NAVIGATING THE ENERGY TRANSFORMATION

UTILITY TRANSFORMATION, GRID MODERNIZATION, AND RESILIENCY TRENDS

PRESENTATION TO WISCONSIN PUBLIC UTILITY INSTITUTE

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Managing Director
Global Energy Practice
ENERGY TRANSFORMATION IS ACCELERATING
THREE FORCES UPENDING THE STATUS QUO

Disruption is a prevailing dogged fact to our industry.

Multiple megatrends underpin utility industry transition:

1. Greater customer demand for choice and more (sustainable) energy options
2. Increased policies and regulations to reduce carbon emissions
3. Shifting power-generating sources
4. Search for shareholder value: new ventures and increased M&A involving traditional utility players and from outsiders
5. Replacement of old infrastructure and transition toward an increasingly clean, decentralized and intelligent grid architecture: the Energy Cloud
6. Adaptation to climate change – Resiliency, Grid hardening
THE ENERGY CLOUD
TOWARD A CLEAN, DECENTRALIZED, INTELLIGENT & MOBILE GRID

Traditional Power Grid
Central, One-Way Power System

The Energy Cloud
Distributed, Cleaner, Two-Way Power Flows

Market Demand
Technology Innovation
Policy & Regulation
Climate Change

Source: Navigant

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THE ENERGY CLOUD

DISTRIBUTED ENERGY RESOURCES WILL BE MOST DISRUPTIVE TO OUR INDUSTRY

Annual Installed DER Power Capacity Additions by DER Technology, United States: 2017-2026

Observations

• DER deployments will reach +30 GW this year in US.
• DER is expected to grow 8 times faster than net new central station generation in the next 10 years (520 GW vs. 66 GW)
**THE RISE OF THE PROSUMER IN THE ENERGY CLOUD**

*LESSONS FROM MULTIPLE INDUSTRIES ALL POINT TO GREATER “PLATFORM” ACCESS*

- **The customer experience** continues to evolve across multiple industries.

<table>
<thead>
<tr>
<th></th>
<th>Past</th>
<th>Future</th>
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<tbody>
<tr>
<td><strong>Products /services</strong></td>
<td>Limited choice, store-front based retail</td>
<td>Many choices, online retail</td>
</tr>
<tr>
<td><strong>Access to information</strong></td>
<td>Limited; monthly billing, paper-based</td>
<td>Expect real-time, 24/7 access on-demand</td>
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<tr>
<td><strong>Mobile</strong></td>
<td>Cell phones used to make calls, send/receive texts</td>
<td>Smart phones and tablets; connected anytime, anywhere</td>
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<td><strong>Personalization</strong></td>
<td>One size fits all</td>
<td>Personal tips and targeted marketing based on behavior analytics</td>
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<tr>
<td><strong>Environmental attributes</strong></td>
<td>Less important for typical customer</td>
<td>More important for more customers</td>
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Walmart’s verified science-based target emissions-reduction plan, ‘Project Gigaton’, aims to reduce emissions in its supply chain by 1 gigaton by 2030.

**Target Areas**

**Energy**
- Achieve 100% renewable target, including suppliers

**Waste**
- Reducing waste in supplier operations

**Packaging**
- Focus on recycling and sustainably-sourced packaging

**Agriculture**
- Spread knowledge on agriculture best practices

**Deforestation**
- Increase transparency on sourcing

**Products**
- Factor consumer use of products into the equation

**Overall Goals:**
- Provide a sustainability toolkit that assists suppliers reduce emissions
- Make a business case for emissions reduction that has a sweeping affect on upstream and downstream markets
- Also reduce direct and indirect GHG emissions by 18% by 2025
Albertson’s - Climate & Energy
Reducing our carbon footprint helps us do our part to address climate change. We strive to lower our energy use in many ways such as: improving fuel efficiency in our trucks, switching to LEDs that use less electricity, and harnessing renewable energy such as wind and solar.

Micron
1. Energy Mitigation: Achieve at least 10% energy savings by 2022 (compared to 2016), achieved 4% so far.
2. GHG emissions reduction: Have been reporting on GHG emissions since 2009 through the CDP (Carbon Disclosure Project). Scope 1 emissions include direct emissions while scope 2 represent the emissions affiliated with purchased energy. Moving into scope 3 GHG emissions reductions, developing a global energy strategy and engaging their entire supply chain.
IMPACTS FOR WISCONSIN UTILITIES
THE EVOLVING ROLE OF THE UTILITY

Facilitating new products and services for the whole system

- Operationally Integrate DERs
- Data strategy and analytics roadmap (AMI, sensors, analytics)
- Advanced, integrated DER forecasting and planning
- Operations automation, resiliency

- Diversify revenue streams with new services and platforms
- Be a facilitator for third party service providers
- Be at the forefront of technology development
- Higher investment risk potentially offering higher shareholder return
- Leverage synergies between the current DNO business and new services (e.g., Transportation2Grid, Smart Cities)
- Build on local community presence and existing customer relationships

Network Owner and System Operator

Integrated Energy Platform Orchestrator

Energy Services Provider
GRID INVESTMENTS

Cyber Security & Interoperability

ADVANCED NETWORK

GRID CONTROL CENTER

DMS
OMS
DERMS

SUBSTATION AUTOMATION

SA Control
Transformer
Flexible Platform

DISTRIBUTION CIRCUIT AUTOMATION

Circuit 1
Advanced Fault Sensor
Automated Reclosers/Feeder Switches
Dispatchable Cap. Bank

Circuits 2-13

DATA / ANALYSIS / PLANNING

TESTING, TRAINING, AND OPERATIONAL PROCESSES

UTILITY OWNED RESOURCE

Energy Storage Microgrids DG

CUSTOMER

Commercial
Residential
Residential
HAN Gateway

PV

EV

M

M

M

Flexible Platform
WHY GRID MOD

**Improved Reliability**
- Greater visibility and control of the grid. Fewer outages, and shorter outages through digitalization, sensors, automation, and analytics

**Operational Cost Savings**
- Reduction of system operating costs through automation, predictive maintenance, efficient operations

**Integration of DER**
- Facilitation of the integration of DERs

**Deferral of T&D Upgrades and Generation capacity (NWA)**
- Delaying investment in transmission, substation and distribution capacity projects, and generation capacity

**Customer Value Proposition**
- Opportunities for customers to reduce bills and contribute to reduction in electricity infrastructure, and carbon footprint
WORLD ECONOMIC FORUM

TOP GLOBAL RISKS – IN TERMS OF LIKELIHOOD AND IMPACT

Top 5 Global Risks in Terms of Highest Impact
HURRICANE MARIA

Hurricane Maria Trajectory and Flooding

Maria
Puerto Rico Flood
9-20-2017
HURRICANE MARIA AFTERMATH

Figure 1. Broken Distribution Poles After the Storm
Source: Public Broadcasting Service by Patty Gorena Morales & Michael Rios

Figure 2. PREPA Rebuild Aerial Operation
Source: Puerto Rico Electric Power Authority
Figure 4. Transmission structure knocked down by hurricane Maria
Source: Institute of Electrical and Electronics Engineers

Figure 5. Dorado Substation Flooding
Source: NYPA Substation Assessment Report
PUERTO RICO – CASE STUDY FOR RESILIENCY AND MODERNIZATION

SITUATION

• Hurricanes Irma and Maria devastated Puerto Rico in Sept 2017
• Maria was an upper-level Category 4 storm with sustained winds in excess of 150 mph and rainfall exceeding 24 inches.
• 80% of the T&D infrastructure destroyed across the island; widespread flooding damage to substations, generation, and distribution facilities
• Left 3.4M people without power; longest recorded outage in U.S. history

RECONSTRUCTION APPROACH

Multi-phase
• Build Back Better vision for the power system reconstruction
• Creation of the Central Office for Recovery Reconstruction and Resiliency – Navigant provides Technical Advisory and Capital Program Oversight
• Development of the Energy System Master Plan Strategy & Roadmap
• Energy Recovery Program Execution
THE PLAN

• Adapts to the unique geography of Puerto Rico and recommends transformation to a more decentralized power grid using distributed renewables, storage, and thermal generation resources, the development of both islandable grids and microgrids to improve local area reliability, and to allow grid operators to isolate damaged circuits and regions in the event of future hurricanes.

• Recognizes that the operation of a more distributed, reliable, and resilient power grid requires that grid operators must constantly monitor real-time system operations throughout the island and immediately take corrective actions to maintain reliability and isolate outage events. The strategy recommends needed information technology investments and cybersecurity efforts to ensure that grid operators have adequate communications, monitoring and operational controls to operate the distributed grid reliably and securely, and that functions are automated to the extent practicable.

• Replaces damaged and unreliable transmission towers, reconductoring lines using technology able to withstand Category 4 winds (130-156 mph), rebuilds and hardens substation operation centers to provide wind and flood protection, and replaces 60% of the most vulnerable and damaged distribution system facilities.