By 2040, RENEWABLES will represent 30% of global net electricity ... or more?

GROWING THE NUMBER of connected devices & smart sensors

GROWING PENETRATION of distributed resources (renewable, storage, efficient devices)

END USER becomes an active actor of the power system ('prosumer')

Growth of Electricity demand, and an acceleration of decentralization of the power sector

TRENDS DISRUPTING THE POWER SECTOR FROM GENERATION TO T&D
From energy challenges... to energy storage benefits

Decarbonization
- Higher variable generation

Digitalization
- Volatility of electricity markets

Decentralization
- Growing electrical grid complexity

Electrification
- New distributed energy uses (EVs...)

Energy storage offers new **application flexibility and unlocks new business value** across the energy value chain

- Firm renewable production
- Stabilize electrical grid
- Control energy flow
- Optimize asset operation
- Monetize new revenue
A Lot Can Happen In 10 Years

Source: GE
WHY STORAGE?
Services That Energy Storage can Provide

Battery energy storage solution offers new application flexibility

- **Short Discharge (High Power)**
  - Frequency Regulation (AGC)
  - Fast Frequency Regulation (FFR)
  - Voltage Regulation
  - Power Factor Correction
  - Spinning Reserve
  - Non-Spinning Reserve
  - UPS (Critical Loads)
  - Blackstart

- **Long Discharge (High Energy)**
  - Capacity
  - Shifting Increase
  - Peak Management
  - TOU Rate Optimization
  - Schedule
  - Solar Load Following

**VALUE TYPE**
- Firming
- Reactive
- Energy
- Contingency

**SERVICE CLASS**
- Power
- Reactive
- Energy
- Contingency

**VALUE**
- Capex Savings
- Revenue
- Savings
- Value

Stacking of services may be required to realize full value.
Benefits of Energy Storage specific to Municipal & Distribution Networks

1. Peak load management
   - Capital deferment when additional capacity is required to service only short duration peak loads.
     - E.g.: Replacement of existing distribution infrastructure cabling which is both expensive and disruptive.
   - Reduction of Notified Maximum Demand Penalties
2. Energy arbitrage cost saving for municipalities

- Municipalities purchasing energy on a time of use basis and selling at a flat structure for ‘peaky’ residential and commercial applications presents an arbitrage opportunity.

![Shifting Diagram](image_url)

**Shifting**

Shifting, or arbitrage, may be done to increase revenue stream by time-shifting wholesale electric energy. This is buying at a low price and selling at high price. Shifting is typically about maximizing the price delta, whereas peak management is about reducing peak demands to drive asset deferral or reduced demand charges.

- **Service Class:** Energy
- **Value Type:** Revenue
- **$/MWh (Delta)**
- **Periodicity:** Daily
- **Duration:** Long
Benefits of Energy Storage specific to Municipal & Distribution Networks (continued)

3. Grid Strengthening
   • Ancillary services
   • Strengthening of the network by deploying storage at the weakest point in the network.
   • Points far from electrical source (transmission & distribution)
Benefits of Energy Storage specific to Municipal & Distribution Networks (continued)

4. Back-up Power
   - Cost of unserved energy.

5. Supporting Decentralized Generation and Microgrids.


**Black Start**

Storage systems are well-suited to serve as black start assets because, unlike generators, they do not need special equipment to start up. The power to dispatch can be available immediately (no need to keep it running in stand by mode). These ES systems can then be used to bootstrap the grid by enabling the startup of additional assets such as natural gas plants.
Jump to Reservoir - Solar
Benefits of Energy Storage specific to Municipal & Distribution Networks (continued)

4. Integration of Battery Energy Storage with Renewable Energy

- **Fast Frequency response**
- **Firming**
- **Curtailment Avoidance**
- **Dispatchable Solar**
GE RESERVOIR STORAGE UNIT . . . Up to 4MWh Capacity

Enhanced to reduce installation cost and shorten project schedule

UP TO 15% EXTENDED BATTERY LIFE UTILIZING PROPRIETARY BLADE PROTECTION UNITS

UP TO 50% REDUCED CONSTRUCTION TIME WITH FACTORY BUILT & TESTED SOLUTION

IMPROVE SAFETY BY REDUCING FAULT CURRENT BY UP TO 5X

ENABLE UP TO 50% MORE SOLAR ENERGY SALES WITH ENHANCED PV TO INVERTER LOADING RATIO
Case Studies
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.

CUSTOMER DISTRIBUTION NETWORK OPERATOR

<table>
<thead>
<tr>
<th>CHALLENGE</th>
<th>APPLICATION</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local grid reliability</td>
<td>Standalone - Distribution Load shifting, frequency &amp; voltage regulation</td>
<td>Nice, France</td>
</tr>
</tbody>
</table>

GE SOLUTION 1MW / 560 kWh BESS, EMS

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

STATUS In operation
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<thead>
<tr>
<th>CUSTOMER</th>
<th>ENERGY STORAGE DEVELOPER</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHALLENGE</td>
<td>Local grid support</td>
</tr>
<tr>
<td>APPLICATION</td>
<td>Standalone - Generation</td>
</tr>
<tr>
<td></td>
<td>Capacity; demand charge management</td>
</tr>
<tr>
<td>LOCATION</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>STATUS</td>
<td>Under construction</td>
</tr>
</tbody>
</table>

41MW / 41MWh BESS

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.
SERVING GLOBAL CUSTOMERS WITH LOCAL EXPERTISE

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CUSTOMER | INVESTOR-OWNED ENERGY COMPANY
---|---
CHALLENGE | Meeting resource adequacy requirement
APPLICATION | Hybrid - Solar
LOCATION | Southern California (US)
GE SOLUTION | 2MW / 8MWH BESS
APPLICATION | Solar integration
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.”
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.

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.
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.

<table>
<thead>
<tr>
<th>CUSTOMER</th>
<th>ENERGY STORAGE ASSET DEVELOPER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CHALLENGE</strong></td>
<td>Balance long duration voltage and frequency irregularities</td>
</tr>
<tr>
<td><strong>APPLICATION</strong></td>
<td><strong>Standalone - Transmission</strong></td>
</tr>
<tr>
<td></td>
<td>Voltage control, reactive power support, frequency regulation, ramp rate control, peak shaving, load shifting</td>
</tr>
<tr>
<td><strong>LOCATION</strong></td>
<td>Ontario, Canada</td>
</tr>
<tr>
<td><strong>STATUS</strong></td>
<td>In operation</td>
</tr>
</tbody>
</table>

"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 warranties and guarantees, and provides a financeable solution to our customers."
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.

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<th>PUBLIC POWER UTILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHALLENGE</td>
<td>Providing grid stability &amp; smoothing renewable output</td>
</tr>
<tr>
<td>GE SOLUTION</td>
<td>33MW / 20MWh BESS</td>
</tr>
<tr>
<td>APPLICATION</td>
<td>Standalone - Transmission</td>
</tr>
<tr>
<td>LOCATION</td>
<td>Southern California (US)</td>
</tr>
<tr>
<td>STATUS</td>
<td>In operation</td>
</tr>
</tbody>
</table>

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.
WHY ENERGY STORAGE?

A battery energy storage solution offers new application flexibility and unlocks new business value across the energy value chain. 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

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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.