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Will We Transform Electricity and Transportation, or Will They Transform Us?

Great River Energy – State of Electric Vehicles Forum
Maple Grove, Minnesota

Ken Colburn
Principal and US Program Director
The Regulatory Assistance Project (RAP)®
Bar Harbor, Maine
United States
+1 617 784 6975
colburn@raponline.org
raponline.org
The Regulatory Assistance Project is a global, non-profit team of veteran regulators advising current regulators on energy sector issues. (www.raponline.org)

- Foundation-funded; some contracts
- Non-advocacy; no interventions

Ken Colburn directs RAP’s U.S. Programs. His experience as a regulator came in New Hampshire. Ken is also a lifelong cooperative member, and serves on the board of NH Electric Cooperative and NRECA.
1 The Big Picture: Power Sector Transformation
US Economic Growth Has Decoupled from Energy

Energy, Carbon, and GDP in the U.S., 1950-2013

Source: Energy in Context, 15 March 2015
Technology is Beating Out Fuels on Price

U.S. Natural Gas Electric Power Price

Wind cost declines since 2009

Solar cost declines since 2009

Average cost of fossil fuels for electricity generation (per Btu) for coal, monthly

Source: U.S. Energy Information Administration
Renewables Are Now Least-Cost…

Xcel Energy, All-Source Bids, December 2017

XCEL BIDS VS. EXISTING PLANTS

- **Fuels**
  - **Coal**: $26 (Fuel) + $11 (O&M) = $37 (Xcel Bids)
  - **Gas**: $25 (Fuel) + $5 (O&M) = $30 (Xcel Bids)
  - **Nuclear**: $7 (Fuel) + $18 (O&M) = $25 (Xcel Bids)

- **Technologies**
  - **Solar**: $30 (Xcel Bids)
  - **Wind**: $18 (Xcel Bids)
Power Sector Jobs Have Shifted

Disruptive Forces Transforming Electricity

Aggregation, Ability to Shape Load, Transactive Energy

Digitization, Artificial Intelligence, Deep Machine Learning

Compounding Network Effects

- Grid Data Explosion
- Renewable Explosion
- Heat Pumps
- Storage & EV Explosion

Source: Chandu Visweswariah, Utopus Insights Inc.
Power Sector Transformation (PST): Sankey Diagram – Vermont 2015→2050

Courtesy Dr. Asa Hopkins from the Vermont Comprehensive Energy Plan, Planning and Energy Resources Division, Public Service Department

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Chandu Visweswariah, Utopus Insights
Not Encouraging Trends for the Traditional Utility Business Model
2 Good News and Bad News…
Good News: Electrification

- Electric Vehicles (EVs)
- Water Heating
- Space Heating
- (Industrial Applications; Indoor Agriculture)
Electrification is Already Happening

Figure 1: Annual global light duty vehicle sales

Source: Bloomberg New Energy Finance

Photo credits: Dennis Schroder, NREL
EPRI’s 2018 US National Electrification Assessment

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total Final Energy</th>
<th>Electric Load</th>
<th>Natural Gas</th>
<th>Economy Wide</th>
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<td>CONSERVATIVE (21% &amp; 32%)</td>
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<td>TRANSFORMATION (21% &amp; 47%)</td>
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<td>18%</td>
<td>67%</td>
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*Figure ES-1. Study Scenarios*

*Figure ES-2. High-level Overview of Modeling Results*
What is *Beneficial* Electrification?

…an original NRECA and RAP concept

1. Saves Members Money Long-Term; New Services
2. Reduces Environmental Impacts
3. Enables Better Grid Management
Electric Power is Getting Much Cleaner…

Environmental Benefits Continue Because Devices “Get Cleaner” Along With the Grid
The “Duck Curve” and Workplace EV Charging

Source: Jim Lazar, RAP
Bad News: Rate Design

- Demand Charges
- Fixed Charges
- Smart Rate Design
Large Commercial Rate Design: Can Impede Workplace Charging

**Eversource NH**
- **$13.75/kW demand**
- **$0.12/kWh energy**
- 6.6 kW charger, 200 kWh/month:
  - **$90 demand** +
  - **$24 energy = $114 = 57¢/kWh = $5.70/gal gasoline**

**SMUD**
- **$2.82/kW demand**
- Off-Peak: $.10
- Mid-Peak: $.13
- On-Peak: $.19
- $18.61 demand + $23 energy = $42 = 21¢/kWh = $2.10/gal gasoline
Large Commercial Load Profile

Source: http://jon.ochshorn.org
How **Should** Ratemaking Be Done?
How Can We Be Most Effective?
Uncontrolled EV and Water Heater Residential Load

Water Heat  Electric Vehicle
Price Can Influence When EVs Are Charged

Dallas/Ft Worth (standard rates)  
San Diego (time-of-use rates)

Source: M.J. Bradley Associates, 2017
Controlled EV and Heat Pump Water Heater Residential Load
Electric Vehicles Are a Lot Like Water Heaters
Really!

**Electric Vehicle**
- 3.3 kW – 6.6 kW
- 2,000 – 3,000 kWh/year
- Morning and early evening peaking if uncontrolled
- Batteries hold a full days supply (usually)

**Water Heater**
- 4.4 kW – 5.5 kW
- 3,000 – 4,500 kWh/year
- Morning and early evening peaking if uncontrolled.
- Tank holds a full day’s supply (usually)
So We Already Have Much Power to Fuel EVs…

- Converting an electric resistance water heater to a heat pump water heater can save 2,000–3,000 kWh/year…
4 Remembering That We Are Cooperatives!
Doing Electrification Right Offers Big Savings

SOURCE: Berkheimer et al SAE Paper, 2014
Including for Low- and Middle-Income Members

- Cost to own and maintain:
  - Earlier-generation EVs get deeply discounted (it’s a technology!)
  - Very low maintenance requirements

- Kolata (IL CUB) May 2018 preliminary analysis of EV “refueling”:
  - Cost for Level 2 owners to power their EV with an optimal charging strategy
  - Year-to-date in ComEd, there have been 99 hours with negative or zero prices
  - Assuming 22 miles charged per hour => 2,178 driving miles at < $0 energy cost
  - Many more hours at < 2¢ / kWh
Electrification Load Will Buy Time – But Not a Reprieve

- Get closer to members
  - Segmentation, new services
  - Focus on RE, EE, DERs, EVs
  - Attend to equity, low-income

- Business Model:
  - Decouple revenue from kWh sales

- Rethink rate design
  - *Not* cavalier fixed or demand charges!

- Act on EVs & heat pumps, distribution system planning, transactive energy, analytics, management of demand, etc.
The Best Path Forward?

• Identify what your members want and need

• Identify the challenges and opportunities they will face
  - Henry Ford: ”If I’d asked my customers what they wanted, they would have said ‘a faster horse.’”

• Address both proactively
  - i.e., Serve the members!
  - It won’t be possible with today’s business model
  - Wayne Gretsky: “Skate to where the puck will be.”
About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org