EIA: “Electricity Industry in Transition”
Eric Gebhardt, Chief Innovation Officer, GE Power

Washington, DC | June 2018
By 2026, RENEWABLES will represent 40% of global installed generation capacity.*

EXPONENTIAL GROWTH of connected devices & smart sensors

GROWING PENETRATION of Distributed Energy Resources

ELECTRIFICATION OF ENERGY-INTENSIVE USES

IMPACT
- Growing share of renewables an increasing challenge to the traditional power system model

IMPACT
- Real time decision making becomes possible ... new software solutions open breakthrough optimization

IMPACT
- End users become active actors of the power system ('pro-sumer') ... growing grid complexity

IMPACT
- Step increase in electricity consumption ... accelerating Decentralization
Evolving Electricity Network

**GENERATION**
- Thermal [Hybrid]
- Wind [Hybrid]
- Solar [Hybrid]
- Hydro [& PSP]

**TRANSMISSION**
- Hybrid Gas Turbine
- Electrification
- Storage

**DISTRIBUTION**

**BEHIND THE INTERCONNECT**
- Storage
- Solar
- EVs
- CHP
- Microgrid
- Storage and Solar

**END-TO-END DIGITAL THREAD**

**Electricity Price (¢/kWh):**
- **WHOLESALE**
  - US: 3¢-6¢
- **COMMERCIAL**
  - NE: 15¢
- **RETAIL**
  - Germany: 30¢
  - Hawaii: 24¢
  - CA: 15¢

Enabling system benefits: lower cost, lower emissions, higher reliability, more resilient
Microgrids and Distributed Energy

ALWAYS-ON, FAIL-SAFE ELECTRICITY SUPPLY

INCREASES RELIABILITY of the local power system
INTEGRATES RENEWABLES to reduce energy cost & CO₂ emissions
SEAMLESS TRANSITION between grid connected & islanded mode
Philadelphia Navy Yard microgrid

Grid Modernization

- Smart meters, communications, microgrid management & DERMS
- Optimize consumption efficiency & environmental footprint

On-site Generation

- 10 MW substation with PECO tie-ins
- 6 MW natural gas peak shaver/back up power
- 1 MW on-site solar generation

Customer Benefits

- Enable local load growth in congested area without expanding city infrastructure
- ↓ Capex
- ↑ Resilience
- ↑ Local Capacity
- Economic Development
- ↓ Opex
GE’S 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
## TYPICAL RESERVOIR APPLICATIONS

### Integrated Hybrid Solution Applications

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Solar</th>
<th>Wind</th>
<th>Thermal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Synthetic Inertia:</strong> Compensate losses of grid inertia caused by high renewable penetration.</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td><strong>Frequency Regulation:</strong> Provide fast regulation of grid frequency to balance supply and demand.</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td><strong>Firming:</strong> Prevent undesirable short-duration effects from rapid fluctuations in solar generation due to intermittency and weather conditions.</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td><strong>Improved Operations:</strong> Optimize thermal generation fleet operation and costs.</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td><strong>Contingency Reserve:</strong> Provide fast ramp-rate to meet grid requirement for online dispatch within a short delay of operating reserve.</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td><strong>Curtailment Avoidance:</strong> Avoid wind output curtailment at certain times, preventing loss of energy production.</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td><strong>Dispatchable:</strong> Control solar generation at request of power grid operators or according to market needs.</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td><strong>Standalone Applications</strong></td>
<td><strong>Generation</strong></td>
<td><strong>Transmission</strong></td>
<td><strong>Distribution</strong></td>
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<tr>
<td>-----------------------------</td>
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<tr>
<td><strong>Voltage Regulation:</strong> Compensate anomalies or disturbances (e.g., voltage magnitude, harmonics, etc.) by sending reactive energy into system.</td>
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<td></td>
<td>✓</td>
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<tr>
<td><strong>Frequency Response:</strong> Provide fast regulation of grid frequency to balance supply and demand.</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><strong>Frequency Regulation:</strong> Provide regulation of grid frequency to balance supply and demand based on signals sent by the grid operator.</td>
<td>✓</td>
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<tr>
<td><strong>Renewable Integration:</strong> Balance the local excesses or deficits of renewable generation caused by rapid weather fluctuations.</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td><strong>Black Start:</strong> Energize part of the generation asset without outside assistance after a blackout.</td>
<td>✓</td>
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<tr>
<td><strong>Back-Up:</strong> Store energy to maintain service continuity and grid resilience in the event of an outage.</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td><strong>Peak Management:</strong> Reduce grid capacity needs during peak periods with local storage.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Shifting:</strong> Buy or produce electricity at low price (off-peak) to store and sell at peak price.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Capacity:</strong> Store renewable energy production for peak and base load consumption.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
OPTIMIZING
GENERATION FLEETS

GE's SOLUTION

Gas Turbine + Energy Storage + Digital Controls

INCREASED UTILIZATION:

50 MW of greenhouse gas-free peaking energy for local contingency
25 MW of high speed frequency regulation for improved response
-8/+5 MVAR Voltage support & primary frequency response when offline
INTEGRATED SYSTEM OPTIMIZATION

REDUCED SYSTEM COSTS & EMISSIONS:

REDUCED THERMAL STRESS on turbine for extended asset life
ZERO FUEL & EMISSIONS on turbine for extended asset life

Reduce costs by optimizing the use of existing generation sources and enabling contingency (spinning) reserve without fuel-burn

2017 Innovation of the Year!
Conclusions

The power grid is becoming increasingly diverse

Energy Storage + Distributed Energy can support grid

Existing assets will be important facilitator of system change

New business models & market structures are critical