IT Services to Support a Changing Utility Industry

Northwest Public Power Association
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Topics

Presentation  Electric Utility Industry Transformation
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Disclaimer

Information shown on the following slides was gathered from various sources. This presentation reflects the perspective of CJB Energy Economics and was developed to stimulate conversation.
IT Project Team

DOES 99% Of THE WORK

HAS NO IDEA WHAT’S GOING ON THE WHOLE TIME

SAYS HE’S GOING TO HELP BUT HE’S NOT DISAPPEARS AT THE START AND DOESN’T REAPPEAR UNTIL THE END
Industry Transformation

- Recent polls have found broad consensus that the electric utility industry is undergoing significant change
  - Utility Dive
  - PwC
  - Black & Veatch

- Agreement about how utilities should respond? Not so much.
Utility Dive 2016 State of the Electric Utility Survey

“If there’s one takeaway from Utility Dive’s third annual State of the Electric Utility industry survey, it’s that the transformation has arrived – but a standardized approach to adapt to it has not.”

www.utilitydive.com/library/state-of-the-electric-utility-2016/
Utility Dive 2016 State of the Electric Utility Survey

Respondents’ most pressing challenges for their utility (descending order)

- Aging Workforce
- Existing Regulatory Model
- Aging Infrastructure
- Renewables Integration
- Stagnant Load Growth
- Physical and/or Cyber Grid Security
- Clean Power Plan Compliance

www.utilitydive.com/library/state-of-the-electric-utility-2016/
“We are witnessing considerable disruption in the power sector arising from a combination of policy, technological and customer change. It’s creating a transformation in how we think about, produce and use electricity.”

www.pwc.com/gx/en/industries/energy-utilities-mining/power-utilities/global-power-and-utilities-survey.html
Nearly all respondents expect to see a medium to very high level of market disruption by 2020

More than 7 of 10 anticipate major or very major business model transformation by 2030

6 of 10 say their main home market will be more than “50% transformed” by 2030

www.pwc.com/gx/en/industries/energy-utilities-mining/power-utilities/global-power-and-utilities-survey.html
Disruptive Forces ( Ranked by Relative Importance)

- Aging Infrastructure
- Reliability
- Environmental Regulation
- Cybersecurity
- Aging Workforce
- Economic Regulation (Rates)
- Emerging Technology

http://bv.com/reports
Three-fourths of respondents view altering the regulatory construct to reflect changing energy markets as important.

Nearly two-thirds expect modest, significant or large investment to be required to accommodate integration of distributed energy resources (e.g., solar PV).

Half believe that by 2020, 6-10% of all U.S. power generation will come from distributed generation.

One-third view distributed generation as a moderate to major threat to their business; one-sixth view it as no threat.

http://bv.com/reports
Traditional Electric Utility System

**GENERATION**
Electricity is generated at various kinds of power plants by utilities and independent power producers.

**TRANSMISSION**
Electric transmission is the vital link between power production and power usage. Transmission lines carry electricity at high voltages over long distances from power plants to communities.

**DISTRIBUTION**
Electricity from transmission lines is reduced to lower voltages at substations, and distribution companies then bring the power to your home and workplace.

Graphic: Indiana University Kelly School of Business
Microgrid With Distributed Generation

Graphic: www.clean-coalition.org
New York Reforming the Energy Vision (NY REV)

Distribution System Platform Provider Model
Driving Forces for Electric Utility System Transformation
Driving Forces for Electric Utility System Transformation

1. Urbanization
2. Stagnating Energy and Electricity Demands
3. Advancing Technologies
4. Public Policies (Laws, Regulations)
5. Climate Change/Decarbonization
6. Mismatch Between Electric Utility Cost Structure and Rate Design
Driving Forces for Electric Utility System Transformation

1. Urbanization
Urbanization

U.S. rural and urban population, 1940-2010

Source: USDA, Economic Research Service compilation of U.S. Census Bureau data. 1940-1990 data are from http://www.census.gov/population/censusdata/urpop0090.txt; 2000 data are from Summary File 1; and 2010 data are from http://www.census.gov/geo/www/ua/uafacts.html.
Urbanization

- As the U.S. continues to shift toward a services-based economy, the nation is becoming increasingly urban.
- Population centers are growing, while rural areas are flat, both in population and economic activity.
- Demographic trend is well-established and expected to continue.
- Urban voters also tend to be more liberal, environmentalist than voters in rural areas.
Driving Forces for Electric Utility System Transformation

1. Urbanization

2. Stagnating Energy and Electricity Demands
Stagnating Energy and Electricity Demands
Stagnating Energy and Electricity Demands

- For decades, increasing use of electricity enabled expansion of the economy and population.
- Since the 1990s, economic and population growth no longer drive growth of electric loads:
  - urbanization
  - shift away from industrial, extraction economy (offshoring)
  - cost-effective energy efficiency
  - increased use of natural gas for space heating
Driving Forces for Electric Utility System Transformation

1. Urbanization
2. Stagnating Energy and Electricity Demands
3. Advancing Technologies
TAKING NOTES
IN THE 21ST CENTURY
Advancing Technologies

- LED lighting, automated controls, heat pumps
LED Lighting
Automated Controls
Advancing Technologies

- LED lighting, automated controls, heat pumps
- Improving performance, falling costs for renewable resources (wind, solar)
Wind Power

U.S. Wind Power Capacity Installations, by State

- CA 5,917
- TX 14,098
- WA 3,075
- OR 3,153
- NV 152
- AZ 238
- HI 206
- AK 62
- ND 1,886
- MN 3,035
- WI 648
- MI 1,531
- IL 1,745
- OH 435
- WV 583
- VA 125
- PR 125

Legend:
- 0 to 100 MW
- >100 MW to 1,000 MW
- >1,000 MW to 5,000 MW
- >5,000 MW to 10,000 MW
- >10,000 MW
Solar Photovoltaic Generation

Price history of silicon PV cells in US$ per watt

Source: Bloomberg New Energy Finance & pv.energytrend.com
Solar Photovoltaic Generation

[Bar chart showing annual solar PV installations (MWdc) from 2000 to 2015, with categories: Residential, Non-Residential, Utility.]
Solar Photovoltaic Generation

Distributed solar PV installed capacity, top 10 states, as of September 2015

- California: 3,057 MW<sub>AC</sub>
- New Jersey: 793 MW<sub>AC</sub>
- Arizona: 609 MW<sub>AC</sub>
- Massachusetts: 507 MW<sub>AC</sub>
- New York: 379 MW<sub>AC</sub>
- Hawaii: 358 MW<sub>AC</sub>
- Colorado: 243 MW<sub>AC</sub>
- Maryland: 208 MW<sub>AC</sub>
- Pennsylvania: 147 MW<sub>AC</sub>
- Connecticut: 129 MW<sub>AC</sub>
- Rest of U.S.: 1,261 MW<sub>AC</sub>

Source: U.S. Energy Information Administration, Electric Power Monthly
Advancing Technologies

- LED lighting, automated controls, heat pumps
- Improving performance, falling costs for renewable resources (wind, solar)
- Hydraulic fracturing, directional drilling
Advancing Technologies

- LED lighting, automated controls, heat pumps
- Improving performance, falling costs for renewable resources (wind, solar)
- Hydraulic fracturing, directional drilling
- High-efficiency combustion turbines
High-Efficiency Combustion Turbines
Advancing Technologies

- LED lighting, automated controls, heat pumps
- Improving performance, falling costs for renewable resources (wind, solar)
- Hydraulic fracturing, directional drilling
- High-efficiency combustion turbines
- Smart grid, grid edge, AMR/AMI
AMR/AMI

Advanced Metering Infrastructure Systems (AMI)
Advancing Technologies

- LED lighting, automated controls, heat pumps
- Improving performance, falling costs for renewable resources (wind, solar)
- Hydraulic fracturing, directional drilling
- High-efficiency combustion turbines
- Smart grid, grid edge, AMR/AMI
- Electric vehicles
Electric Vehicles
Electric Vehicles
Advancing Technologies

- LED lighting, automated controls, heat pumps
- Improving performance, falling costs for renewable resources (wind, solar)
- Hydraulic fracturing, directional drilling
- High-efficiency combustion turbines
- Smart grid, grid edge, AMR/AMI
- Electric vehicles
- Battery storage
TESLA Powerwall

Launched April 30, 2015

7 kWh daily cycle (~1/4 of average daily residential load)

2.0 kW continuous output

3.3 kW peak output

5.8 amp nominal

8.6 amp peak

~20% roundtrip losses

34” x 51” x 7”

220 lbs.

~$7,000 installed cost

~$0.15/kWh storage cost

Source: Tesla
Driving Forces for Electric Utility System Transformation

1. Urbanization
2. Stagnating Energy and Electricity Demands
3. Advancing Technologies
4. Public Policies (Laws, Regulations)
Public Policy Motivations

- Energy independence
- Preserve rainforests
- Sustainability
- Green jobs
- Livable cities
- Renewables
- Clean water, air
- Healthy children
- Etc. etc.

What if it's a big hoax and we create a better world for nothing?
Public Policies (Laws, Regulations)

- Limits on air, water emissions (NOx, SO2, particulates)
- State emissions performance standards
- Federally-funded R&D
- Renewable portfolio standards
- Federal and state tax credits (ITC, PTC)
- Net energy metering
Driving Forces for Electric Utility System Transformation

1. Urbanization
2. Stagnating Energy and Electricity Demands
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4. Public Policies (Laws, Regulations)
5. Climate Change/Decarbonization
Climate Change/Decarbonization

- Growing evidence/recognition of climate change
- Growing commitment to reduce carbon emissions

- Carbon cap and trade, carbon tax programs
- Clean Air Act Section 111(b) rule - new
- Clean Air Action Section 111(d) rule – existing
- E3, other studies of decarbonization strategies, costs
Wait, How Much Is All This Costing Ratepayers?
Wait, How Much Is All This Costing Ratepayers?

U.S. residential retail electricity price (1960-2014)
cents per kilowatthour

- real price (in 2014$)
- nominal price

12.5 ¢/kWh
Driving Forces for Electric Utility System Transformation

1. Urbanization
2. Stagnating Energy and Electricity Demands
3. Advancing Technologies
4. Public Policies (Laws, Regulations)
5. Climate Change/Decarbonization
6. Mismatch Between Electric Utility Cost Structure and Rate Design
# Electric Utility Cost Structure

## Fixed and Variable Costs

<table>
<thead>
<tr>
<th>Function</th>
<th>Average Residential Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>100%</td>
</tr>
<tr>
<td>Distribution</td>
<td>20%</td>
</tr>
<tr>
<td>Transmission</td>
<td>40%</td>
</tr>
<tr>
<td>Generation</td>
<td>70%</td>
</tr>
<tr>
<td>Total</td>
<td>38%</td>
</tr>
</tbody>
</table>

### Fixed and Variable Cost by Function

- **Customer**: 100%
- **Distribution**: 20%
- **Transmission**: 60%
- **Generation**: 30%
- **Total**: 62%

- **Fixed**
- **Variable**
Electric Utility Revenues from Customer and Energy Charges

Residential Average Customer

- Fixed
- Variable kWh

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

$-  $20.00  $40.00  $60.00  $80.00  $100.00  $120.00  $140.00  $160.00  $180.00  $200.00  $220.00  $240.00  $260.00  $280.00  $300.00  $320.00  $340.00  $360.00  $380.00  $400.00  $420.00  $440.00  $460.00  $480.00  $500.00  $520.00  $540.00  $560.00  $580.00  $600.00  $620.00  $640.00  $660.00  $680.00  $700.00  $720.00  $740.00  $760.00  $780.00  $800.00  $820.00  $840.00  $860.00  $880.00  $900.00  $920.00  $940.00  $960.00  $980.00  $1,000.00  $1,020.00  $1,040.00  $1,060.00  $1,080.00  $1,100.00  $1,120.00  $1,140.00  $1,160.00  $1,180.00  $1,200.00  $1,220.00  $1,240.00  $1,260.00  $1,280.00  $1,300.00  $1,320.00  $1,340.00  $1,360.00  $1,380.00  $1,400.00  $1,420.00  $1,440.00  $1,460.00  $1,480.00  $1,500.00  $1,520.00  $1,540.00  $1,560.00  $1,580.00  $1,600.00  $1,620.00  $1,640.00  $1,660.00  $1,680.00  $1,700.00  $1,720.00  $1,740.00  $1,760.00  $1,780.00  $1,800.00  $1,820.00  $1,840.00  $1,860.00  $1,880.00  $1,900.00  $1,920.00  $1,940.00  $1,960.00  $1,980.00  $2,000.00  $2,020.00  $2,040.00  $2,060.00  $2,080.00  $2,100.00  $2,120.00  $2,140.00  $2,160.00  $2,180.00  $2,200.00  $2,220.00  $2,240.00  $2,260.00  $2,280.00  $2,300.00  $2,320.00  $2,340.00  $2,360.00  $2,380.00  $2,400.00  $2,420.00  $2,440.00  $2,460.00  $2,480.00  $2,500.00
Electric Utility Revenues with Net Energy Metering

Residential Average Customer

- Non Adopter
- Adopter
Could Rooftop PV + Batteries Kill the Grid?
If an average Seattle home went “off grid” and generated an amount of rooftop solar power equal to their annual consumption, over 500 Powerwalls would be needed to store the seasonal imbalances between generation and load at the home.

\[(8,536 \text{ kWh} \times 0.34 \div 0.8) \div (7 \text{ kWh}) = 518\]
Solar Generating Potential Varies by Location

Photovoltaic Solar Resource of the United States

Annual average solar resource data are shown for a tilted-latitude collector. The data for Hawaii and the 48 contiguous states are a 10 km satellite modeled dataset (SUNY/NREL, 2007) representing data from 1998-2005. The data for Alaska are a 40 km dataset produced by the Climatological Solar Radiation Model (NREL, 2003).
San Diego, California
10 Percent Seasonal Imbalance

### Monthly Electricity Use and Rooftop Solar Generation

**Average Residential Customer - San Diego, CA**

<table>
<thead>
<tr>
<th>Kilowatt-Hours per Month</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>588</td>
<td>590</td>
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</tr>
</tbody>
</table>

**Annual energy use per customer:** 5,878 kWh

**PV capacity needed for net zero energy:** 3.65 kW DC

**~18 percent annual capacity factor**
Long Island, New York
10 Percent Seasonal Imbalance
Seattle, Washington
34 Percent Seasonal Imbalance

Monthly Electricity Use and Rooftop Solar Generation
Average Residential Customer - Seattle, WA

- Annual energy use per customer: 8,536 kWh
- PV capacity needed for net zero energy: 7.83 kW DC
- ~12 percent annual capacity factor
Where Does Energy Storage Fit?

- While battery technology can help with diurnal shaping, energy storage volume is limited.
- Other forms of storage with longer cycles, greater energy storage volume are also needed.
- Consumers will still need to rely on the utility system for energy storage.
- Single-family homes not most cost-effective place for storage – network effects create opportunity for utilities or others.
Traditional Electric Utility System

- Load Growth: strong and sustained; driver for economic development
- Generation: large, often CO2-emitting; remote from major load centers
- Technologies: electromechanical, limited intelligence, manual, not well-integrated
- Utility Cost Structure: majority of costs for generation, transmission, distribution were fixed
- Utility Average Cost: declining; increasing volume reduces rates
Traditional Electric Utility System

- Competing Electric Providers: none
- Customer Behavior: passive consumption; little awareness of what utilities do to provide reliable, low-cost service
- Retail Electric Service: universal, one-size-fits-all
- Residential Rate Design: majority of costs recovered through energy changes (customer charges low)
- Utility-Customer Interaction: monthly bills, call center, outages, rate changes
Emerging Electric Utility System

- Load Growth: flat/declining; no longer a major driver for economic development; however, EVs and other forms of electrification can help achieve environmental goals

- Generation: increasingly renewable but intermittent; undifferentiated energy has low value; distributed generation and storage being located at or near loads

- Technologies: digital, smart, automated, integrated

- Utility Cost Structure: majority of costs for generation, transmission, distribution still fixed; stranded cost risks

- Utility Average Cost: flat/increasing; increasing volume no longer reduces rates
Emerging Electric Utility System

- Competing Electric Providers: solar installers and leasing companies; energy efficiency; demand response
- Customer Behavior: more active; engaging technologies and third parties; making choices to protect environment
- Retail Electric Service: still universal, but one-size-fits-all service no longer sufficient; customers still need the grid
- Residential Rate Design: recovering majority of fixed costs through volumetric energy charges no longer viable
- Utility-Customer Interaction: increasing use of meter data; growing pushback if rate changes are perceived to ‘protect monopoly by blocking competition’
How Are We Feeling?
Don’t Worry!
Lose your phone?

Didn't have your contacts backed up?

Don't worry, the NSA has them all saved for you.

(301) 688-6527
Topics

Presentation: Electric Utility Industry Transformation

Conversation: Implications for IT Services at NWPPA Member Utilities
Implications for IT Services at NWPPA Member Utilities

- General thought and observations
Implications for IT Services at NWPPA Member Utilities

- If a utility has not yet determined its response to industry transformation, how can its IT efforts help prepare for it?
Implications for IT Services at NWPPA Member Utilities

- What about rural utilities?
  - Will industry transformation happen in rural areas?
  - Will it look different?
  - If it does, how can IT respond?
Implications for IT Services at NWPPA Member Utilities

- Electric utility industry transformation is blurring functional lines within the organization (G/T/D/C&F). How will this affect IT?
  - Roles
  - Priorities
Implications for IT Services at NWPPA Member Utilities

- Will it realistically be possible to meet all IT needs?
- If not, what are the top priorities and why?
- Ideas about triage?
- Funding?
Thank You!

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