Energy in Nebraska: Trends and Opportunities

University of Nebraska at Omaha
For NPPD, OPPD, and LES
Overview

• Background
• Key Power Sector Trends
• Conclusions
Nebraska Background

### Carbon Emissions

<table>
<thead>
<tr>
<th>Year</th>
<th>MM Tons CO₂</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>47.7</td>
<td>0.9% of US</td>
</tr>
</tbody>
</table>

- **Coal**: 22.3 (46%)
- **Petroleum (Transportation)**: 16.4 (34%) (13.5 (82%))
- **Natural gas**: 9.3 (19%)

[https://www.eia.gov/environment/emissions/state/](https://www.eia.gov/environment/emissions/state/)
US Wind Resources
### Capacity & Generation

<table>
<thead>
<tr>
<th>State</th>
<th>Installed Capacity</th>
<th>MW Under Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kansas</strong></td>
<td>6.128 MW</td>
<td>871 MW</td>
</tr>
<tr>
<td><strong>South Dakota</strong></td>
<td>1,019 MW</td>
<td>505 MW</td>
</tr>
<tr>
<td><strong>Iowa</strong></td>
<td>8,965 MW</td>
<td>1,122 MW</td>
</tr>
</tbody>
</table>

#### Electric Grid Mix in Kansas

- **Coal**: 39.59%
- **Wind**: 36.56%
- **Nuclear**: 17.73%
- **Natural Gas**: 5.81%
- **Biomass**: 0.12%
- **Oil**: 0.10%
- **Hydro**: 0.05%

**Source**: U.S. Energy Information Administration's Open Data API, Electricity Net Generation.

#### Electricity Net Generation

- **Coal**: 45.05%
- **Wind**: 33.66%
- **Natural Gas**: 11.58%
- **Nuclear**: 7.72%
- **Hydro**: 1.46%
- **Biomass**: 0.33%
- **Oil**: 0.17%
- **Solar**: 0.02%

**Source**: U.S. Energy Information Administration's Open Data API, Electricity Net Generation.
Key Power Sector Trends

• Changing Desires of Consumers
• Falling Costs of Clean Energy
• Environmental and Health Drivers
• Electrification
• DERs and Their Impacts
• Changes in Bulk Power Markets
• Evolving Approaches to Utility Regulation
Changing Desires of Consumers

• When it comes to managing their energy usage, consumers want to be in the *driver’s seat*.

• Customers want access to *cleaner energy* sources, and many, especially younger ones, are willing to pay a premium.

• Programs that encourage shifting energy usage could be a *win-win* for consumers and providers.

*Source: Smart Energy, 2018 State of the Consumer Report*
EVIDENCE OF A CHANGING ELECTRIC INDUSTRY
THE RISE OF CUSTOMER-CENTRIC THINKING

• Customers are coming to expect higher levels of service from their utilities.
• This comes in part from a shift in consumer expectations in other industries, whether it be media services (Netflix), lodging (AirBnB), or retail (Amazon).
• The common thread in these industry shifts is digital disruption, with customer-centric thinking winning out in the end.
• These revolutionary business models have used technological innovation at the offerings – and platform – level to provide seamless, fast, and convenient service to customers.

(Source: Navigant Research)
The Evolving Utility

**YESTERDAY**
- SAFE
- RELIABLE
- AFFORDABLE

**TODAY**
- SAFE & SECURE
- RELIABLE & RESILIENT
- AFFORDABLE
- CUSTOMER-FOCUSED
- INCREASINGLY CLEAN

**TOMORROW**
- SAFE & SECURE
- RELIABLE & RESILIENT
- AFFORDABLE & EQUITABLE
- CUSTOMER-FOCUSED & INTERACTIVE
- CARBON FREE
- SERVICE PLATFORM
- PLATFORM FOR OTHER INFRASTRUCTURE
Opposition to Tri-State Brews Among Electric Cooperatives

From the 2019 Jemez Mountains Electric Cooperative Elections series

By Amanda Martinez SUN Staff Writer Feb 2, 2019 • 1 • 3 min to read

Two more electric co-ops are trying to leave Tri-State Generation. They’ve asked the Colorado PUC for help

Jemez Mountains Electric Cooperative District 6 Trustee Bruce Duran attended the Jan. 19 meeting and was critical of Tri-State Generation & Transmission Association’s limit on the amount of renewable energy each cooperative is allowed to generate. He said it is time for members to get together and collectively ask for the percentage to be raised. “I think the time is right,” he said.

(SUNoto by Amanda Martinez)

and said energy wanted to shut down the plant to save money and spend its transition to renewable energy sources.

(Ed Kosmicki, Special to The Colorado Sun)
State RPS & CES Policies

Renewable & Clean Energy Standards

Key Power Sector Trends

- Changing Desires of Consumers
- **Falling Costs of Clean Energy**
- Environmental and Health Drivers
- Electrification
- DERs and Their Impacts
- Changes in Bulk Power Markets
- Evolving Approaches to Utility Regulation
Which trend to bet on?
Levelized Cost of Energy - Alternative Sources of Power
2009 to 2018, Unsubsidized Costs

Source: Calculated from estimates in Lazard Levelized Cost of Energy Analysis Version 12.0, November 2018
In constant 2017$
Xcel Energy, All-Source Bids, December 2017

Xcel Energy, All-Source Bids, December 2017. Existing Plant Average Fuel and O&M from USE IA, Table 8.4, Electric Power Annual 2016
Bold $500 million offer to replace 3 coal-powered plants with renewables, gas met by reluctance from Tri-State

Miami's Guzman Energy already helped a New Mexico co-op leave Tri-State and says switching to renewable energy will cost less.
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US Pollutants of Concern

SULFUR DIOXIDE, 2016
- Electric Utilities: 44%
- Transportation: 20%
- Industrial & Other Processes: 34%
- Other Sectors: 2%

NITROGEN OXIDES, 2016
- Other Sectors: 58%
- Transportation: 13%
- Electric Utilities: 19%
- Industrial & Other Processes: 10%

MERCURY, 2014
- Utility Boilers: 44%
- Mobile Sources: 20%
- C&I Boilers/Heaters: 28%
- Other Sectors: 2%

GREENHOUSE GAS, 2015
- Electric Power Industry: 30%
- Other Sectors: 28%
- Industrial & Other Processes: 15%
- Transportation: 17%

RAP’s “Layer Cake” of EE Benefits

Source: https://www.raponline.org/knowledge-center/recognizing-the-full-value-of-energy-efficiency/
“Benefits-per-kWh” (EPA) Make EE and RE Much More Cost-Effective

Health Benefits of Energy Efficiency and Renewable Energy

- Northeast
- Southeast
- Mid-Atlantic
- Upper Midwest

Cents per kWh:

- Northeast: 4
- Southeast: 2
- Mid-Atlantic: 9
- Upper Midwest: 4
Understand the Emissions Effects of Changes in Load
Key Power Sector Trends

- Changing Desires of Consumers
- Falling Costs of Clean Energy
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Beneficial Electrification (BE)

1. Saves Customers Money Over Long-Term
2. Reduces Environmental Impacts
3. Enables Better Grid Management
Electrification is Already Happening

Figure 1: Annual global light duty vehicle sales

Source: Bloomberg New Energy Finance

Photo credits: Nest and Dennis Schroder, NREL
Per BNEF’s latest analysis, the crossover point — when electric vehicles become cheaper than their combustion-engine equivalents — is now **2022** for large vehicles in the EU, mostly due to declining battery costs.
Grid-Integrated Water Heating

- Water heaters only need to run 2-3 hours/day
- Can be controlled into low-cost, low-emission hours
- Options: Resistance or even more efficient heat pumps
- Important: Can also provide ancillary services
- Similar options to control HVAC and EVs
Scale of Hot Water Heater Opportunity

- 45 million existing electric water heaters
  - Controlling all could double RE integration
- 66 million are still fossil fueled…

Census Housing Survey Table 2.5 (2010)
Electrified Devices “Get Cleaner” with the Grid
What will electrification do to load?


Source: EPRI, 2018 US National Electrification Assessment
But, New EE Technologies Will Emerge: Ultrasonic Clothes Drying; RF Crop Drying

- Sound waves “shake” moisture out of clothes
- 80% reduction in electricity

S&P Global Utility Practice:
“Expect little net load growth going forward.”
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Game-Changer: DERs Enable Flexible Load (aka Active Management of Demand)

- For 100+ years, we have managed supply to meet load
- Now, we can schedule load to meet supply
- Lawrence Berkeley National Lab: Use DERs to “Shape, shift, shimmy, and shed” load
Value of Flexible Load for Grid Operations
Value of Flexible Load for Integrating Renewables

Avoid Home Charging during these hours

Workplace Charging

Source: California ISO
Electrification Will Boost Load Flexibility

<table>
<thead>
<tr>
<th></th>
<th>Generation capacity avoidance</th>
<th>Reduced peak energy costs</th>
<th>System peak related T&amp;D deferral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct load control</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Interruptible tariff</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Demand bidding</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Time-of-use (TOU) rates</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Batteries Are Following Moore’s Law Too

Batteries prices fell 87% in real terms from 2010 ($1,100/kWh) to 2019 ($156/kWh). Look for ~$100/kWh by 2023.

– BloombergNEF, December 3, 2019
Home Solar & Batteries: the future, today

**Wholesale: e.g., ISO-NE**
- 20 MW bid won in 2019 Forward Capacity Auction
- Spread through number of New England states & ~5,000 homes
- First in nation
- Still providing backup power!

**Retail: e.g. BYOD**
- Bring Your Own Device: reduce G, T&D costs
- Utility program reducing wholesale or utility costs
- MA, VT, NH, NY, soon CT
- Low risk, pay for performance
- Still providing backup power!

**Utility: e.g. Aggregation**
- Virtual Power Plant Procurement
- NWA - locational
- Peaker replacement
- Low-income/multifamily
- Still providing backup power!
OCTOBER 01, 2018

Energy Storage Poses a Growing Threat to Power Plants

CHARLES NEWBERY

Batteries are posing a threat to natural gas plants, and may even displace them.
Key Power Sector Trends

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Many Bulk Power Issues Brewing...

- Integrated *system* planning
  - Including generation, transmission, distribution, and behind-the-meter
- ERCOT’s Energy-Only Market Success vs. Capacity Markets
- Organized Markets or Vertically Integrated?
  - Westward expansion? Southern?
- Accommodation of state policies
- Transmission ROE & pricing?
- Adherence to markets (vs. FERC/DOE initiatives)?
- SPP wind curtailment
Effective planning creates a context in which decentralized choices can be aligned with systemwide outcomes, enabling energy optimization.
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Let’s Look at the Fundamentals…

U.S. electricity use and economic growth, 1950 - 2040
percent growth (3-year compound annual growth rate) and trend lines

History | Projections
---|---
14% | 2.4%
12% | 0.9%
10% |
8% |
6% |
4% |
2% |
0% |
-2% |


Electricity use: 2015: ~0.8%, 2017: ~0.6%

Energy (& Carbon) & Economy Have Decoupled

Source: Energy in Context, 15 March 2015
Summary of Alternative Regulatory Mechanisms
Revenue Adjustment Mechanisms

Revenue adjustment mechanisms, which are increasingly adopted in the U.S., can be used to transition a utility towards a performance-based and customer value-centric regulatory model.

Revenue adjustment mechanisms focus on how a utilities' target revenues are determined, collected and/or adjusted over time, and include policy tools that shift regulation away from a backward-looking focus on costs and sales to a more forward-looking approach that incentivizes cost control and rewards utility performance.
Evolving Regulatory Model – PBR

PBR = Regulatory mechanisms that create stronger connection between a utility’s performance and its earnings.

Utility motivations for PBR:
• Better aligns financial goals with performance
• Less frequent rate cases
• Rate predictability
• Aids in cost control
• Rewards improved customer satisfaction, system reliability, system resiliency
• Allows for greater innovation, collaboration, and embracing new business models

Trickier with public power and co-ops (who have no shareholders), but not impossible.
Next-Generation Performance-Based Regulation

*Emphasizing Utility Performance to Unleash Power Sector Innovation*

David Littell, Camille Kadoch, Phil Baker, Ranjit Bharvirkar, Max Dupuy, Brenda Hausauer, Carl Linvil, Janine Migden-Ostrander, Jan Rosenow, and Wang Xuan

*Regulatory Assistance Project*

Owen Zinaman and Jeffrey Logan

*National Renewable Energy Laboratory*

September 2017
Conclusion
Disruptive Forces Transforming Electricity

Aggregation, Ability to Shape Load, Transactive Energy

Digitization, Artificial Intelligence, Deep Machine Learning

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

Chandu Visweswariah, Utopus Insights
Power Sector Jobs Have Shifted, Will Continue

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

Ken Colburn
Principal & US Director
The Regulatory Assistance Project®
kcolburn@raponline.org

Nancy Seidman
Senior Advisor
The Regulatory Assistance Project®
nseidman@raponline.org
Questions

• How will these trends impact Nebraska?
• What should Nebraska utilities do about it?
• What are some appropriate next steps?
Rate Design Digression

- Time of Use (TOU) – Echoes real markets
- Customer Charges – Promotes bypass
- Demand Charges – Creates “arms race”
TOU Rates Can Focus on the System Peak

Source: Sacramento Municipal Utility District [https://www.smu.org/en/Rate-Information/Time-of-Day-Rates/Time-of-Day-5-8pm-Rate]
Key Elements of TOU Rates: Fort Collins, Colorado

<table>
<thead>
<tr>
<th></th>
<th>Summer</th>
<th>Winter</th>
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<tbody>
<tr>
<td>Customer Charge</td>
<td>$6.16</td>
<td>$6.16</td>
</tr>
<tr>
<td>Off-Peak</td>
<td>$.066</td>
<td>$.065</td>
</tr>
<tr>
<td>On-Peak</td>
<td>$.235</td>
<td>$.211</td>
</tr>
<tr>
<td>Tier Charge All Usage</td>
<td>+$.017</td>
<td>+$.017</td>
</tr>
<tr>
<td>Over 700 kWh</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1900 kWh of storage needed to reduced peak demand to 310 kW average demand.
Large Retail Customer Demand with Solar

- Red: Before Solar
- Blue: After Solar
600 kWh of storage needed to reduce demand from 450 to 250 kW.
Large Retail Customer Demand with Solar and Batteries

- **Before Solar**
- **After Solar**
- **After 600 kWh Batteries**
Fixed Charges Aren’t the Answer Either

Landline Phone Companies

Cable TV Subscribers in the United States
How Do Other Industries Recover Fixed Costs?
Other Digressions

- Patti Poppe Video – CEO of Consumers Energy
- Joshua Rhodes – Virtual Clean Energy
- IRP Discussion
Clean and Lean

Old Utility Model

Results in excess capacity, higher cost

Clean And Lean

Matches supply with demand

*Illustrative
Annual Use of Supply

PEAK REDUCTION

Demand Response (Peak Shave Savings)

Peak

Average

Electric Vehicles
Economic Development

www.MiCleanEnergyPlan.com
Purpose and Use of an IRP

A blueprint for acquiring resources that meet utility’s needs while considering **cost**, **quality**, and **reliability**:

- May not be least **cost** plan
- May not be lowest **environmental impact**
- Should not compromise **reliability**
- May lead to unexpected outcomes
# Resource Considerations

<table>
<thead>
<tr>
<th>Supply-Side</th>
<th>Demand-Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>• New generation, large and small</td>
<td>• End-use efficiency</td>
</tr>
<tr>
<td>• Existing resources</td>
<td>• Demand response</td>
</tr>
<tr>
<td>• New transmission</td>
<td>• Combined heat &amp; power</td>
</tr>
<tr>
<td>• Upgrades to existing capacity</td>
<td>• Distributed generation</td>
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</table>
Illustrative IRP Process