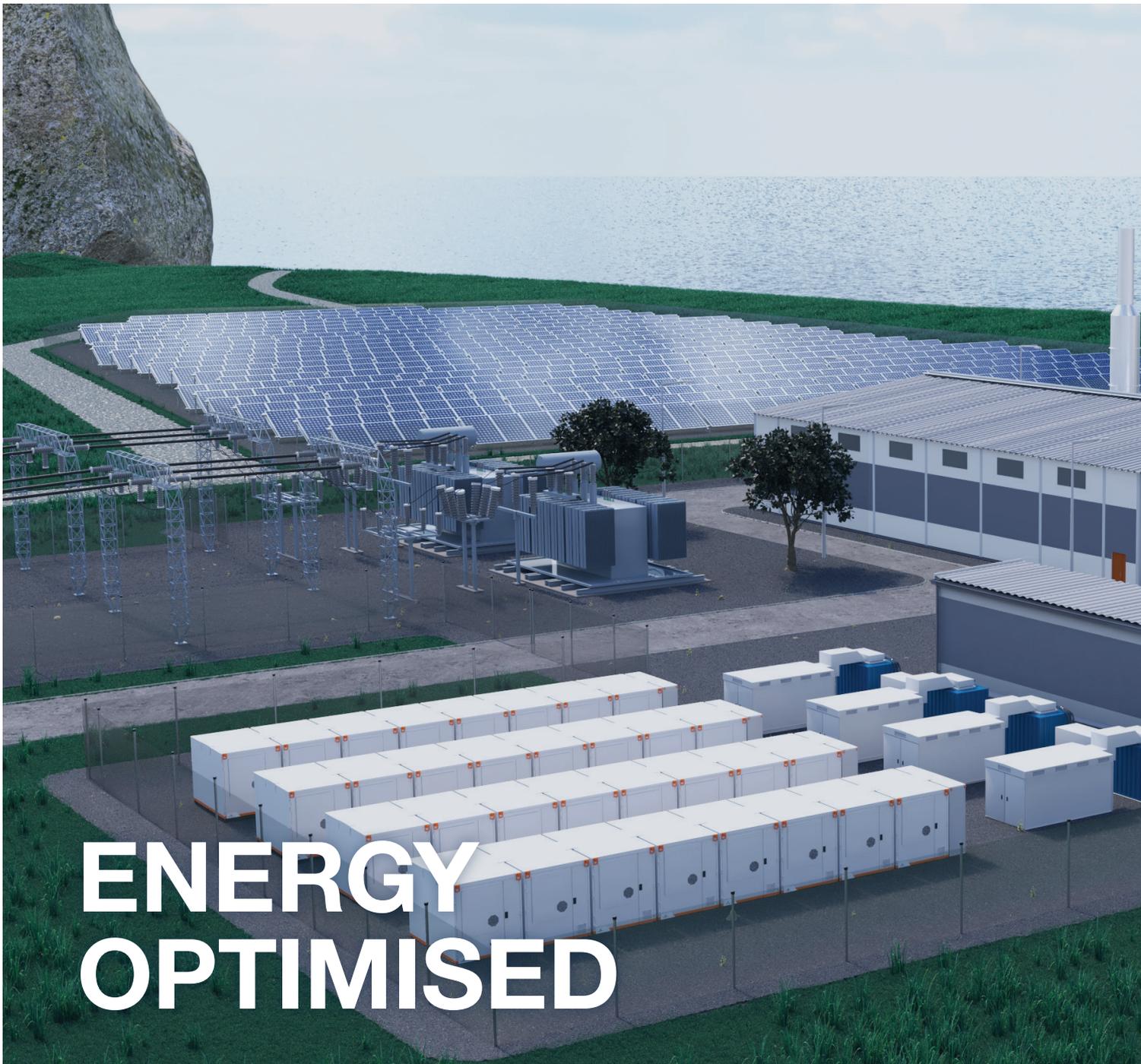


ENERGY STORAGE AND OPTIMISATION

Read more at
storage.wartsila.com





ENERGY OPTIMISED

As the world moves towards 100% renewables, energy providers are motivated to harness the potential of clean energy, including energy storage and intermittent energy sources such as solar, wind and hydro power. At Wärtsilä, energy storage plays a key role in our vision towards a 100% renewable grid.

**OPTIMISING ENERGY FOR A SMARTER,
SAFER, MORE RELIABLE GRID.**



**WE'RE UNLOCKING THE
WAY TO AN OPTIMISED
RENEWABLE ENERGY
FUTURE.**

TOWARDS A 100% RENEWABLE ENERGY FUTURE

Wärtsilä Energy Storage & Optimisation (ES&O) is leading the introduction of disruptive, game-changing products and technologies to the global power industry. We're unlocking the way to optimised power systems with our flexibility solutions.

By integrating renewables, energy management technology and storage with traditional energy resources, we reinvent clean energy production from the largest and most complex grids to the most remote and essential islanded grids.

SMART TECHNOLOGY

Hybrid energy with sophisticated software

Spanning grid-scale, hybrid and island microgrid solutions, an intelligent software is at the heart of our GEMS energy management platform, enabling customers to tap into the full potential of their resources. GEMS software enables intelligent energy applications that deliver a true "renewables as baseload" solution that is climate-friendly, increases resilience and efficiencies and can be supported by existing grid infrastructure.

TOTAL FLEXIBILITY

Leading global energy storage optimiser

Combined with the deep global resources and expertise, we seamlessly integrate traditional and renewable power sources, provide visibility into critical energy systems and optimise multiple generation assets, all while delivering unsurpassed reliability, flexibility and safety to energy operators around the world.

A HYBRID FUTURE REALISED

Expertise with a proven track record

We reach into an expanding global market for programmable energy storage with operations in over 200 locations in more than 80 countries around the world. We offer unrivaled solutions to the most pressing energy challenges, including the integration of more renewables.

5GWh+
GLOBAL STORAGE FLEET

200+
LOCATIONS

110+
DEPLOYMENTS

ES&O Products

GEMS DIGITAL ENERGY PLATFORM

Wärtsilä's sophisticated **GEMS Digital Energy Platform** is a smart software platform that monitors, controls and optimises energy assets on both site and portfolio levels. Addressing complex technical and economic factors, GEMS supports a wide variety of battery and power electronics to achieve optimal system performance. GEMS integrates and controls individual resources and entire fleets comprising energy storage, renewables and thermal generation. Using machine learning and historic and real-time data analytics to optimise the asset mix, GEMS enables customers to remotely monitor, operate, identify and diagnose equipment with unrivaled safety, reliability, and flexibility. GEMS' flexible architecture—dynamically adjusting based on market conditions—addresses a critical need for intelligent and adaptable software.

Real-time optimisation can create new revenue streams by leveraging the available transmission capacity at existing sites while providing ancillary services.

For example, GEMS optimises wind and solar on the Portuguese island of Graciosa, providing energy security and independence for the once fuel-dependent island. Likewise, the flexible software also analyses changes in market conditions and rate structures in the first energy storage installation in Hungary. The unique integration of energy storage and GEMS within an engine power plant—combining new energy generation with the existing three Wärtsilä W34SG engines—allows the plant to operate in a virtual mode, opening new opportunities in the Hungarian energy market.

Finally, in a project with Duke Energy at a retired coal plant in Ohio, USA, GEMS provides precise and synchronised response to the PJM (Pennsylvania-New Jersey-Maryland) market, delivering quick power versus the lengthy ramp time of a traditional power plant.



Wärtsilä's GEMS is an energy management platform that integrates, manages and optimises multiple generation assets seamlessly and in real-time under both site and portfolio levels.

Wärtsilä Energy Storage & Optimisation
first to achieve cybersecurity
certification for a hybrid controller



THE GEMS PRODUCTS

The **GEMS Fleet Director** (FD) provides centralised, real-time visibility into a global fleet of power plants and is hosted in the cloud, including:

- Data historian and analytics
- Market bidding
- Smart performance warranty
- Fleet management

The **GEMS Power Plant Controller** (PPC) conducts intelligent power control and optimised energy management operations at power plants of all sizes:

- Power Plant Control
- Energy management
- Power management

The **GEMS Grid Controller** (GC) is responsible for:

- Grid control
- Intelligent plant dispatch optimisation in island grid



Combining multiple data sources, GEMS uses algorithms and machine learning to automate decision-making for energy producers.

 **Wärtsilä North America awarded IEC 62443 certifications for the GEMS Power Plant Controller**

GEMS IntelliBidder

The key to the growth of energy storage as a market category is **auto-bidding**, the ability to leverage artificial intelligence for the automated bidding of stored renewable power into competitive electricity markets.

Wärtsilä's GEMS IntelliBidder is a **cloud-based software product that provides smart-bidding functions**. The GEMS IntelliBidder is part of the GEMS Digital Energy Platform product suite. It uses optimisation algorithms and machine learning based on both automated and forecasted data, such as price and load forecasting, for smart bidding. The product creates revenue-optimised suggested bid decks for the available services based on the current state of the energy storage system (ESS), forecasted pricing, and related market operating conditions. It also provides price forecasts for market services, based on a time-series analysis of the relevant and correlated input data.

Employing these capabilities, Wärtsilä offers configurable automated bidding solutions for key markets, including: ERCOT (Texas, USA), CAISO (California, USA), MISO (Midwest, USA), AEMO (Australia) and National Grid ES (UK).

The GEMS IntelliBidder provides the following capabilities to evaluate bid optimisation functions and strategy performance:

- Electricity market price and renewable forecasting
- Schedule commitment
- Automatic bid generation
- Manual bid entry
- Integration with Independent System Operator (ISO) Application Programming Interfaces (APIs) for bid submission
- Key performance indicator monitoring

The result? Revenue opportunities for customers via the maximisation of economic benefits within real-time market operations according to their objectives, portfolio constraints, and market trends/uncertainties.

GEMS INTELLIBIDDER IN ACTION

Featuring a 40MW / 80MWh DC-coupled solar plus storage GridSolv Quantum system, the Hickory Park Solar project in Georgia, USA uses the IntelliBidder to provide advanced, day-ahead, hourly power commitments. With IntelliBidder, Hickory Park Solar optimizes and risk handles its Power Purchase Agreement (PPA) commitments in a bilateral arrangement between the project's developer and off-taker.



GRIDSOLV QUANTUM

Optimised for flexibility, functionality and safety.

GridSolv Quantum introduces modular flexibility as a holistic, fully integrated system. Compact and minimalist in design, GridSolv Quantum ensures the lowest lifecycle costs and the smallest system footprint, plus minimised scope and complexity of Engineering, Procurement and Commissioning (EPC) activities across locations and market applications.

GridSolv Quantum comprises the following main parts:

- **Battery enclosure** with pre-installed liquid cooled battery racks and all sub-systems such as HVAC
- **AC and DC outdoor rated cabinet**, which interfaces battery strings with the inverter and provides an interface for auxiliary power and communications
- **Interconnection busbars** and **cables**

[Make Wärtsilä's next generation energy storage system your next smart investment.](#)

Flexible design. Speed of delivery. Optimised energy.

GridSolv Quantum can be paired with leading inverter manufacturers' products, lending maximum flexibility for project-specific configuration and grid connection options.



MILILANI SOLAR I

156 MWh energy storage

Wärtsilä partnered with Clearway Energy to deliver O'ahu's first ever large scale energy storage system. Comprising 156 MWh of battery storage, the system features Wärtsilä's GridSolv Quantum solution along with its proprietary GEMS Digital Energy Management Platform to help with solar load shifting. Mililani Solar I is part of a broader 5-project portfolio of projects with Clearway Energy across Hawaii and California amounting to 2GWh of energy storage. The project includes Wärtsilä's long-term Service+GAP agreement, guaranteeing capacity and providing maintenance through the energy storage system's lifetime.



Mililani Solar I is O'ahu's first large scale solar-plus-storage project and features 156 MWh of Wärtsilä's GridSolv Quantum solution.

ES&O Solutions

STORAGE+

Grid Reliability, Resilience, Frequency Regulation, Ancillary Services, and additional applications

Globally, there is a growing demand for optimised energy, including energy management and security. Energy storage solutions, paired with smart energy management technology, such as Wärtsilä's GEMS, enable utilities, IPPs and developers to optimise their energy, future-proof their assets and create additional or maximised revenue streams. Applications vary based on markets and use-case.



One application is resilience against power disruptions in an increasingly volatile climate, especially in vulnerable regions—such as California, USA, where high wind conditions force utilities to cut power in order to prevent wildfires, or Puerto Rico, where extreme weather conditions threaten the electric power grid.

Greater resilience lessens the short-term impact on the grid itself. Energy storage has the unique ability to provide a stable infrastructure by cost-effectively enhancing grid reliability and security. Storage does so by providing a buffer between supply and demand that enables electric systems to rebalance during and after a disturbance, including energy arbitrage, blackstart, and peak shaving capabilities. One key example is in rural Roscoe, Texas, USA where a project with E.ON Texas Waves saw the integration of an intelligent energy storage solution at a wind farm. The system was able to provide rapid response to shifting power demand during an unusually cold season in early 2018, delivering short-term energy to the Electric Reliability Council of Texas (ERCOT).



ISLAND GRID+

Microgrids and islanded grids

Microgrids present a unique set of challenges, particularly the need for reliable energy to provide critical power needs. Energy storage Island Grid+ solutions offer both economic and environmental benefits for grid-scale capabilities for localised energy.

Take the Northern Azores region, for example. Energy security was a concern for the island of Graciosa due to a high dependence on fossil fuel imports in an isolated area. Storage is a sustainable alternative, bringing islanding capabilities that result in lower energy costs, a smaller carbon footprint, the ability to boost renewable energy consumption, and critically, increased reliability and sustainability of the grid. In the case of Graciosa, a hybrid approach to island grid energy generation—optimising multiple generation assets, including wind, solar, storage and thermal generation—addresses baseload supply requirements while accommodating fluctuations in output that are inherent to energy supplied from renewable sources. The entire system is optimised and monitored by GEMS, operating as the island grid controller, to maximise the performance and longevity of the Graciosa energy system.



GEMS not only makes the UNESCO classified 'World Biosphere Reserve' island of Graciosa greener by boosting renewable energy consumption from 15% to 65%, but also eliminates the need for 17,000 litres of diesel per month. This reduces the island's carbon footprint and greatly impacts the cost of energy going forward.

RENEWABLES+

Integrating solar, wind, balancing thermal and/or hydro

In working towards Wärtsilä's goal of a 100% renewable energy future, energy storage is becoming increasingly critical to help strengthen the reliability and flexibility of the grid and to integrate more renewable power into the system. For example, a paired storage and GEMS solution at the University of Arizona Science and Technology Park provides frequency response and voltage control and can integrate a new 2 MW solar array. The project supports Arizona's Renewable Energy Standard's goal of delivering at least 30% of its power from renewable resources and demonstrates how a hybrid system offers energy shifting and ramp rate control capabilities, plus improves resilience while reaching clean energy goals.



The combination of renewables and storage makes it possible to produce smooth power output when weather conditions are less than ideal, minimising impacts on grid stability. Solar and wind on its own are intermittent resources that can disrupt the grid with frequency and voltage fluctuations on cloudy days and when there is no wind. For example, fast-acting energy storage operating in concert with the solar system can control power quality by calibrating battery charging and energy exports to the grid. Consequently, storage mitigates the need for large-scale solar to curtail output as clouds come and go.



ENGINE+

Hybrid Energy

Engine+ enhances the efficiency, flexibility, and speed of engine power plants by delivering power to the grid instantly, pairing engines with energy storage to form a fully integrated system. This solution primarily generates value by reducing engine power plant operational expenses through the GEMS PPC platform—leveraging sophisticated forecasting and machine learning to provide real-time optimisation—flexible engines and energy storage technology.

The benefits provided by this integrated and automated smart renewable mix include: fuel savings through the improved efficiency of the engines' run time, spinning reserve replacement, which saves running hours and maintenance, as well as a fast return on investment—the typical payback period ranges from 2.5-4.5 years for an existing power plant. This is a power generation solution for islanded or isolated grids, small islands, and commercial and industrial (C&I) sectors.

Wärtsilä Hybrid Power Plant Solutions

Fast-starting, internal combustion engines—integrated with energy storage and renewables—offer considerable potential for fuel and cost savings. Especially in remote areas, such as island and isolated grids where fuel prices are generally high, these types of integrated hybrid power plants hold great promise.

The Wärtsilä hybrid power plant is configured and sized specifically for the customer's needs to ensure maximum asset value in the specific operating environment. All integrated assets are controlled, monitored and dispatched through Wärtsilä's GEMS, which seamlessly leverages the most cost-effective source in real-time, while maintaining system stability and respecting all operational requirements to meet the operator's goals.

Service+ Solution

OPERATIONAL SERVICES FOR THE LIFECYCLE OF ENERGY STORAGE SYSTEM(S)

Ensuring returns on clean energy investments requires a holistic, system-level approach to energy storage. The approach: comprehensive lifecycle solutions for improved performance. **Wärtsilä's Service+ Solution** is a suite of lifecycle solutions applicable for energy storage systems delivered and integrated by Wärtsilä, with secured connectivity. Service+ ensures that the GEMS energy management system software is always up to date, maximising the value from a customer's investment and supporting the reliable operations of the system.



THE WÄRTSILÄ SERVICE+ SOLUTION COMPRISES THREE COMPREHENSIVE ENERGY STORAGE SERVICES.

SERVICE+ BASE

Expertise to support your daily operations

Wärtsilä's Service+ Base provides operational support and GEMS maintenance for the energy storage system.

Service+ Base includes:

- Remote Operational Support
- Software Maintenance

SERVICE+ PRIME

Ensure safe and reliable operations

Wärtsilä's Service+ Prime provides energy storage system maintenance with predictable maintenance costs.

Service+ Prime includes:

- Planned Maintenance
- Remote Operational Support
- Software Maintenance



Contact a Wärtsilä storage expert today to learn more about GEMS technology and our purpose-built end-to-end grid management capabilities.

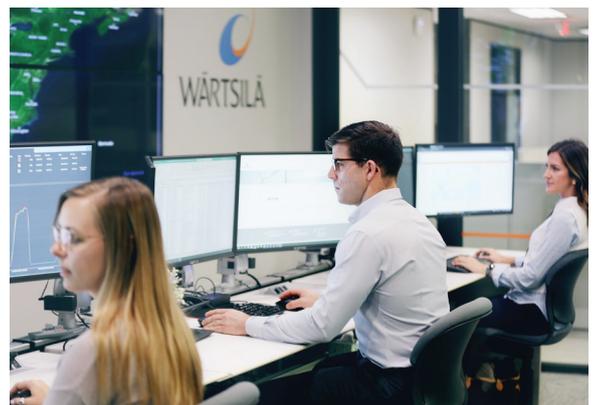
SERVICE+ GAP

Ensure energy storage system performance

Wärtsilä's Service+ Guaranteed Asset Performance (GAP) provides energy storage system maintenance with performance guarantees.

Service+ GAP includes:

- Performance Guarantees
- Remote Operational Support
- Extended System Warranty
- Software Maintenance
- Planned Maintenance



Wärtsilä Expertise Centre – Houston, TX

WÄRTSILÄ ENERGY

Wärtsilä Energy leads the transition towards a 100% renewable energy future. We help our customers in decarbonisation by developing market-leading technologies. These cover future-fuel enabled balancing power plants, hybrid solutions, energy storage and optimisation technology, including the GEMS energy management platform. Wärtsilä Energy's lifecycle services are designed to increase efficiency, promote reliability and guarantee operational performance. Our track record comprises 76GW of power plant capacity and more than 110 energy storage systems delivered to 180+ countries around the world.

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