Reinventing the Electricity Sector

Lena Hansen

Seattle City Light Utility of the Future Discussion, July 30th, 2015
Rocky Mountain Institute works across industries on challenging energy issues to drive the efficient and restorative use of resources with market-based approaches.

e-Lab brings together leading electricity sector actors to solve regulatory, business, and economic barriers to the economic deployment of distributed resources.
Agenda

1. There’s been a lot of transformation lately
2. Trends to help us read the tea leaves
3. Transformation can happen fast
4. Reporting from the front lines
5. Navigating to the future is not simple
Technology has fundamentally transformed the way we live, work, and communicate.

RMI transforms global energy use to create a clean, prosperous, and secure future.
But it has not [yet] impacted the electricity sector as fully.

RMI transforms global energy use to create a clean, prosperous, and secure future.
Trends to help us read the tea leaves
“Truths” of the historical electric system may no longer hold in their entirety…creating challenges but also opportunity

| ✓ CERTAINTY OF INCREASING DEMAND |
| ✓ BIGGER IS BETTER: ECONOMIES OF SCALE |
| ✓ UNI-DIRECTIONAL POWER & INFO |
| ✓ NATURAL MONOPOLY |
| ✓ DISENGAGED CUSTOMERS |

RMI transforms global energy use to create a clean, prosperous, and secure future.
The U.S. may invest up to $1.4 trillion in the electricity sector in the next 15 years.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Investment (Billion)</th>
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<tbody>
<tr>
<td>Generation</td>
<td>$505</td>
</tr>
<tr>
<td>Transmission</td>
<td>$300</td>
</tr>
<tr>
<td>Distribution</td>
<td>$580</td>
</tr>
<tr>
<td>Total</td>
<td>$1,385</td>
</tr>
</tbody>
</table>

Source: DOE QER 2015; EEI

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Demand may flatten or decline

Annual changes in U.S. electricity consumption, Reinventing Fire analysis
LEDs alone could shave up to 10% of US electricity use.
U.S. buildings are becoming much more efficient

3-4x energy productivity worth 4x its cost

~277→173 (–38%) 2010 retrofit
284→85 (–70%) 2013 retrofit
...→108 (–63%) 2010–11 new
...→≤50 (–83% to –85%) 2015 new

Site energy intensities in KWH/M2-Y; U.S. office median~293
The price of solar continues to fall

Historical price of electricity by source (unsubsidized renewables)

Source: EIA, CIA, Bloomberg, Bernstein analysis and estimates

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Meaning it may soon be cost competitive in much of the country

For reference:

Austin Energy RFP from April 2015 yielded 1.2 GW of PV for under $0.04/kWh
Falling PV costs follow the experience curve, and batteries show signs of the same.
Innovations starting to stick

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More efficiency by connecting devices

- Automated email if no more ink
  - $100

- No email if filter must be changed
  - $10,000
Microgrids to drive resilience

Preparing for the Zombie Apocalypse: Are Microgrids Our Only Chance?

The electricity industry’s been abuzz recently about the need for a more resilient grid. As a result, microgrids are quickly becoming the industry’s topic du jour—in fact, they’re the theme of the current July/August issue of IEEE’s Power & Energy magazine. However, nobody is talking about what is likely the most compelling reason to invest in microgrids: to prepare for the zombie apocalypse.

Scoff at your own peril, but consider this: Doomsday Preppers—a reality TV show about families who stock up on non-perishable food, ammunition, fuel, and weapons—has three million viewers. One of the preppers is the owner of a microgrid company.

The idea is simple: if a grid failure occurs, communities with microgrids can continue to operate, providing electricity and water to nearby homes even when the rest of the city is down. The microgrids could be connected to the grid’s infrastructure and still function during power outages. This is an example of how microgrids can serve as a more resilient grid.
The shift will continue

<table>
<thead>
<tr>
<th>Trends pushing down the cost of solar, other renewables and energy efficiency</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Increasing technical innovation | • New battery chemistries  
 • New solar PV technologies |
| Synergistic solutions increasing the value of renewables | • Solar PV + battery storage  
 • IT and storage for peak shaving |
| Data and internet of things increasing integration | • Sensors  
 • Predictive software  
 • Demand response automation |
| Innovative business models increasing customer bases | • No up front costs  
 • Funnel analysis  
 • Value beyond energy |
| Innovative financing reducing cost of capital | • Third-party financing  
 • Green bonds  
 • YieldCos |
And even more disruptive change is always possible...although not necessarily desirable.

RMI “Grid Defection” analysis

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Transformation can happen fast
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Easter Parades on Fifth Avenue, New York 13 years apart

1900: where’s the first car?  
1913: where’s the last horse?

There are several different possible responses to these building trends.

- Combat
- Wait and See
- Embrace
The New York Public Service Commission’s take on this

“Utilities, and this Commission, could respond to [the challenges facing the industry] by clinging to the traditional business model for as long as possible, relying on protective tariffs, regulatory delay, and other defenses against innovation.

Alternatively, we can identify and build regulatory, utility, and market models that create new value for consumers and support market entrants and this new form of intermodal competition—in other words, embrace the changes that are shaking the traditional system and turn them to New York’s economic and environmental advantage.

We decisively take the latter approach.”

—REV Regulatory Policy Order
4 Reporting from the front lines
Globally: shifting make up of generation capacity additions

2010-2020 (GW)

**Fossil fuel and nuclear**

- **2010**: 106 GW
  - Nuclear: 93 GW
  - Gas: 100 GW
  - Coal: 93 GW
- **2013**: 87 GW
  - Nuclear: 146 GW
  - Gas: 181 GW
  - Coal: 225 GW
- **2015**: 78 GW
  - Nuclear: 93 GW
  - Gas: 100 GW
  - Coal: 93 GW
- **2020**: 64 GW
  - Nuclear: 146 GW
  - Gas: 181 GW
  - Coal: 225 GW
- **2025**: 52 GW
  - Nuclear: 290 GW
  - Gas: 225 GW
  - Coal: 290 GW
- **2030**: 39 GW

**Renewables**

- **2010**: 106 GW
  - Wind: 93 GW
  - Solar: 146 GW
  - Biomass & waste: 181 GW
  - Hydro: 225 GW
  - Other: 290 GW
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Source: Bloomberg New Energy Finance
Europe: choreographing variable renewable generation

<table>
<thead>
<tr>
<th>Region</th>
<th>Percentage</th>
<th>Notes</th>
</tr>
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<tbody>
<tr>
<td>Scotland</td>
<td>44%</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>50%</td>
<td>(33% wind; 2013 windpower peak 136%-55% for all December)</td>
</tr>
<tr>
<td>Germany</td>
<td>25%</td>
<td>(2013 peak 70%)</td>
</tr>
<tr>
<td>Portugal</td>
<td>60%</td>
<td>(peak 100% in 2011; 70% for the whole first half of 2013, incl, 26% wind &amp; 34% hydro; 17% in 2005)</td>
</tr>
<tr>
<td>Spain</td>
<td>42%</td>
<td>(including 21% wind, 14% hydro, 5% solar)</td>
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California: planning & rate design

Identify Distribution Planning Areas

Perform Planning Analyses

Calculate Locational Net Value

• Time-of-use rates, minimum bill
• Demonstration projects
• Valuing distributed resources

Source: MTS WG - SolarCity
New York: driving system efficiency
Reforming the Energy Vision (REV) proceeding

Example: Avoid a $700MM in substation upgrades in New York City by harnessing distributed batteries & energy efficiency

- Distributed system platform
- DER providers as partners and customers, not competitors
- New revenue sources and performance incentives

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Hawaii: 100% renewables by 2045

- Reconsideration of net metering & rate design
- Role of smart inverters
Minnesota: performance based regulation

- Performance-based regulation
- Integrated Resource Planning
- Rate reform

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Fort Collins: the utility’s role in a net zero electricity system

Integrated Utility Services (IUS) model

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At the end of the day, these places are wrestling with many of the same questions

• What are the pathways along which the electricity system might evolve, and which are preferred?

• What is the real value of distributed resources, and what’s the best way to reflect that in pricing and compensation mechanisms?

• How do you plan the electricity system when resources are increasingly outside the utility’s control?

• How do you ensure reliability and efficient investment in that context?

• The system seems to be getting much more complex…what is the right balance of accuracy and simplicity?

• What is the role of the utility in enabling this future? (Hint—I think it’s pretty important)

• How should the utility business model be reformulated to best align with customer and societal objectives? Should performance incentives be the icing on the donut, or the creamy filling?
Navigating the future is not simple
Lots of mixed messages and mental models: need to get the facts on the table

Wind, solar and other types of renewables will overtake coal (Fatih Birol, IEA)

If we use even 1/3 of known fossil fuels, global warming will be well above 2°C

Without subsidies, renewables can soon compete with fossil-based electricity in much of the world

Two billion poor people around the world need coal-based energy for development

Renewables are still too expensive and batteries will never work

You cannot balance an electricity grid with mostly renewables
We have a physics problem
Reaching a new optimum will require significant energy
Why are we stuck in the current state?

<table>
<thead>
<tr>
<th>STAKEHOLDER</th>
<th>MAJOR ROADBLOCKS</th>
<th>SIGNS OF HOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MASS MARKET CUSTOMERS</td>
<td>• Usually think about energy 5-10 minutes a year</td>
<td>• Nest, Opower, Tesla</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Superstorm Sandy</td>
</tr>
<tr>
<td>LEGISLATORS</td>
<td>• Partisan by definition</td>
<td>• Hawaii</td>
</tr>
<tr>
<td></td>
<td>• Many conflicting priorities</td>
<td>• Green Tea Party</td>
</tr>
<tr>
<td>REGULATORS</td>
<td>• High turnover</td>
<td>• REV Proceeding in NY</td>
</tr>
<tr>
<td></td>
<td>• Reactive rather than proactive</td>
<td>• California, Minnesota</td>
</tr>
<tr>
<td></td>
<td>• Risk averse</td>
<td></td>
</tr>
<tr>
<td>UTILITIES</td>
<td>• Many misaligned incentives</td>
<td>• Lots</td>
</tr>
<tr>
<td></td>
<td>• Hard to innovate in a reliability-driven world</td>
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</tbody>
</table>
Models designed for an historically centralized system are misaligned with current trends.

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Typical rate design disguises the true marginal cost of service.
There is a lack of clarity on the value that new technologies provide to the system.

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Two potential paths forward?

POSSIBLE TRAJECTORIES FOR ELECTRICITY GRID EVOLUTION

PATH 1 INTEGRATED GRID

One path leads to grid-optimized smart solar, transactive solar-plus-battery systems, and ultimately, an integrated, optimized grid in which customer-sited DERs such as solar PV and batteries contribute value and services alongside traditional grid assets.

PATH 2 GRID DEFECTION

Another path favors non-exporting solar PV, behind-the-meter solar-plus-battery systems, and ultimately, actual grid defection resulting in an overbuilt system with excess sunk capital and stranded assets on both sides of the meter.
Where to from here?

• What is your vision for the electricity system in 5-10 years? What objectives are you trying to meet?

• Recognizing that the utility has a foundational role in realizing that vision, how might its business model need to be modified or how can it best partner with customers and service providers?

• How can you start to get a handle on the value that different types of resources can provide, so that customers, service providers, and the utility can all be fairly compensated?

• How can planning appropriately account for new, customer-driven technologies, and how can flexibility be optimized to integrate new resources?

• What types of programs can be put in place now to enable innovation?
Walker, there is no path
The path is made by walking

—Antonio Machado (1875-1939)
Thank you

www.rmi.org

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