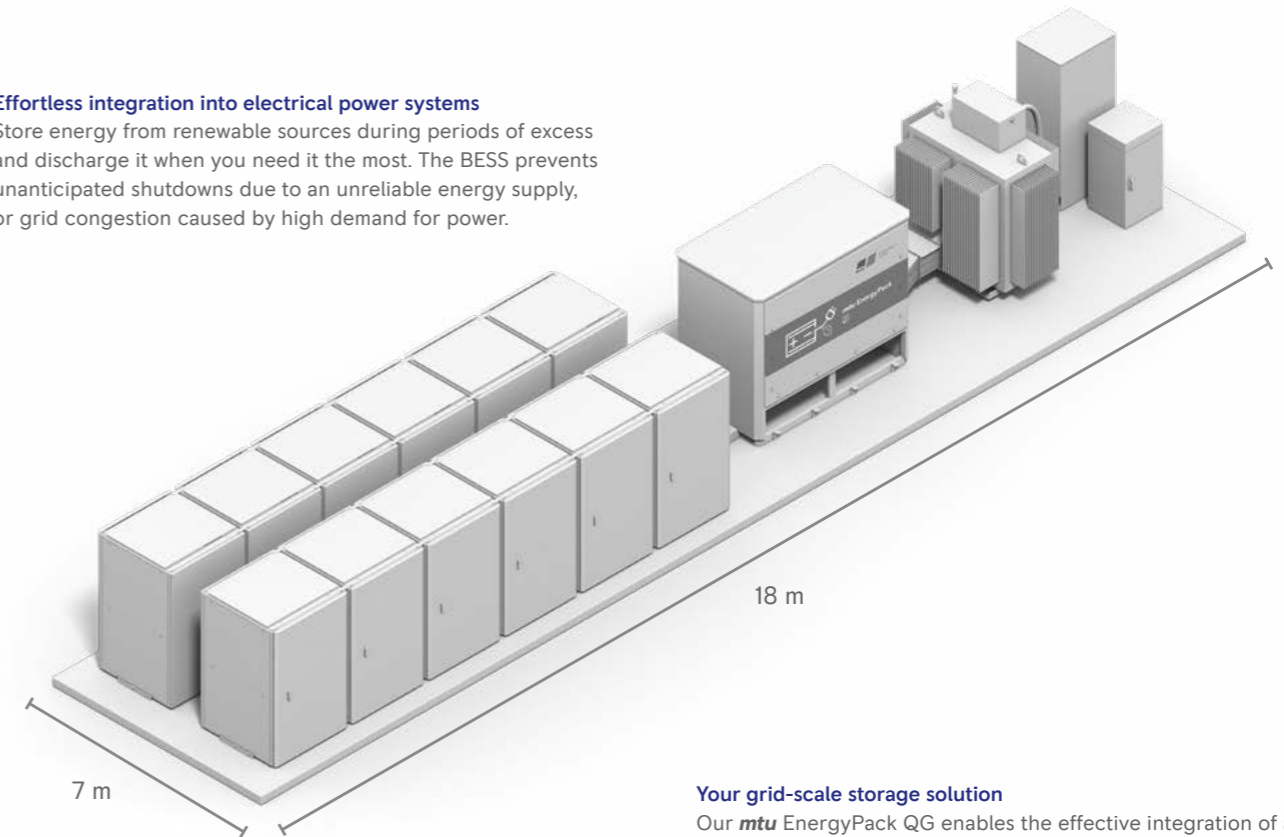
As utility networks worldwide continue to add more renewable energy, our grid-scale battery energy storage system (BESS) helps to stabilize the grid. Combined with the **mtu** EnergetIQ Manager, it efficiently stores and dispatches energy by bringing together high-quality hardware, intelligent software and unparalleled service.

We help lower life cycle costs and provide reliable energy solutions for utilities and developers alike - make a smart investment in the future of energy with our innovative solutions.



Effortless integration into electrical power systems

Store energy from renewable sources during periods of excess and discharge it when you need it the most. The BESS prevents unanticipated shutdowns due to an unreliable energy supply, or grid congestion caused by high demand for power.



Your grid-scale storage solution

Our **mtu** EnergyPack QG enables the effective integration of a high level of renewables, solar or wind, in energy systems.

The scalable design is optimized for front of the meter grid-scale battery energy storage system with typical storage capacity ranging from around 8.9 MWh to 100 MWh and more.

SUSTAINABLE POWER THAT MATTERS

The Power Systems Business Unit of Rolls-Royce is focused on creating sustainable, climate-neutral solutions for drive, propulsion and power generation. We are making a significant contribution to the energy transition with environmentally-friendly technologies from our **mtu** product and solution brand. As leaders in standby power for safety-critical plants and in integrated drive and propulsion systems for ships and heavy-duty land vehicles, our customers know they can depend on us, and have been doing so for over 110 years.

KEY FEATURES BASED ON INDUSTRY-LEADING TECHNOLOGY



Highest level of safety and reliability

- Protection level IP54
- Insulation monitoring device
- Aerosol fire protection system



Long service intervals and life cycle

- Market leading supplier of LFP batteries and inverters
- Liquid cooling system lowers cell temperature deviations, allows longer lifetime and higher energy density
- Low maintenance



Simple integration for minimal installation risk and time

- Flexible tailoring of base units, scalable to project-specific power and capacity needs
- Modular design and high energy density footprint
- Easy assemble after transportation



Excellent performance for the most demanding grid-scale applications

- Minimal downtime, fast charge and discharge rates
- Ultrafast (ms) response and load acceptance, ideal for frequency regulation services
- Standardized and modular for economic design
- System voltage of up to 1,500 V increases operating efficiency



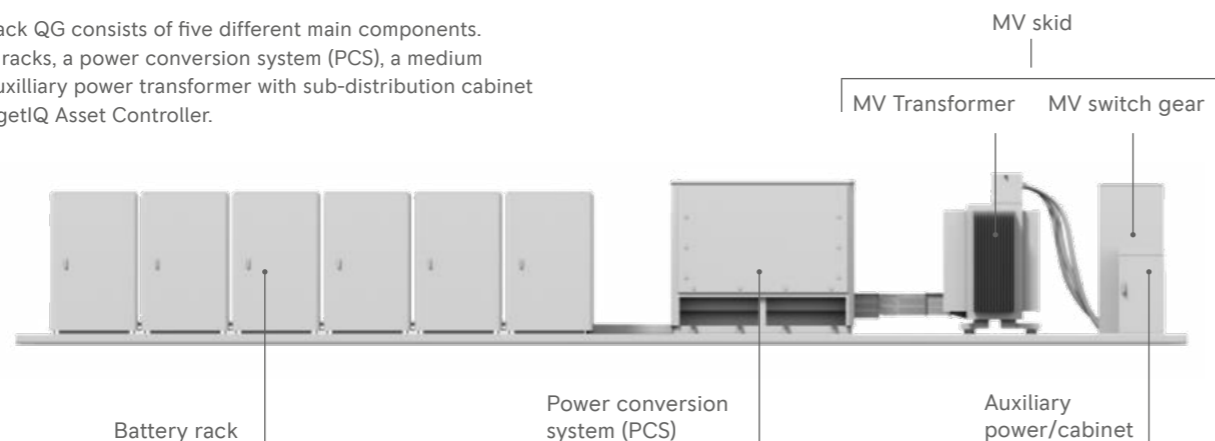
Intelligent control platform *mtu EnergetIQ* for optimal performance and flexibility

- Automated control of power generation, storage and demand for an optimized operation
- Cloud data storage for performance analysis and optimization
- Easy integration of assets
- Monitoring of asset and system performance for a range of energy sources

mtu ENERYPACK QG

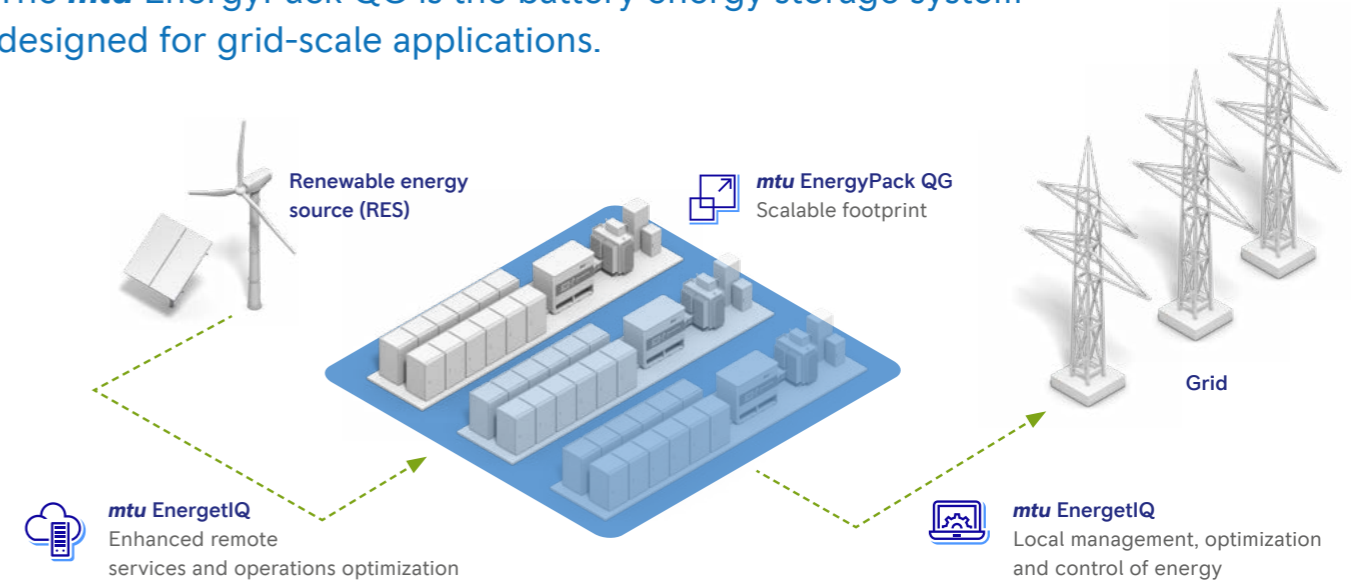
The *mtu* EnergyPack QG is key to effectively integrating a high level of solar and wind renewables in power systems.

The *mtu* EnergyPack QG consists of five different main components. These are battery racks, a power conversion system (PCS), a medium voltage skid, an auxiliary power transformer with sub-distribution cabinet and the *mtu* EnergetIQ Asset Controller.



UNLIMITED SCALING MEETS PROJECT-SPECIFIC NEEDS

The *mtu* EnergyPack QG is the battery energy storage system designed for grid-scale applications.



A complete plant design may consist of multiple building blocks. Each block is designed for 4.39 MVA nominal charge and discharge rating up to 17.89 MWh, consisting of up to 48 battery racks. One battery rack has an energy content of 372.7 kWh and contains

integrated control, fire suppression, cooling and heating systems. As standalone operational units and due to their modular design, the racks can easily be replaced in case of failure, ensuring reliable operation with the highest availability of your batteries.

Three basic system configurations are available: QG0.25 (4h storage) / QG0.5 (2h storage) / QG1 (1h storage)

Name of System	QG0.25	QG0.5	QG1
C-rate of the system	0.25	0.5	1
C-rate of the used battery	0.5C or 1C		
Maximum number of battery racks with 372.7 kWh each	24 / 48	24	12
Total capacity of batteries in MWh	8.94 / 17.89	8.94	4.47
Number of asset controllers (1 per 12 battery racks)	2 / 4	2	1
AC output power MVA @40°C	2.19 / 4.39	4.39	4.39
Operating grid voltage VAC	6.6 kV / 11 kV / 13.2 kV / 15 kV / 20 kV / 22 kV / 23 kV / 25 kV / 30 kV / 33 kV / 34.5 kV		
DC voltage range VDC	976 - 1500		

TECHNICAL DATA

The **mtu** EnergyPack QG based on one fully assembled base unit.

Sections	Value	mtu EnergyPack QG0.5	Unit
System	Cell chemistry	LFP	
	Nominal capacity at 0.5 C	8.94	MWh
Ambient conditions	Minimum ambient temperature	-20 (-30)	°C
	Maximum ambient temperature	+40 (+55)	°C
	Humidity	< 95 condensing	%
	Maximum operation altitude	≤ 1,000 (≤ 2,000)	m
Electrical	Nominal apparent power	4.39	MVA
	AC short circuit capability	TBD	kA
	Grid frequency	50 / 60	Hz
	Power factor range	TBD	
	Black start capability	Optional	
Housing	Corrosion protection	C4	
	Protection class	IP54	
	Footprint of one fully assembled base unit	7.1 x 19	m
MV-skid option	Voltage	6.6 to 34.5	kV
Interface	Supported communication protocol	Modbus-TCP (Modbus-RTU, IEC 60870-5-104, IEC 61850, DNP3)	

Note: values in parentheses () are optional and might have an impact on derating.

Standards

- IEC 62619, IEC 62477-1, IEC 61000-6-2
- Power conversion system: IEC 61000-6-3 or IEC 61000-6-4, IEC 62485-5, CE

ALL KINDS OF SOLUTIONS FOR ALL KINDS OF PROJECTS

The **mtu** EnergyPack QG can be scaled in line with demand to cost-effectively maximize asset value.

Utilities and grid service providers

Our **mtu** EnergyPacks take care of frequency regulation, manage grid congestion and help to avoid significant investment in grid infrastructure. Solar and wind power become more reliable and instantly switchable, while gas or diesel power plants operate more efficiently when combined with the **mtu** EnergyPack.



Community

For local power generation, our **mtu** EnergyPacks increase the self-sufficiency of urban areas and provide reliable backup power. Areas not connected to the public grid can ensure high-quality power while integrating renewable energies to reduce their carbon footprint and reduce costs.

Industry

Industrial operations that currently run on diesel power and are not connected to the grid can reduce their fuel consumption and meet legal and company environmental standards by integrating renewable sources with an **mtu** EnergyPack. Grid-connected operations can utilize an **mtu** EnergyPack to reduce the power draw charges, increase own-use consumption of existing onsite generation and mitigate rising energy costs.



WIDE RANGE OF TARGET APPLICATIONS

The **mtu** EnergyPack's industrial design is built for the most demanding applications. The system is highly configurable to meet your operational requirements and can be scaled in line with demand to cost-effectively maximize asset value.

Energy shifting

The **mtu** EnergyPack stores excess energy from PV systems or any other generation source in the grid for use at a later time (e.g. peak shaving, load shifting).

Energy trading

In combination with the **mtu** EnergetIQ Manager, the system facilitates participation in the higher level electricity markets in front of the electric metering point. In deregulated electricity markets, revenues can be generated by trading in wholesale markets e.g. day-ahead or intraday markets.

Frequency regulation and power balancing

Our solution monitors the grid and ensures an instantaneous active and reactive balance between load and generation to help stabilize the frequency of the network (ancillary services).

Reactive power and voltage regulation

The power electronics part of the **mtu** EnergyPack contributes to the voltage regulation of the grid and provides reactive power support to the network.

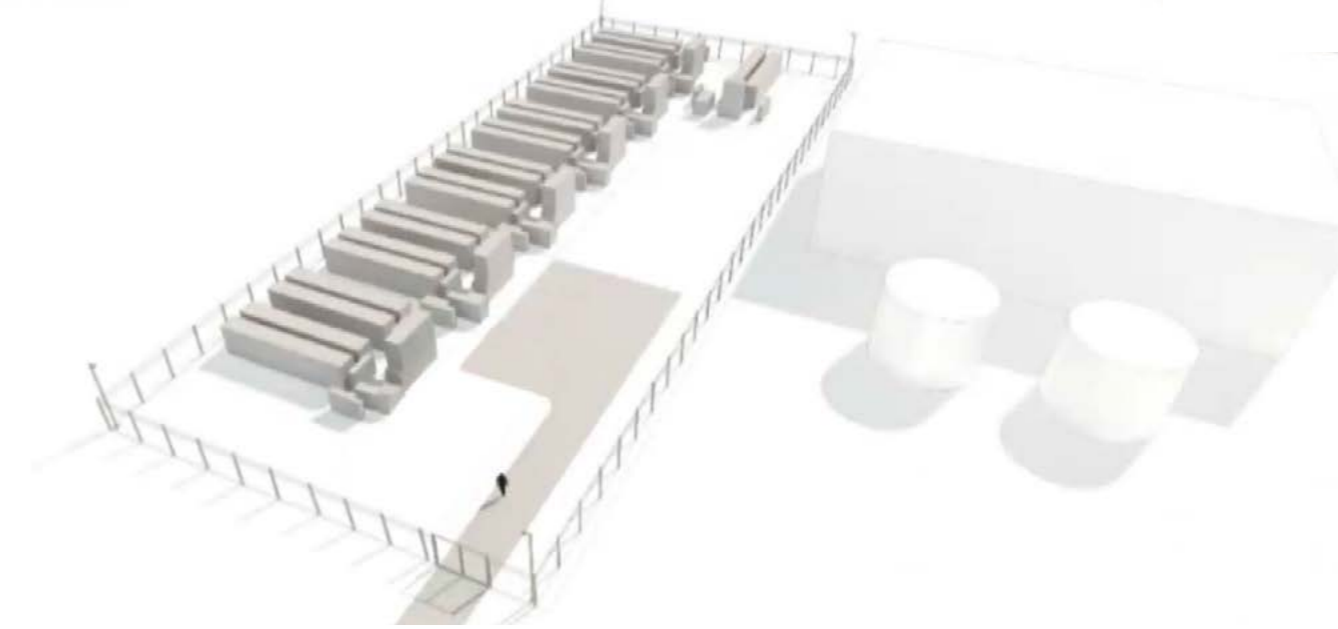
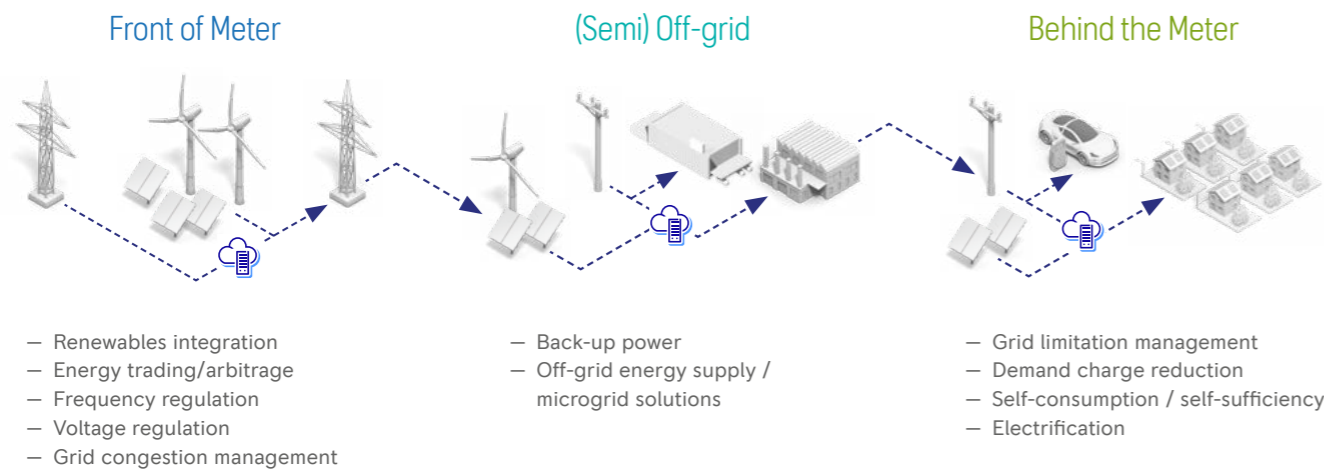
Performance optimization

The combination of the above functionalities enables the integration of large amount of renewable energy, lowers the cost of conventional energy generation systems, and provides high quality and reliable power in on-grid applications.

Transmission and distribution support

Grid-scale energy storage solutions supply enough capacity to defer or eliminate the need to upgrade grid infrastructure. This enables grid congestion management.

We address your needs with a comprehensive BESS portfolio



REFERENCE PROJECT: SEMPERPOWER

One of our **mtu** EnergyPack QG systems is the largest battery storage facility in the Netherlands at the time of commissioning and one of the largest in the EU, providing a comprehensive EPC turn-key solution.

Description: Battery storage for frequency control and arbitrage

Location: Vlissingen, NL

Customer: SemperPower

Scope: **mtu** EnergyPack QG including: 168 battery racks, DC/AC inverters, transformers 690 V / 11 KV, **mtu** EnergetIQ Manager. EPC: construction, grid connection building, site facilities, road, fencing, and civil works including: logistics, project management, quality control and HSE supervision. Mechanical and electrical installation, commissioning and testing.

Installed capacity: 30.7 MW / 62.6 MWh, 0.5 C, 690 V / 11 KV

Timeline: December 2022 - February 2023 / Commissioning August 2023

Takeaways:

- Our project scope includes the supply and installation of a large-scale battery storage system on a turnkey basis to the Dutch energy company SemperPower in Vlissingen.
- The order includes general contractor services, as well as the construction of the building and other infrastructure.
- Main applications: grid frequency regulation in the Netherlands to integrate electricity from renewable energy sources into the public grid.
- When fully charged, the system has the capacity to supply 8,000 households with electrical energy for an entire day.
- Solution consists of 168 battery units, 7 inverters and the intelligent control platform **mtu** EnergetIQ.

“We see it as our task to accelerate the energy transition. We do this by using energy storage systems that store sustainable energy in times of surplus and release it when the market needs it. We are delighted to have found Rolls-Royce as a partner who, with its high-quality solutions, is pulling in the same direction as us.”

Dennis Schiricke, CEO SemperPower B.V.

GLOBAL TRACK RECORD

Our expertise and experience have enabled us to achieve a proud track record and to continuously improve product performance.

5
continents

39
countries

>190
MWh installed



- 1 *mtu*-certified technicians
- 2 Lifetime-Based Overhaul (LTBO)
- 3 Factory reman solutions
- 4 Complete life-cycle support

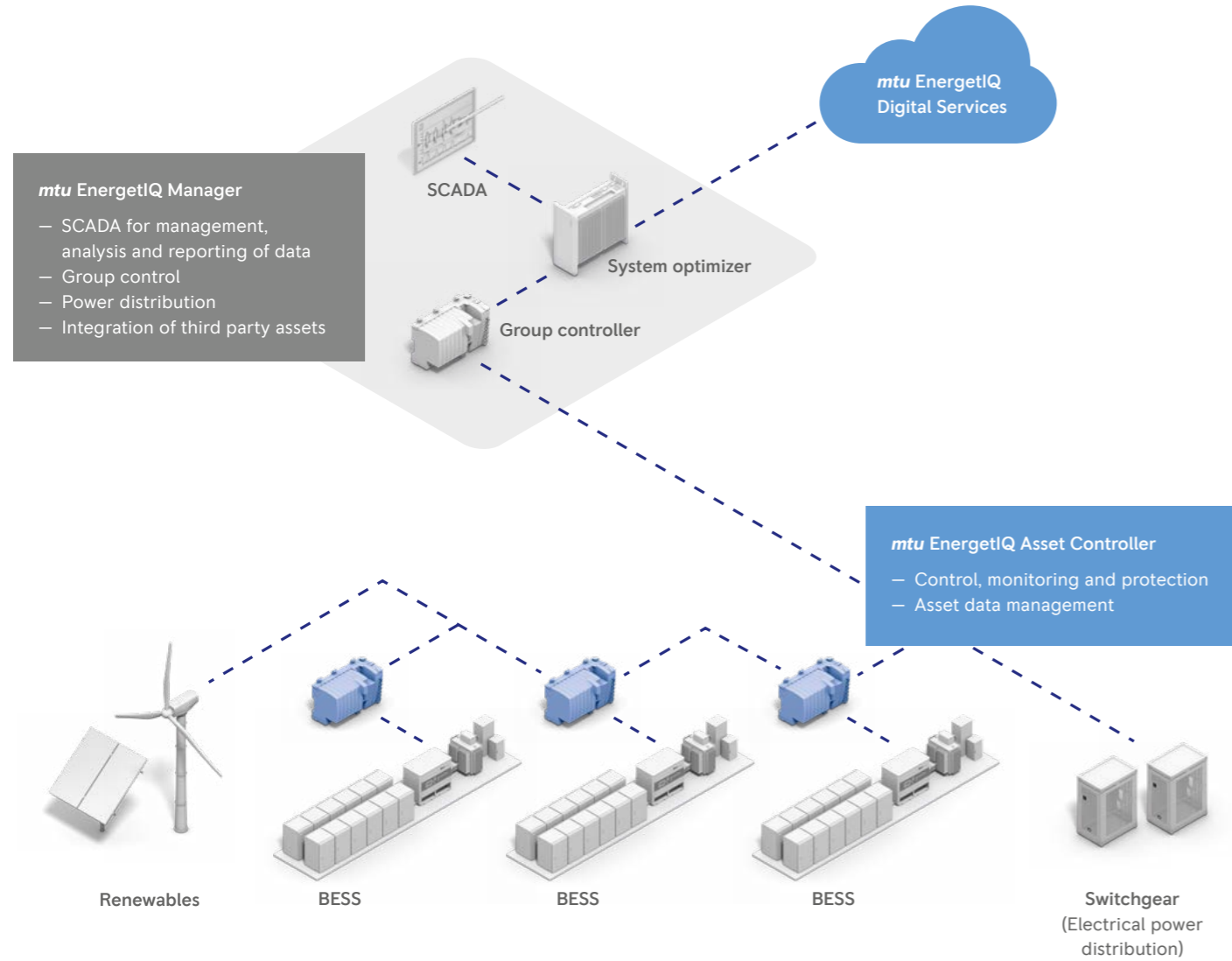
STRONG SALES AND SERVICE PLATFORM ACROSS THE WORLD

-  1,200 locations
-  180 countries
-  >350 service partners
-  4 customer care centres

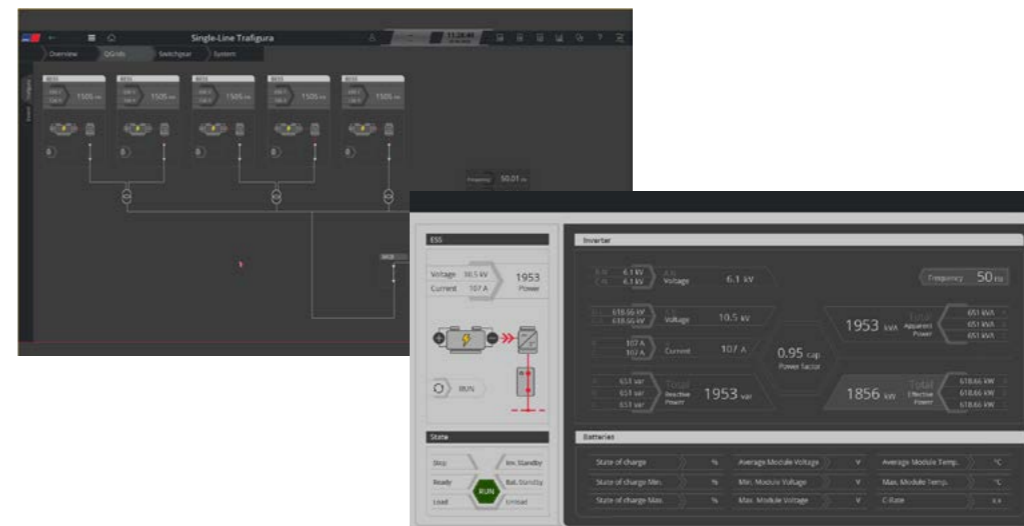


mtu ENERGETIQ: THE BRAIN OF YOUR POWER PLANT

The **mtu EnergetIQ Manager** optimizes your power plant's performance, by seamlessly integrating its diverse assets and automating the control of power generation, storage, and demand. With the **mtu EnergetIQ Asset Controller** you can easily control and monitor the functional-level of your **mtu EnergyPack**.



Offering	Characteristics
System-wide services	<ul style="list-style-type: none"> One common user interface for all different assets Easy SCADA system integration and customization options User management with audit trail to control and record access to plant manager and assets IT security concepts according to project specific analysis
Data management	<ul style="list-style-type: none"> Data acquisition of connected assets, switchgear and grid SQL database with access by web-based query technology Modular data analysis including correlation to external data Data visualization and reporting with dashboards and interactive Jasper reports
Functions	<ul style="list-style-type: none"> Real-time control, monitoring and protection Asset health analytics Multiple BESS applications covered, such as, the reserve market, energy storage control, spinning reserve, load shedding, sector coupling etc. Wide range of predefined and configurable layouts for trending and reporting



All data on one screen, including assets such as gensets, BESS, photovoltaics and more.

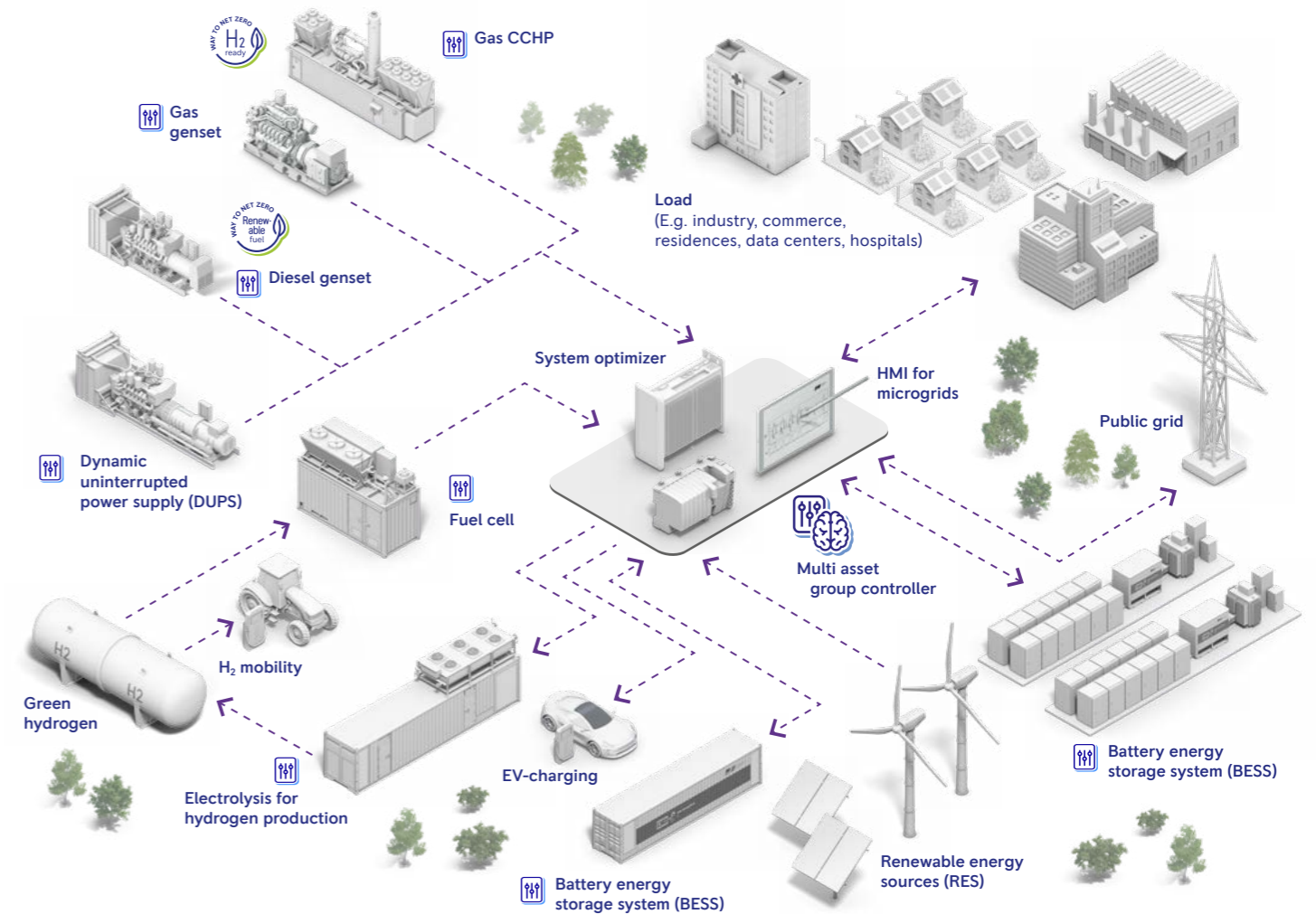
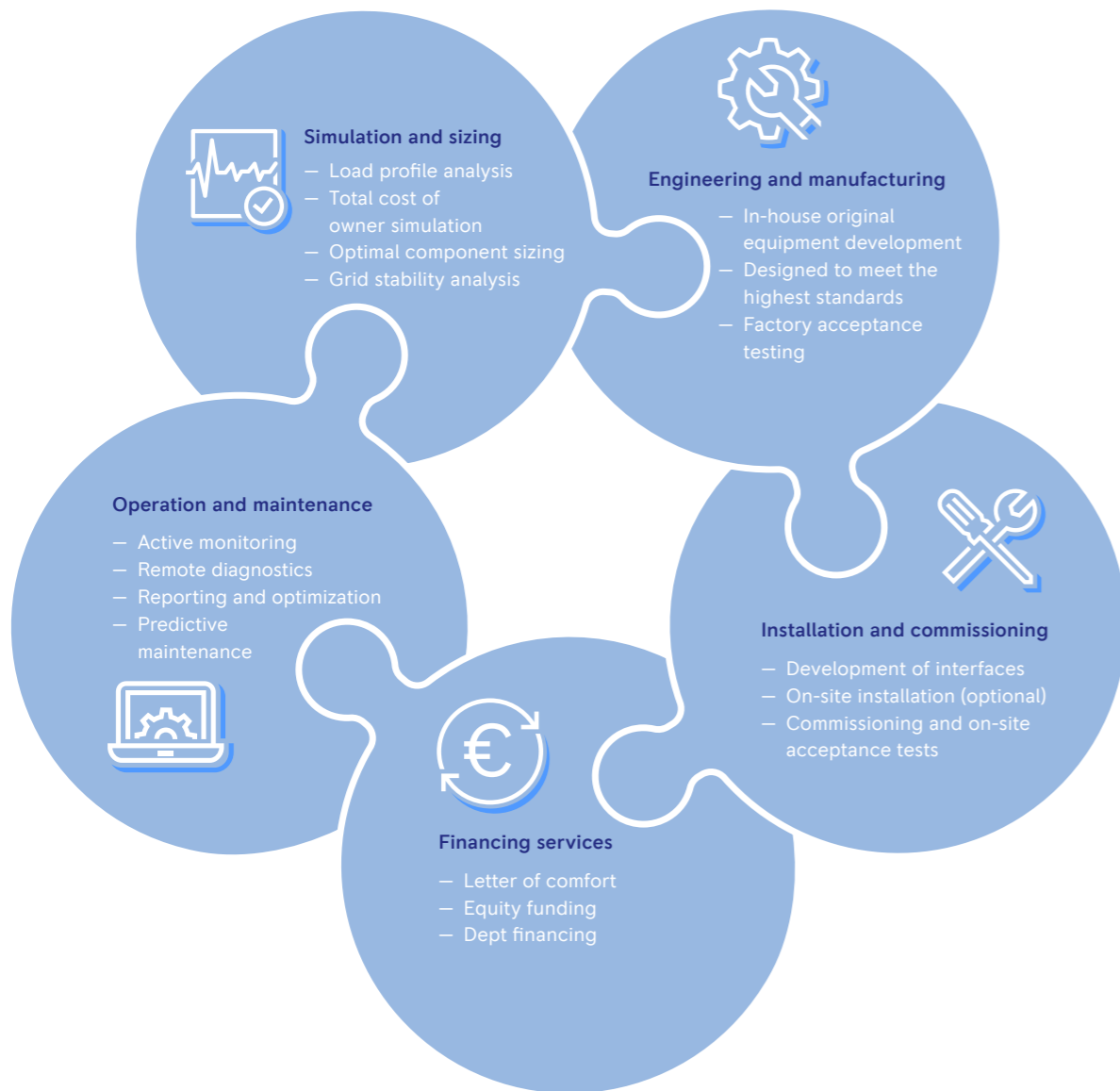
- Comprehensive presentation of information
- System-wide states / alarms / relevant power data
- Individual, region-specific settings are available (colors and symbols)

WE OFFER COMPLETE INTEGRATED SOLUTIONS

With our broad portfolio of sustainable energy solutions we meet your needs today and tomorrow.

The Power Systems Business Unit of Rolls-Royce provides a variety of services and complete life-cycle support under the product and solution brand **mtu**. Each can be individually designed to serve your

specific needs. BESS services include consulting, planning, financing, single-source supply of hardware and software, as well as installation and maintenance.



Do you need support?

Our team of experts will help you design a system that meets your project goals and maximizes your site's potential.

www.mtu-solutions.com/powergen

We are here to support you at every stage from design to installation and throughout the system's operational life.

- Overall system evaluation and design support from project development through project closing
- Detailed hardware and software engineering including integration of existing power generation units
- Delivery and commissioning of the energy storage solution
- Training of local operator and maintenance staff
- Remote technical support and monitoring during operation



Follow us for our latest news
and energy solutions: @mtusolutions



Rolls-Royce Group
www.mtu-solutions.com/powergen

The Rolls-Royce name, Rolls-Royce badge and Rolls-Royce monogram logos are registered Trade Marks of Rolls-Royce plc