GE Power

RESERVOIR SOLUTIONS

Flexible, modular
Energy Storage Solutions
unlocking value across the electricity network

TODAY'S **ENVIRONMENT**

The electricity industry is facing new challenges that have not been seen for the past 100 years. As consumers become active power producers who demand clean, reliable, and affordable power, the transforming grid needs innovative technical solutions that can unlock new business models and revenue streams.

78% OF THE **9000GW+** OF NEW GENERATION FORECAST TO BE BUILT BY **2040** WILL BE **RENEWABLE**

TOTAL ENERGY STORAGE SOFTWARE REVENUE TO HIT **$3.3 BILLION** BY **2025**

Sources: *Bloomberg - New Energy Outlook Report*
Navigant Research - Energy Storage Software Report
Navigant Research - Global DER Deployment Forecast

ANNUAL INSTALLED CAPACITY OF DISTRIBUTED ENERGY RESOURCES IS EXPECTED TO REACH **530 GW** BY **2026**

This change to energy generation and consumption is being driven by three powerful trends: the arrival of increasingly affordable distributed power technologies, decarbonization of the world's electricity network through the introduction of more renewable energy sources, and the emergence of digital technologies.

Decarbonization

The rapid deployment of low-carbon technologies such as wind and solar is making it increasingly difficult to forecast variable generation, creating challenges around grid stability, congestion and market volatility.

Digitization

A rise in the number of connected devices and smart sensors enables fast decision-making on dynamic and nodal prices, while intelligent control systems and internet-enabled software optimize power plants and the grid.

Decentralization

The growing penetration of distributed energy resources, including renewables and storage, is creating more "prosumers" (end users who are active in the power system), greatly increasing distribution grid complexity.

INTEGRATING INTERMITTENT RENEWABLES INTO AN AGING GRID REQUIRES **FLEXIBLE AND RESILIENT TECHNOLOGIES**, ABLE TO **RAMP QUICKLY** AND **DYNAMICALLY ADJUST** TO REAL-TIME GRID SIGNALS

WHY ENERGY STORAGE?

A battery energy storage solution offers new application flexibility and unlocks new business value across the energy value chain, from conventional power generation, transmission & distribution, and renewable power, to industrial and commercial sectors. Energy storage supports diverse applications including firming renewable production, stabilizing the electrical grid, controlling energy flow, optimizing asset operation and creating new revenue by delivering:

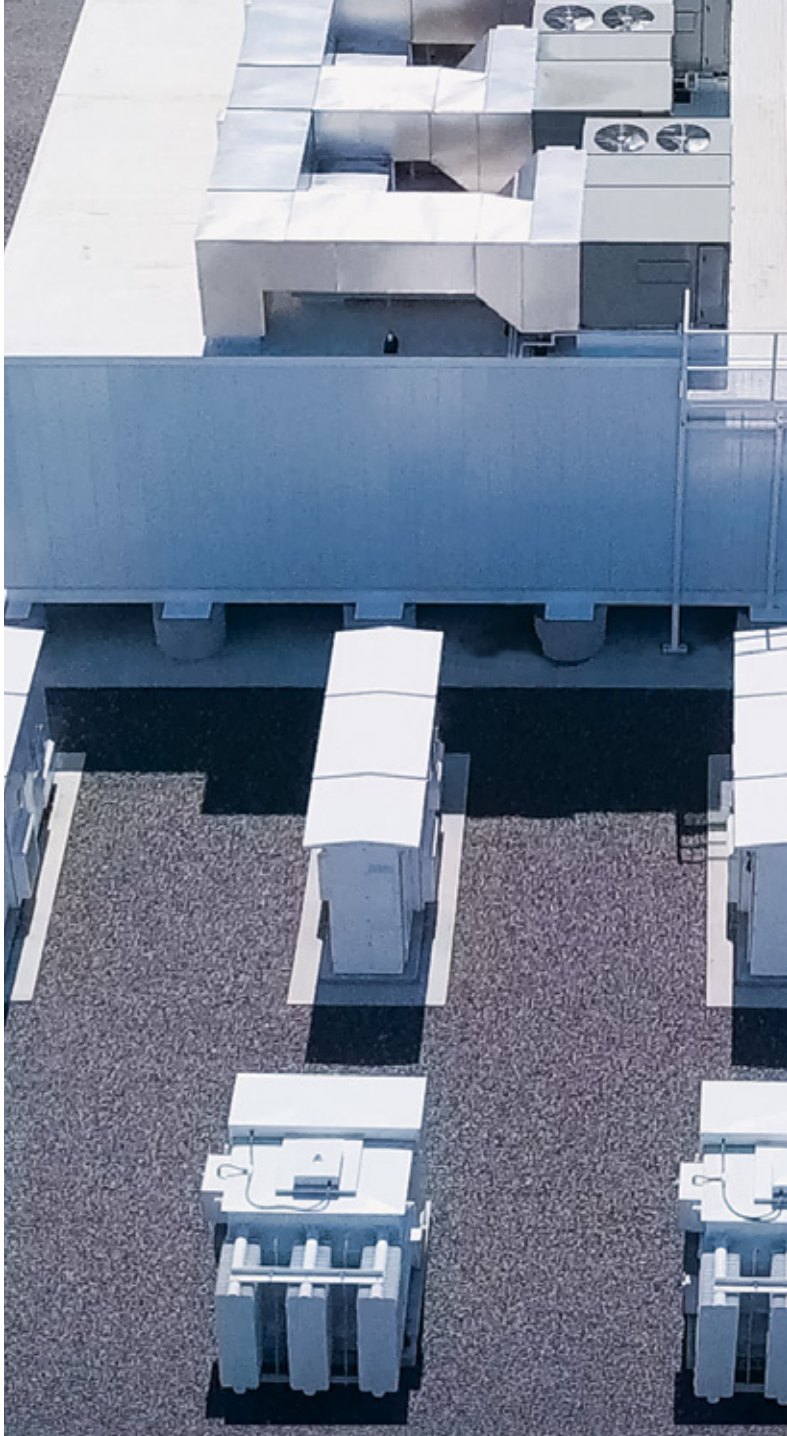
Active Power Services

- Frequency regulation
- Frequency response
- Peak shaving/firming
- Remote power commands
- Ramp rate control
- Curtailment avoidance
- Scheduled dispatch/shifting
- Scheduled power commands
- State of charge management
- Islanding
- Black start

Reactive Power Services

- Voltage control
- Voltage droop
- Power factor control
- VAR control

$103B INVESTMENT IN ENERGY STORAGE PROJECTS BY **2030**



Outcomes achieved with **GE'S RESERVOIR SOLUTION**

- **ENABLE UP TO 50% MORE SOLAR ENERGY SALES** WITH ENHANCED PV TO INVERTER LOADING RATIO
- **UP TO 50% REDUCED CONSTRUCTION TIME** WITH FACTORY BUILT & TESTED SOLUTION

Courtesy: Convergent Energy + Power

- **UP TO 15% EXTENDED BATTERY LIFE** UTILIZING PROPRIETARY BLADE PROTECTION UNITS
- **IMPROVE SAFETY** BY REDUCING FAULT CURRENT BY **UP TO 5X**

UNLOCKING NEW BUSINESS VALUE WITH GE'S RESERVOIR ENERGY STORAGE SOLUTION

Improve Financial Performance

Monetize assets through new revenue streams, increased asset utilization, improved yield, and reduced operating costs.

Increase Renewables Integration

Improve integration and maximize utilization of the energy generated from photovoltaics (PV) and wind turbines.

Optimize Electrical Grid

Defer upgrades, relieve congestion, control voltage, provide reserves and ancillary services, and improve reliability with backup power and black start functionality.

Reduce Energy Costs

Commercial and industrial end users can mitigate demand charges, optimize differential (Time of Day) energy prices, and benefit from additional onsite PV generation.

Develop Microgrids

Create a new and more flexible grid by locally integrating renewable generation and smart devices with energy storage and real-time communication.

GE'S RESERVOIR IS A FLEXIBLE ASSET THAT HELPS ENABLE **GRID OPTIMIZATION**

GE APPROACH

GE's broad portfolio of Reservoir Solutions can be tailored to your operational needs, enabling efficient, cost-effective storage distribution and utilization of energy where and when it's needed most. Our expert systems and applications teams utilize specialized techno-economic tools to help optimize the lifetime economics of a project. Our approach results in an investment grade business case that provides the basis of project planning and financing.

GE's System Approach

1	2	3	4	5
Consulting Services Customized Solutions Based on Needs Analysis	**Business Case** Cost-Benefit Analysis	**Project Planning & Financing** Value Engineering, Plan & Budgets, Financing	**Turnkey Service Project** Implementation & Production Roll Out	**Service Agreement** Training, Operations, Long Term Services

System Design Process & Optimization

Once the project scope, business objectives and services are established, GE's technical experts will define the energy sources, equipment and services required. Using advanced system planning and optimization tools, GE will deliver a tailored solution to meet the desired objectives.

GE INPUTS

ENERGY SOURCES

- Solar PV
- Wind Turbine
- Reciprocating Engines

PRODUCTS

- Inverters
- Batteries
- Reservoir Control Unit
- Substation
- PREDIX Analysis

SERVICES

- Regional Costs
- Local Policy
- Energy Markets
- Service Costs
- Financing

CUSTOMER INPUTS

BASICS

- Location
- Market
- Use Case

SPECIFICS

- Finance Details
- Project Life
- PPA Structure
- Grid Connection
- Services Required
- Constraints

GE OPTIMIZATION TOOL

ENHANCED RESERVOIR SOLUTION


MCC

GE SOLUTION

GE's Reservoir is a flexible, compact energy storage solution for AC or DC coupled systems. The Reservoir solution combines GE's advanced technologies and expertise in plant controls, power electronics, battery management systems and electrical balance of plant – all backed by GE's performance guarantees.

POWER CONVERSION

- Inverters are a bidirectional system converting AC to DC for battery charge and DC to AC for discharge
- 4 quadrant operation
- High efficiency

BATTERY MANAGEMENT

- Battery Protection Unit
- Long life Li-ion battery
- Integrated lockable disconnect
- Active string balancing
- Factory tested
- Field replacement

PURPOSE BUILT ENCLOSURES

- Ships with batteries installed
- Enhanced cooling and insulation
- Built in redundancy for 25 years of life
- Fast and flexible installation

RESERVOIR CONTROL UNIT

- Advanced functionalities to monitor batteries and help optimize asset operations
- Based on GE Mark™ VIe

FLEXIBLE SYSTEM DELIVERY

The solution can be delivered as Engineered Equipment Package (EEP), Engineering, Procurement, and Construction (EPC) turnkey solution or lease and financing arrangement.

MV TRANSFORMER

- Connects to any MV network up to 66kV through a step-up transformer
- Dry or oil-type transformer designed for both outdoor or e-house indoor environment

MV SWITCHGEAR

- MV switchgear and LV auxiliaries integrated into an ISO container for easy site installation

CONSULTING & SERVICES

- Technical and economic feasibility studies
- Network analysis
- Project management & design
- Real-time optimization services
- Long term service contracts
- Performance guarantees

SOFTWARE SUITE

- Asset performance management
- Fleet management
- Dispatch optimization

World's First Hybrid Electric Gas Turbine,
10 MW/4.3 MWh Energy Storage Solution

RESERVOIR STORAGE UNITS

The Reservoir Storage unit is a **modular** high density solution that is factory built and tested to reduce project risk, shorten timelines and cut installation costs. The Reservoir Storage unit is built with GE's Battery Blade design to achieve an industry leading energy density and minimized footprint. GE's proprietary Blade Protection Unit actively balances the safety, life and performance of each Battery Blade, extending battery life by up to 15% and reduce fault currents by up to 5X. The modular system has multiple installation and cabling options including pad or pier and is configured to minimize operation and maintenance (O&M) expenses over the life of the project with all weather capabilities and high efficiency cooling system.

ELECTRICAL INTEGRATION

- DC disconnect, service rated
- Auxiliary power equipment
- Optional combiner package for DC coupled PV
- Bottom and front entry cable option

ENCLOSURE

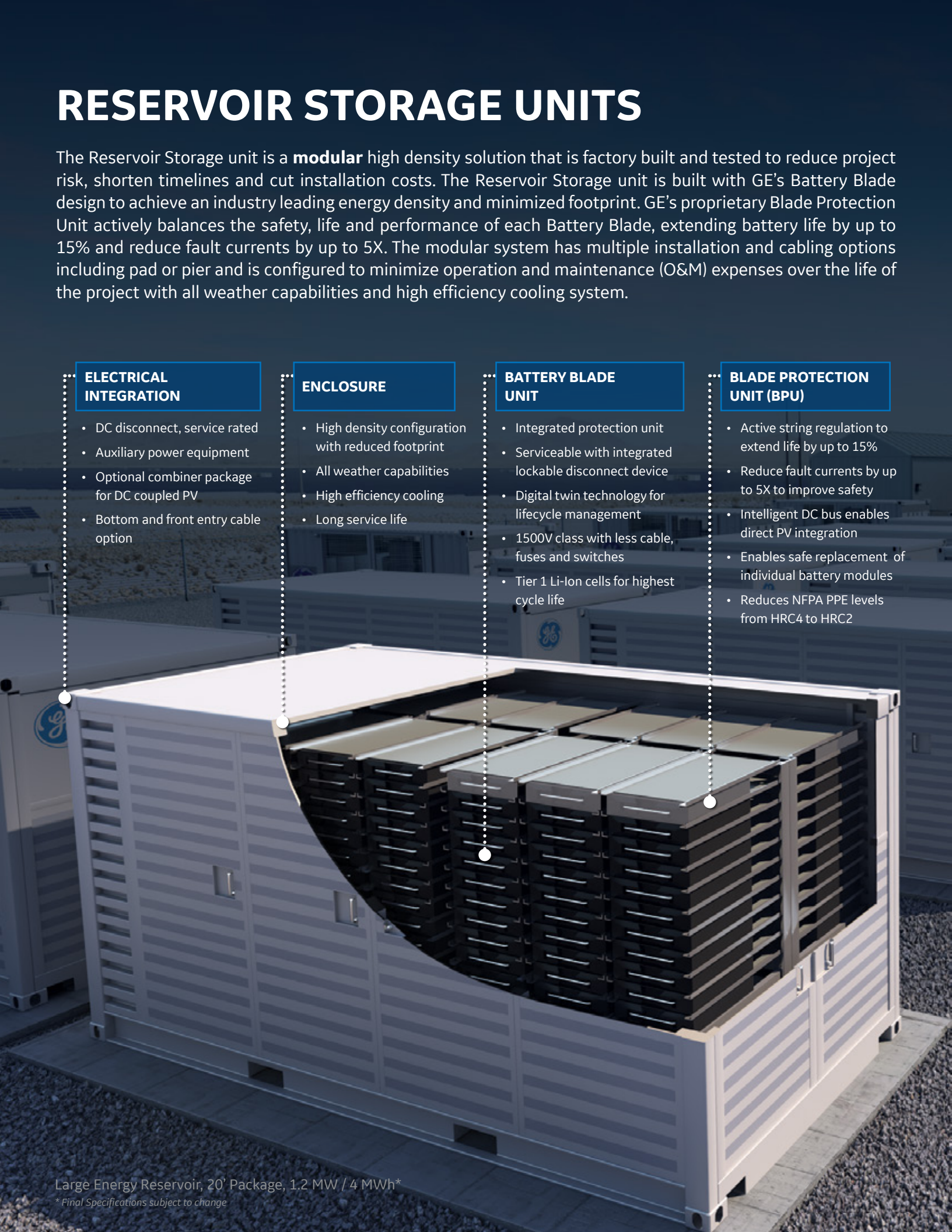
- High density configuration with reduced footprint
- All weather capabilities
- High efficiency cooling
- Long service life

BATTERY BLADE UNIT

- Integrated protection unit
- Serviceable with integrated lockable disconnect device
- Digital twin technology for lifecycle management
- 1500V class with less cable, fuses and switches
- Tier 1 Li-Ion cells for highest cycle life

BLADE PROTECTION UNIT (BPU)

- Active string regulation to extend life by up to 15%
- Reduce fault currents by up to 5X to improve safety
- Intelligent DC bus enables direct PV integration
- Enables safe replacement of individual battery modules
- Reduces NFPA PPE levels from HRC4 to HRC2



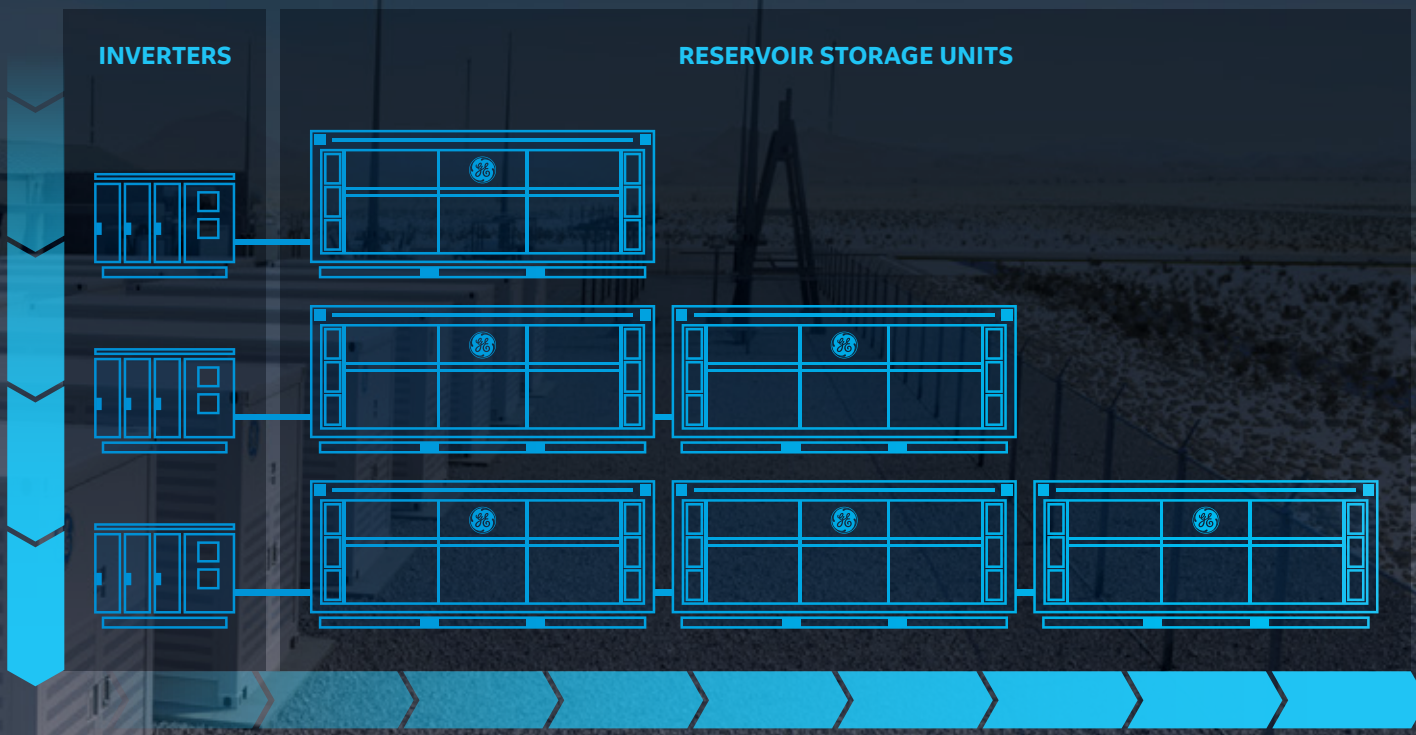
Large Energy Reservoir, 20' Package, 1.2 MW / 4 MWh*

** Final Specifications subject to change*

SYSTEM CONFIGURATIONS

The Reservoir Solution can be designed in a power or energy configuration depending on the required application. In an energy configuration, the batteries are used to inject a steady amount of power into the grid for an extended period of time. In a power configuration, the batteries are used to inject a large amount of power into the grid over a short period of time. The configuration of power or energy is determined by the ratio of inverters to batteries.

Modular and Scalable Solution



MORE POWER
Additional inverters are added to achieve desired power level.

MORE ENERGY
Additional reservoir storage units are added to achieve desire energy output.

GE'S **DC COUPLED RESERVOIR SOLUTION** ENABLES **ENHANCED PV TO INVERTER LOADING RATIO** RESULTING IN UP TO **50%** **INCREASE IN ANNUAL SOLAR ENERGY SALES** PER SITE

TYPICAL **RESERVOIR APPLICATIONS**

Standalone Applications

POWER

ENERGY

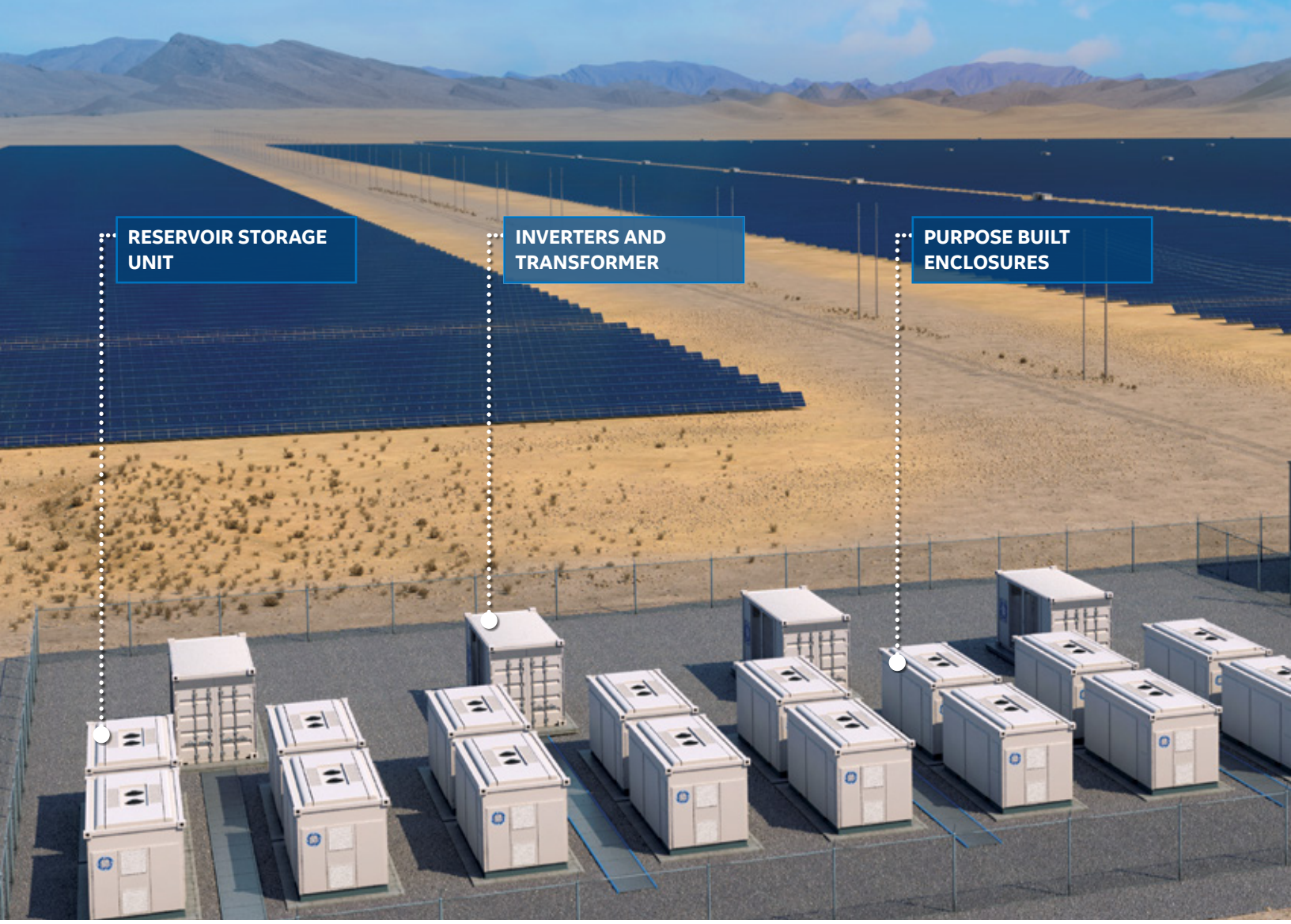
	Generation	Transmission	Distribution
Voltage Regulation Compensate anomalies or disturbances (e.g., voltage magnitude, harmonics, etc.) by sending reactive energy into system.			✓
Frequency Response Provide fast regulation of grid frequency to balance supply and demand.		✓	
Frequency Regulation Provide regulation of grid frequency to balance supply and demand based on signals sent by the grid operator.	✓		
Renewable Integration Balance the local excesses or deficits of renewable generation caused by rapid weather fluctuations.			✓
Black Start Energize part of the generation asset without outside assistance after a blackout.	✓	✓	
Back-Up Store energy to maintain service continuity and grid resilience in the event of an outage.			✓
Peak Management Reduce grid capacity needs during peak periods with local storage.		✓	✓
Shifting Buy or produce electricity at low price (off-peak) to store and sell at peak price.	✓		
Capacity Store renewable energy production for peak and base load consumption.	✓	✓	

Integrated Hybrid Solution Applications

POWER

ENERGY

	Solar	Wind	Thermal
Synthetic Inertia Compensate losses of grid inertia caused by high renewable penetration.			✓
Frequency Regulation Provide fast regulation of grid frequency to balance supply and demand.	✓	✓	✓
Firming Prevent undesirable short-duration effects from rapid fluctuations in solar generation due to intermittency and weather conditions.	✓	✓	
Improved Operations Help optimize generation fleet operations and costs.			✓
Contingency Reserve Provide fast ramp-rate to meet grid requirement for online dispatch within a short delay of operating reserve.			✓
Curtailment Avoidance Avoid output curtailment at certain times, preventing loss of energy production.	✓	✓	
Dispatchable Control solar generation at request of power grid operators or according to market needs.	✓	✓	



KEY COMPONENTS

Reservoir Control Unit (RCU)

GE's integrated Reservoir Control Unit is a supervisory control and data acquisition system for energy storage plants.

At the heart of the system is GE's field proven Mark™ Vle control system used to monitor and control gas turbines, wind and solar energy fleets.

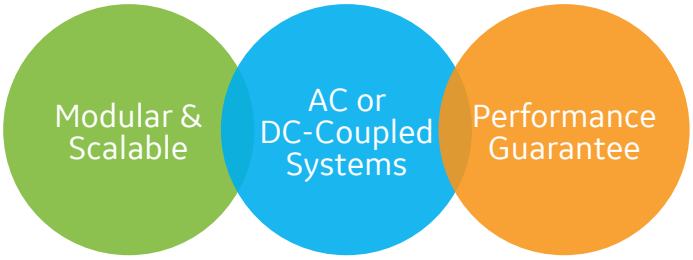
Inverters

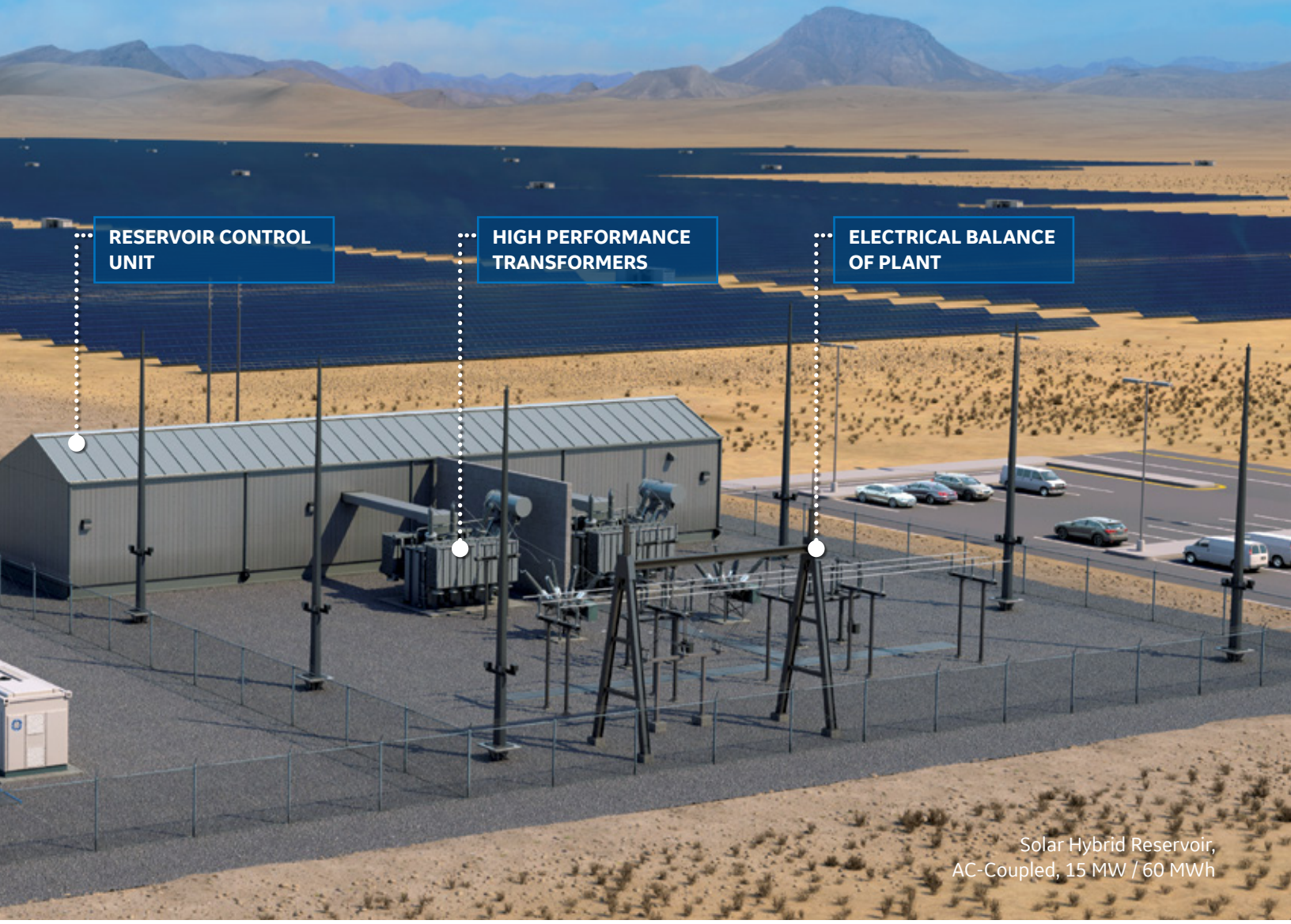
GE's inverters are designed specifically for dynamic operation and high performance lithium ion batteries.

Built with enhanced technology including integral ground fault detector/interrupter low voltage, zero voltage and high voltage ride through capability (LVRT, ZVRT, HVRT).

Reservoir Storage Unit

GE utilizes proven Li-Ion technology for battery storage solutions; each solution is tailored based on the customer's application. GE's battery solution exceeds industry standards for protecting against common industrial battery failure and reduces environmental impact with restricted use of substances controlled by US EPA, Global REACH and RoHS regulations.





Solar Hybrid Reservoir,
AC-Coupled, 15 MW / 60 MWh

High Performance Transformers

GE provides comprehensive portfolio of HV and MV transformers. Each transformer is made for performance, efficiency and immunity to withstand electronic noise.

Electrical Balance of Plant

GE offers a comprehensive portfolio of high voltage and medium voltage substation equipment and technical expertise to ensure efficient and reliable interconnection of power generation.

Purpose Built Enclosures

GE's enclosures are prefabricated with redundant HVAC and optional fire suppression systems, and provide the following benefits:

- Low maintenance, configured with enhanced cooling and insulation with built-in redundancy for 25 years of life.
- Easy transportation, minimal installation effort on site and better battery insulation

FROM ADVANCED TECHNOLOGIES AND PLANT CONTROLS TO BATTERY MANAGEMENT SYSTEMS, **GE DELIVERS COMPREHENSIVE STORAGE SOLUTIONS**

RESERVOIR SOFTWARE SUITE

The reservoir software suite includes edge to cloud infrastructure that's scalable, adaptable and easy to use. The software suite includes:

FLEET MANAGEMENT

Fleet aggregation software designed for asset monitoring, alerts, trends and forecasting.

COMPONENT LIFE ANALYTICS

Manages battery life based on history and expected future use profiles to minimize downtime and unplanned outages.

DISPATCH OPTIMIZATION

Charges and discharges batteries based on equipment status and market conditions to maximize customer outcomes.

Reservoir Services

GE's service agreements are customized based on the customers' requirements and can lower operating costs and mitigate operational and financial risks. GE's services include:

Planned Maintenance

Routinely service equipment and keep the energy storage system online, resulting in superior fleet performance.

Unplanned Maintenance

Monitor, troubleshoot and inspect equipment, boosting uptime and lifecycle production.

Parts Plans

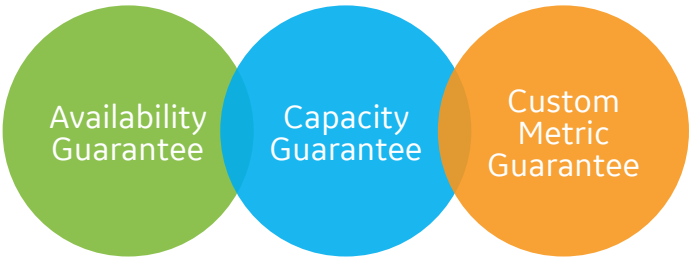
Provide full range of offerings to support preferred levels of service. Our forecasting capability, driven by fleet-wide parts consumption data configuration and management knowledge, can even help to predict what you may need.

Remote Operations Center

Provides continuous monitoring and diagnostics services 24 hours a day, 365 days a year. An on-site SCADA system enables continuous tracking of key operating parameters and detects abnormal conditions. GE technicians can then troubleshoot or reset the equipment remotely, in real-time.

Performance Guarantee

The specific performance criteria and duration of the performance guarantee will vary depending on your application, economic incentives, and requirements. Performance guarantees are only available to customers who maintain a contractual services agreement with GE and include:



Availability Guarantee

This guarantees that the battery energy storage solution will be available to charge or discharge electric energy at the nameplate power output and at the agreed-upon percentage of time.

Capacity Guarantee

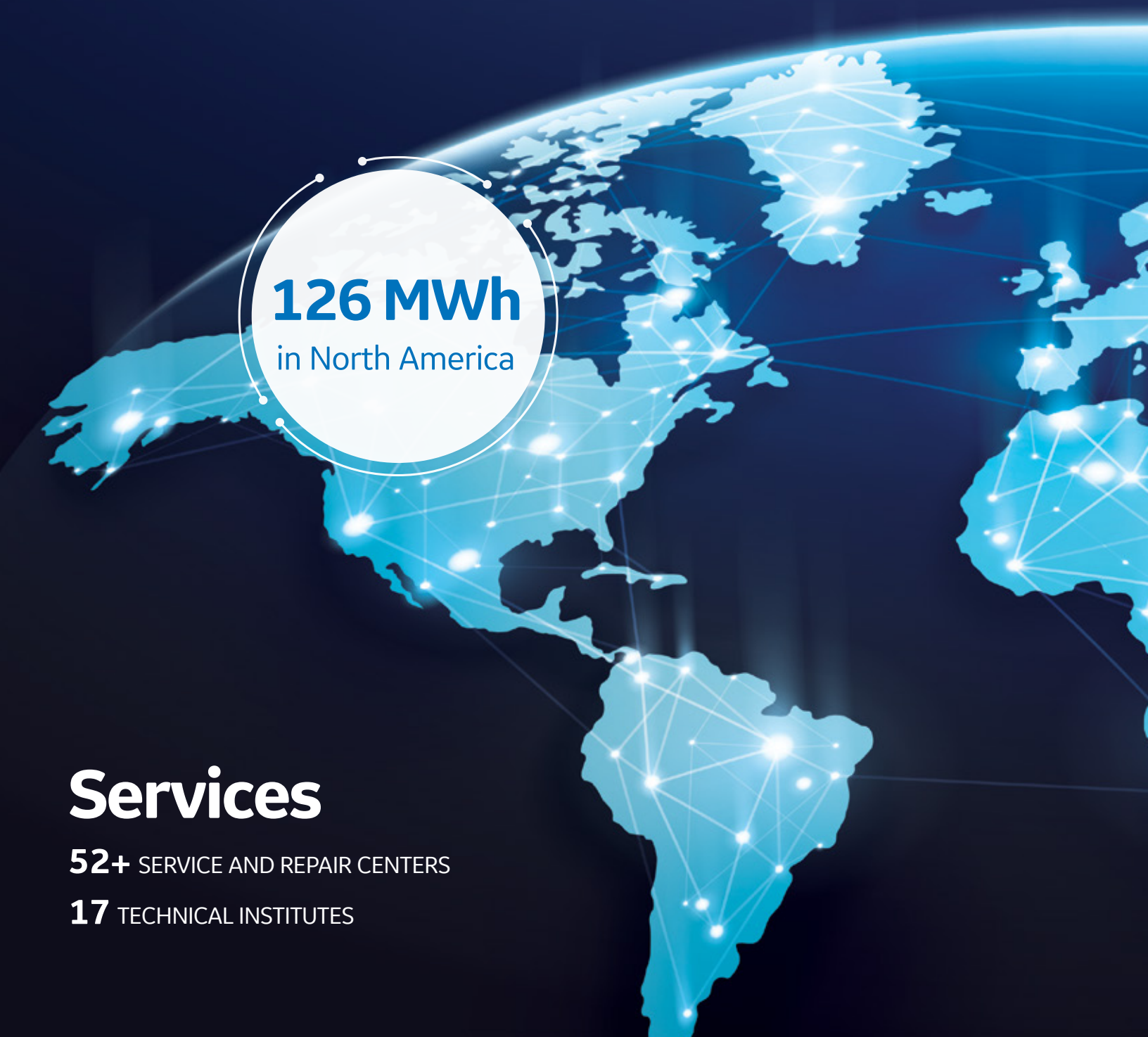
The amount of energy that the battery is able to extract from and discharge to the grid can be guaranteed.

Custom Metric Guarantee

Some owners have unique measurements or metrics, such as the PJM fast response frequency regulation score. In such cases, GE works with you to assess the risks involved and define a guarantee structure that aligns the interests of both parties throughout the life of the asset.

SERVING **GLOBAL CUSTOMERS** WITH **LOCAL EXPERTISE**

GE is globally recognized for designing and delivering customized energy storage solutions for diverse applications. With regionally located technical experts, our teams work directly with customers during the lifetime of the project. To date GE has more than **207 MWh of energy storage** in operation or in construction globally.



Services

52+ SERVICE AND REPAIR CENTERS

17 TECHNICAL INSTITUTES

INDUSTRY EXCELLENCE

10 years
of storage experience

20 year
performance guarantee

PIONEERING

1st Hybrid EGT
storage + gas turbine peaker in operation

Black Start
first proven emergency start of CCGT

LOCAL EXPERTISE

40+ Countries
providing comprehensive consulting & services

CUSTOMER APPLICATIONS

CUSTOMER ENERGY STORAGE DEVELOPER

CHALLENGE
Local grid support

GE SOLUTION
41MW / 41MWh BESS

APPLICATION
Standalone - Generation
Capacity; demand charge management

LOCATION
United Kingdom

STATUS
Under construction

This project will relieve pressure on the host country's energy system and provide flexibility when it is most needed to deliver a more balanced, secure energy system and help reduce consumer energy cost. The focus is on building long term commercially sustainable battery storage systems that are not reliant on subsidies and incentives.

CUSTOMER INVESTOR-OWNED ENERGY COMPANY

CHALLENGE
Meeting resource adequacy requirement

GE SOLUTION
2MW / 8MWH BESS

APPLICATION
Hybrid - Solar
Solar integration

LOCATION
Southern California (US)

STATUS
In operation

"We have a history of working with GE in thermal and wind, and we are pleased to continue our long-standing collaboration into the evolving world of energy storage. GE brings a strong technical solution, along with performance guarantees."

CUSTOMER PUBLIC POWER UTILITY

CHALLENGE
Addressing local grid reliability concerns

GE SOLUTION
10MW / 4.3MWh BESS, integrated controls

APPLICATION
Hybrid - Thermal (EGT)
Spinning reserve

LOCATION
Southern California (US)

STATUS
In operation

This project consists of two 10 MW of battery energy storage systems, each paired with GE's proven 50 MW LM6000 aeroderivative gas turbines, capable of providing instantaneous response during a spinning reserve event.

CUSTOMER DISTRIBUTION NETWORK OPERATOR

CHALLENGE
Local grid reliability

GE SOLUTION
1MW / 560 kWh BESS, EMS

APPLICATION
Standalone - Distribution
Load shifting, frequency & voltage regulation

LOCATION
Nice, France

STATUS
In operation

Smart-solar energy demonstration project. First application of large storage integrated at microgrid level, combined with a solar PV farm.

CUSTOMER APPLICATIONS

CUSTOMER ENERGY STORAGE ASSET DEVELOPER

CHALLENGE
Balance long duration voltage and frequency irregularities

GE SOLUTION
7MW / 7MWh BESS

APPLICATION
Standalone - Transmission
Voltage control, reactive power support, frequency regulation, ramp rate control, peak shaving, load shifting

LOCATION
Ontario, Canada

STATUS
In operation

"GE worked with us to create a fully integrated energy storage solution that helps meet the growing needs of the local transmission system. The project utilizes reliable GE equipment and products ranging from enclosures through the point of utility interconnection — a strategy that is cost-efficient, simplifies system warrantees and guarantees, and provides a financeable solution to our customers."

CUSTOMER LARGE INDUSTRIAL COMPANY

CHALLENGE
Grid support; pilot program

GE SOLUTION
2MW / 2MWh BESS

APPLICATION
Standalone - Transmission
Frequency regulation

LOCATION
Belgium

STATUS
Under construction

This project will repurpose their facility in order to develop a large scale storage park. The goal of the storage park is to further develop know-how on large scale storage. In the first stage, 6 MW of li-ion battery energy storage systems will be installed to deliver primary frequency regulation for the Transmission System Operator as a first application.

CUSTOMER PUBLIC POWER UTILITY

CHALLENGE
Providing grid stability & smoothing renewable output

GE SOLUTION
33MW / 20MWh BESS

APPLICATION
Standalone - Transmission
Emergency power / black start capability, distribution management system integration, ramp rate control, frequency response, spinning reserve

LOCATION
Southern California (US)

STATUS
In operation

Located in California, which has some of the most aggressive renewable portfolio requirements in the US, this 33MW / 20MWh battery system complements the integration of renewable resources, such as solar and wind, by adding stability and improving power quality.

CUSTOMER UTILITY

CHALLENGE
Local grid reliability

GE SOLUTION
1MW / 560 kWh BESS

APPLICATION
Standalone - Transmission
Frequency regulation

LOCATION
France

STATUS
In operation

The project is part of a larger initiative to test battery storage in real conditions for the purpose of frequency regulation, stabilizing the grid and preventing blackouts.

Courtesy: Convergent Energy + Power

For more information about
GE's Energy Storage Solutions visit
www.GEPower.com/**EnergyStorage**

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