Staff Electricity Subcommittee
Advancing Electrification: How to Ensure it is Efficient and Beneficial
Moderator: Michael Marchand, Arkansas Staff

Panelists: Arshad Mansoor, EPRI and Ken Colburn, RAP
Efficient Electrification

*What is the Opportunity?*

2018 NARUC Winter Policy Summit
February 11–14, 2018

Dr. Arshad Mansoor
Senior Vice President
EPRI
The Integrated Energy Network – Efficient Electrification

Efficient Electrification is a Key Enabler for the Integrated Energy Network
Winter Olympics 2018

Clean Air… Clear Choice
Paper Mill – Infrared Drying

Clean Air...
Less Water...
Clear Choice
Indoor Agriculture

Clean Air... Less Water... Less Land... Less Pesticide... More Yield... Clear Choice
## Efficient Electrification – Win…Win…Win

<table>
<thead>
<tr>
<th>METRIC OPTIONS</th>
<th>BENEFIT</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CUSTOMER</td>
<td>UTILITY</td>
<td>SOCIETY</td>
<td></td>
</tr>
<tr>
<td><strong>Economic Efficiency</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>• It costs less</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Energy Efficiency</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>• Uses fewer Btu overall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Economic Development</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>• Jobs creation and retention</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Development of community assets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>• Emissions reduction, CO₂ savings, water savings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Grid Flexibility</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><strong>Productivity Improvements</strong></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>• Plant output increases</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>• Reduction in energy intensity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Improved product quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Worker Safety Improvements</strong></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>• Reduced lost time and accidents</td>
<td></td>
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</table>
# EPRI National Electrification Assessment

## EPRI MODEL INPUTS

<table>
<thead>
<tr>
<th>SCENARIO</th>
<th>VARIABLES</th>
<th>TECHNOLOGY</th>
<th>FUEL COST</th>
<th>POLICY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSERVATIVE</td>
<td></td>
<td>Slower Technology Change</td>
<td>Flat Fuel Prices</td>
<td>No Additional CO₂ Policy</td>
</tr>
<tr>
<td>REFERENCE</td>
<td></td>
<td>Rapid Technology Change</td>
<td>Rising Fuel Prices</td>
<td>No Additional CO₂ Policy</td>
</tr>
<tr>
<td>PROGRESSIVE</td>
<td></td>
<td>Rapid Technology Change</td>
<td>Rising Fuel Prices</td>
<td>40% Economy-Wide CO₂ Emissions Reductions by 2050</td>
</tr>
<tr>
<td>TRANSFORMATION</td>
<td></td>
<td>Rapid Technology Change</td>
<td>Rising Fuel Prices</td>
<td>80% Economy-Wide CO₂ Emissions Reductions by 2050</td>
</tr>
</tbody>
</table>

## MODEL OUTPUTS

- Electric Generation Mix
- Economy-Wide CO₂ Emissions
- Electric and Non-Electric End-Use Energy Demands
Scenario Impacts on Final Energy, CO$_2$, and Electric Load: Between 2015 and 2050

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total Final Energy</th>
<th>Economy Wide</th>
<th>Electric Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSERVATIVE (21% &amp; 32%)</td>
<td>20%</td>
<td>19%</td>
<td>24%</td>
</tr>
<tr>
<td>REFERENCE (21% &amp; 36%)</td>
<td>22%</td>
<td>20%</td>
<td>32%</td>
</tr>
<tr>
<td>PROGRESSIVE (21% &amp; 39%)</td>
<td>27%</td>
<td>57%</td>
<td>35%</td>
</tr>
<tr>
<td>TRANSFORMATION (21% &amp; 47%)</td>
<td>32%</td>
<td>67%</td>
<td>52%</td>
</tr>
</tbody>
</table>
US Electrification Assessment…Key Insights and Actions

Customers Increase Reliance on Electric End-Uses
- Driven by economic technology adoption and consumer choice; accelerated by policy and regulatory constructs

Final Energy Consumption Decreases
- Efficient electrification, coupled with continued efficiency gains, leads to a decline in total energy consumption

Natural Gas Use Increases
- Both for end-use applications across the economy and for electric generation

Air Emissions Decrease
- GHG emissions reduced as generation continues to be clean and electrification growth increases

Accelerate Grid Modernization
- Increasing electrification will require a more reliable, resilient and flexible electricity grid

Optimize Grid Operations and Planning
- Planning and operation of the grid must evolve with connected efficient electric technologies as grid resource

Pursue Market Transformation
- Fuel neutral energy efficiency policy, innovative rate structure, public charging infrastructure and customer awareness and education

Prioritize Technology Innovation
- Innovation in energy storage, power electronics, and materials key to advance efficient electrification and helping to manage affordability
OBJECTIVES & SCOPE
Integrated analysis of customer energy demand and the electric power system combined with detailed technology assessments to support utility decision making.

VALUE
- Actionable research on renewable targets, air quality attainment, energy market reforms, and CO₂ mitigation
- Technology assessment on renewables integration, flexible operations, and distributed energy resources
- Analytics to inform your understanding of how increased electrification will impact your evolving power system
- Unbiased information to inform industry stakeholders on the benefits/costs of electrification for society and customers

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Allen Dennis
865.218.8192 | adennis@epri.com

Task 1: Energy System Assessment (2020 to 2050)
Task 2: Environmental Assessment (2020 to 2050)
Task 3: Transmission Assessment (selected years)
Task 4: Utility-level Assessment and Implementation Plan (selected years)

State-Level Assessment
Utility-Level Assessment
Coming in 2018...Efficient Electrification Benefit/Cost Assessment Methodology

Environmental Impacts
- GHG Emissions
- Air Quality
- Water
- Land
- Other Resources

Economic Impacts
- Productivity
- Product Quality
- Worker Health and Safety
- Occupant Comfort
- Cost of Service

Integrated Energy Network Infrastructure
- Avoided Costs
- Grid Flexibility
- Reliability

Leverage Framework of Standard Tests for Energy Efficiency Cost-Effectiveness

SAVE THE DATE
AUGUST 20–23, 2018 LONG BEACH, CALIFORNIA

ELECTRIFICATION 2018 CONFERENCE TRACKS

Electric Transportation (20%)
Industrial Electrification (20%)
Residential and Commercial Electric Technologies (20%)
Understanding the Costs and Benefits of Electrification (17%)
Grid Modernization for and Electrified Economy (9%)
The Policy and Regulatory Landscape for Electrification (14%)
Breakthrough Technologies (9%)

Scan here for the latest EPRI Efficient Electrification newsletter
Together…Shaping the Future of Electricity
Advancing Electrification: Ensuring It’s Beneficial

NARUC Staff Subcommittee on Electricity

07 February 2018
Disruptive Forces Transforming Electricity

**Aggregation, Digitization, Ability to Shape Load**

**Artificial Intelligence, Deep Machine Learning**

**Information & Network Effects**

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

**Adoption**

**Time**

- Solar grid parity
- Wind grid parity
- Smart meter roll-out
- PMUs
- $150/kWh
- We are here

Source: Chandu Visweswariah, Utopus Insights Inc.
Electrification is Well Underway

Figure 1: Annual global light duty vehicle sales

Source: Bloomberg New Energy Finance

Photo credits: Nest and Dennis Schroder, NREL
But, Not All Electrification is Created Equal

- It’s all about load growth, right?
- Brattle: “Utility sales could nearly double by 2050”!
What Makes for **Beneficial** Electrification (BE)?

*Three explicit criteria:*

1. Saves Customers Money Long-Term; New Services
2. Reduces Environmental Impacts
3. Enables Better Grid Management
## Metrics Matter...

<table>
<thead>
<tr>
<th>Emissions Efficiency</th>
<th>Marginal Resource on System to Serve Load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing Fuel #CO2/MMBTU</td>
</tr>
<tr>
<td>Utility System #CO2/MWh</td>
<td>2,000</td>
</tr>
<tr>
<td>Space Heating - Oil to Heat Pump</td>
<td>202</td>
</tr>
<tr>
<td>Warm Climate 3,000 - 6,000 HDD</td>
<td>209</td>
</tr>
<tr>
<td>Cold Climate &gt;7,000 HDD</td>
<td>314</td>
</tr>
<tr>
<td>Space Heating - Natural Gas to Heat Pump</td>
<td>130</td>
</tr>
<tr>
<td>Warm Climate</td>
<td>209</td>
</tr>
<tr>
<td>Cold Climate</td>
<td>314</td>
</tr>
<tr>
<td>Water Heating - Gas to Electric Resistance</td>
<td>167</td>
</tr>
<tr>
<td>Warm Climate</td>
<td>209</td>
</tr>
<tr>
<td>Cold Climate</td>
<td>314</td>
</tr>
<tr>
<td>Water Heating - Gas to Heat Pump</td>
<td>167</td>
</tr>
<tr>
<td>Warm Climate</td>
<td>209</td>
</tr>
<tr>
<td>Cold Climate</td>
<td>314</td>
</tr>
<tr>
<td>Clothes Drying - Gas to Ultrasonic</td>
<td>167</td>
</tr>
<tr>
<td>Automobile - Gasoline to EV</td>
<td>0.65</td>
</tr>
</tbody>
</table>

- Green = BE
- Yellow ~ OK
- Red = Don’t electrify, yet
Think Ahead: Electric Power is Getting Much Cleaner...

So Benefits Will Increase Over Time as Devices Improve Along With the Grid
Grid Management: Workplace EV Charging

Source: Jim Lazar, RAP
Where Will Electrification Initiatives Originate?

- Customers
- Policymakers
- Commission Initiatives
- Utility Proposals
How Best to “Manage” and “Influence”? (1)

- **Commission Initiatives:**
  - Structure Explicit Processes
  - Establish Principles and Goals
    - Include the *Three Criteria*
  - Define Utility Role and Cost Recovery
  - Get Stakeholder Feedback
  - Design, Plan, and Implement
  - Learn and Revise
How Best to “Manage” and “Influence”? (2)

- **Utility Proposals:**
  - Meet the *Three Criteria*
  - How: Rate Design = Cornerstone
  - Where: Distribution System Planning done?
  - Aligns with Power Sector Transformation initiatives?
  - Aligns with state RE and EE policies?
    - Modify RPS to avoid discouraging BE?
    - Modify EERS to avoid discouraging BE?
  - Equity Impacts?
  - Resiliency Impacts?
  - Cybersecure?
How Best to “Manage” and “Influence”? (3)

• **Alignment with Other Policy Goals?**
  - Jobs
  - Economic Development
  - Policy Leadership

• **Alignment with the Future?**
  - *Three Criteria* benefits over time
  - Technology development continues…
  - Storage, Transactive Energy, Blockchain, etc.
Technology Development Continues: Ultrasonic Clothes Dryer

- Uses sound waves to “shake” moisture out
- 80% reduction in electricity consumption compared to electric resistance dryer

![LADWP Efficiency for Clothes Drying Chart]

![Image of Ultrasonic Clothes Dryer]
Risks Also Loom…

• Perpetuation of kWh-throughput business model and existing rate designs

• Hitching to the electrification bandwagon

• Transactive energy and storage become economic first => bypass

• Regulatory awareness, issues, delays
There’s Not a Lot of Time…

<table>
<thead>
<tr>
<th>5th Avenue, NYC, Easter 1900</th>
<th>Park Avenue, NYC, Easter 1913</th>
</tr>
</thead>
<tbody>
<tr>
<td>See any automobiles?</td>
<td>See any horses?</td>
</tr>
</tbody>
</table>

RAP papers on operationalizing beneficial electrification coming soon.

Source: Tony Seba
About RAP

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

Learn more about our work at raponline.org
Staff Electricity Subcommittee