Digital Solutions to Improve Coal Plant Efficiency, Flexibility and Emissions

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GE Power Digital Solutions
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Today, **TWO BILLION PEOPLE** have insufficient or unreliable power.

And **MORE THAN A BILLION PEOPLE** don’t have any access to electricity at all.
Global Trends Transforming the Power Industry

**CHALLENGES**
- Slower GDP Growth
- Resource Restraints
- Financing Constraints

**OPPORTUNITIES**
- Growth in Emerging Regions
- Global Clean Energy
- Digital Capabilities
An Energy Mix Is Required to Meet the World’s Growing Demand

**INDUSTRY DYNAMICS**

**Fossil Fuels**
Remains 60%+ of industry and a must to stabilize the grids

**Renewables**
Fastest growing segment

**Emerging Markets**
85% of electricity growth, each country with unique needs

Affordable, reliable and sustainable power
Global Power Market

Power generation and coal generation is growing globally

World electrical generation by fuel (TWh in '000s)

- **Renewables**: ~31K
- **Nuclear**: ~24K
- **Oil**: 5
- **Coal**: 3
- **Gas**: 9

Source: GE Power Marketing
US Power Market

U.S. Electricity Generation by Fuel, All Sectors
thousand megawatt-hours per day

Note: Labels show percentage share of total generation provided by coal and natural gas.

Source: Short-Term Energy Outlook, August 2016.
What Are the Consequences?

Coal capacity dropping
What Are the Consequences?

Coal capacity dropping

Remaining boilers — larger, cleaner, newer
What Are the Consequences?

Coal capacity dropping

Remaining boilers — larger, cleaner, newer

Declining demand, declining prices
US Power Market — What Are the Drivers

- Competition for base load drives efficiency
US Power Market — What Are the Drivers

- Competition for base load drives **efficiency**
- Intermittent nature of renewables, and gas prices drives flexibility
US Power Market — What Are the Drivers

- Competition for base load drives efficiency
- Intermittent nature of renewables, and gas prices drives flexibility
- Environmental regulations drives emissions
Industries Re-imagined with Software

<table>
<thead>
<tr>
<th>Company</th>
<th>Value (BN)</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uber</td>
<td>$50</td>
<td>Taxi Service</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The world's largest taxi company that owns no vehicles</td>
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<tr>
<td>Apple</td>
<td>$18</td>
<td>Consumer App Economy</td>
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<td></td>
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<td>The world's largest consumer software company only creates a few apps</td>
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<tr>
<td>Amazon</td>
<td>$50</td>
<td>Retail to Web Service</td>
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<tr>
<td></td>
<td></td>
<td>The world's largest retailer that owns no stores</td>
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</tbody>
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Industrial IoT — Inevitability, Not a Probability

- Installed base of Smart Meters to grow +1B by 2020
- By 2020 over 100M internet connected light bulbs
- Cars connected to Internet grow six fold by 2020: 152M
- by 2020 $10^6$ Terabytes a day generated by GE Machines
Energy Is Going Digital

By 2020
Digital Transformation Spending

$90B
Utilities

$225B
Industrial Internet
What Is the Industry Asking For?

- Better Performance
- Greater Reliability
- Emissions Compliance
- Profitable Growth

Leading Efficiency, Increased Flexibility, Lower Emissions, Better Economics
Industrial Internet Driving OT/IT Convergence

Physical and Analytical

Brilliant Machines

Industrial Big Data

People and Work
Coal Plants Are Big Data Machines

Operational Tradeoffs
Balances Goals v Points

Financial Tradeoffs
Balances Goals v Points

Mills
20 – 100 Points

Combustion Process
30 – 100 Points

Sootblowing Operations
200 – 300 Points

FGD
10 – 20 Points

ESP
50 – 100 points

ACI / DSI Systems
20 – 40 Points

SCR / SNCR
10 – 50 Points
Digital Capabilities
DIGITAL POWER PLANT FOR STEAM

Performance Optimization – FlexiLoad - Fuel Analyser - Boiler Optimization

1.5% Efficiency
5% Unplanned Downtime
3% CO₂

Adding $50,000,000 in NPV
Additional power for more than ~100,000 homes
Saving 105,000 tons coal per year
Equivalent to more than 200,000 cars off the road

Delivering better performance, greater efficiency & improved reliability over the life of the plant

Market Reference: 1,000 MW Double Reheat Plant China
The Winning Equation

leading 
EFFICIENCY  
1% point efficiency improvement  
• + 22MW Power Output  
• +$30 Million NPV Over Asset Life  
• - 67,000 Tons Coal Consumption  
• - 120,000 Tons CO₂ Emissions  

increased 
FLEXIBILITY  
Better ramping capabilities  
Better load following

reduced 
EMISSIONS  
Environmental Compliance  
Reduced CO₂ Emissions  
Better Air Quality  
Local Project Support

greater 
ECONOMICS  
Lower lifecycle cost  
Profitable growth  
Improved delivery time  
Access to financing

Increased value through digitization
Key Takeaways

Coal fired assets data heavy and are prime targets for digitization

Implementation of digital software solutions in coal-fired assets has shown:

• Efficiency can be improved by 0.5-1%
• Baseloaded plants can ramp and follow load better
• NOx, SOx, GHG, and CO excursions can be reduced
Questions?