Role of Electrification in Decarbonization

Tom Wilson
Principal Technical Executive
Energy and Environmental Analysis, EPRI

IEA-IETA-EPRI Workshop on GHG Emission Trading

Paris, FR
11 October 2017
EPRI – Born in a Blackout

Founded in 1972 as an independent, nonprofit center for public interest energy and environmental research

New York City, The Great Northeast Blackout, 1965
Our Members...

- 450+ participants in more than 30 countries
- EPRI members generate approximately 90% of the electricity in the United States
- International funding – nearly 25% of EPRI’s research, development, and demonstrations
U.S. Greenhouse Gas Reduction (GHG) NDC: Economy-wide Reduction of 28% by 2025; Longer-term Goal of 80% by 2050

Source: US-REGEN data; Energy Modeling Forum 24
U.S. Greenhouse Gas Reduction Targets:
What Role will the Electric Sector Play in Economy Reductions?

Rest of economy must make dramatic reductions – HOW?

Source: US-REGEN data; Energy Modeling Forum 24
Increasing Attention on Electricity’s Role in Decarbonization

The Tighter the CO\textsubscript{2} Cap, The Greater the Role Electricity Plays

US National Electrification Assessment – forthcoming Q1 2017
Requires New Demand-side Modeling

Energy Use
- Climate zones
- Building types
- Household characteristics
- Industrial mix
- End-use technology detail

Electric Generation
- Investment and dispatch
- Transmission
- Intermittent renewables
- Energy and capacity requirements
- State-level policies and constraints

Model Outputs:
- Economic equilibrium for generation, capacity, and end-use mix
- Emissions, air quality, and water

Synchronized Hourly Load, Renewables, and Prices
Electrification Potential – Depends on Fuel Use and Technology
(2014 US Energy Use, Quad BTUs)
National Electrification Assessment: Future Scenarios
An Iterative Process as Key Drivers Emerge

- **Reference Case**
  - “Likely” technology future with no new policies; consumer adoption of economically viable technologies

- **Aggressive Technology Case**
  - Rapid technology improvement/cost reductions

- **Economy-wide Greenhouse gas (GHG) cases**
  - 2050 emissions 80% below 2005 levels
  - 2050 emissions 40% below 2005 levels

- **Electrification Policies**
  - National and regional policies promote adoption of electric technologies via:
    - Electric technology tax credits (e.g., renewables)
    - Technology standards, or mandates (e.g., French/British EV mandates)
    - Focused incentive/information programs (e.g., state energy efficiency programs)
U.S. Final Energy...Drivers of Growth – Based on DOE AEO 2017

- GDP Growth (AEO)
- Structural Change (AEO)
- Energy Service Growth
- Efficiency Improvements

- Hypothetical Energy Use with no change in fuel/technology choice
U.S. Final Energy – EPRI Projection with No Carbon Price, but Aggressive Light Duty Vehicle Assumptions

Energy Declines…Share of Electricity Increases

Structural Change (AEO)

Efficiency Improvements

Electrification

Non-Electric Energy

Electricity

20%

32%
Electric Generation and CO2 Emissions ... without US Carbon Policy

National Load Growth Increases as Electric Technologies Displace Direct Use of Fossil Fuels

+31%
2015 → 2050

National CO₂ Emissions Decline Driven by Efficiency and Electrification

-30%
2015 → 2050

Assumes no additional GHG policy on power sector → 30% decline in CO₂ intensity
Load Shape Changes...Electrification and Efficiency Impact

SE-Central 2015

Heating Peak Exceeds Cooling Peak in Some Regions

- Space Heating
- Non-Seasonal
- Cooling
- Vehicle Charging
Load Shape Changes...How Will This Impact Supply Mix/Grid Assets?

SE-Central 2050

- Space Heating
- Non-Seasonal
- Cooling
- Vehicle Charging

© 2017 Electric Power Research Institute, Inc. All rights reserved.
Hourly Load Shape Aggregated Across Uses

SE-Central 2015

- Winter Peak
- Summer Peak

GW

© 2017 Electric Power Research Institute, Inc. All rights reserved.
Load Shape Changes...How Will This Impact Supply Mix/Grid Assets?

SE-Central 2050

Winter Peak

Summer Peak

Aggregate Load

GW

J F M A M J J A S O N D

2015

© 2017 Electric Power Research Institute, Inc. All rights reserved.
Distribution across US of Electric Heating Cost Premium

Based on today’s fuel prices and new vintage technology

Areas where electric heating has the lowest total costs

Areas where electric heating has a cost premium relative to gas

Florida
Pacific
SE-Central

Mtn-S
Texas
SW-Central

California

Mid-Atlantic
NE-Central
Mtn-N
New England
New York
NW-Central
Higher carbon prices $\rightarrow$ more electric heating in the money

Based on carbon-adjusted fuel prices and new vintage technology

Cost Premium for Electric Heating ($ per year)

Cumulative square footage installing new equipment 2015-2030 (billions)

- $0/t\text{CO}_2$
- $100/t\text{CO}_2$
- $200/t\text{CO}_2$
- $300/t\text{CO}_2$

Florida
Pacific SE-Central
S-Atlantic
Mtn-S
Texas
SW-Central
California
NE-Central
Mtn-N
New England
New York
NW-Central

© 2017 Electric Power Research Institute, Inc. All rights reserved.
EPRI Initiative on Efficient Electrification – Much More to Come

National Assessment Q1 2018
Regional Assessments

Efficient Electrification Newsletter

International Conference
August 20-23, 2018
Long Beach, CA
www.electrification2018.com

Efficient Electrification Research Project Portfolio

Center of Excellence

Together...Shaping the Future of Electricity
Concluding Thoughts

- Electrification very likely to play a key role in decarbonization
- Policy needs to allow this transition (or encourage it)
- Price/markets play a key role, accompanied by changes in technology and regulatory structures
Together...Shaping the Future of Electricity
Passenger Vehicles:
Two Revolutions (Electric and Autonomous)

Service Demand

- ICEV
- PHEV
- EV
- Autonomous EV

“Deadheading”
(VMTs with no passenger)

Final Energy

- Efficiency Improvements
- Electrification

Liquid Fuels
Electricity

© 2017 Electric Power Research Institute, Inc. All rights reserved.
Occupied Floor Space by Main Heating Technology (RECS)

- Unheated
- Other
- Electric (heat pump)
- Electric (resistance)
- Wood
- Oil
- Natural Gas