100% Clean Energy Collaborative Webinar

Power After Carbon: Findings and Insights for State Policymakers

September 9, 2020
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Webinar Speakers

Peter Fox-Penner
Founder and Director, Boston University’s Institute for Sustainable Energy and Professor at the BU Questrom School of Business

Warren Leon
Executive Director, Clean Energy States Alliance (moderator)
PETER FOX-PENNER

POWER AFTER CARBON

Building a Smart, Clean and Resilient Power Industry

Presented to:
Clean Energy States Alliance Webinar
September 9, 2020
Part I

Electricity’s Role in Climate Solutions
The Climate Crisis

At the current rate of warming of 0.2°C per decade, the planet will likely reach the lower target of 1.5°C by as early as 2030.

Arctic warming 2-3x faster than global average; its sea ice is declining at a rate of 12.8% per decade.

US CO₂ emissions from fossil fuel combustion rose 2.7% in 2018, fell 1.9% in 2019.

Power sector emissions are down 29% from 2005 levels.
Total U.S. Greenhouse Gas Emissions By Economic Sector in 2018

Sources of Greenhouse Gases By Sector - US

- Transportation: 1,869.5
- Electricity: 1,803
- Industry: 1,469
- Agriculture: 667.7
- Commercial & Residential: 801.2

Total Emissions in 2018: 6,677

*Percentages may not add up to 100% due to independent rounding.

Energy-Climate Strategy for the Developed World: Efficiency + Clean Electricity + Clean Fuels

- Accelerate energy efficiency
- Electrify most transportation
- Electrify most building heat
- Electrify some industrial processes

And the key:

- A large enough power system -- and clean gas/liquid fuels

✓ No carbon
✓ High resilience and reliability
✓ Affordable and financially feasible
The Upper Regions of “Electrifying Everything”

U.S. Energy Use 2018

- Transportation: 37% (28.3 quadrillion BTUs)
- Industry: 35% (26.3 quadrillion BTUs)
- Residential: 16% (11.9 quadrillion BTUs)
- Commercial: 12% (9.4 quadrillion BTUs)

 Converted into TWh
- 2,598 TWh (3x current efficiency)
- 3,005 TWh (2x)
- 889 TWh (2x)
- 647 TWh (2x)

TOTAL: 7,139 TWh
*Incremental ~2x above current use*

How Much Power Will We *Really* Need?

The diagram illustrates the relationship between electricity demand and various factors influencing power need. Key elements include:

- **U.S. GDP** and **U.S. Population**
- **Weak Efficiency Policies**
- **Strong Policies**
- **Electrification Policies**

The diagram shows three levels of electricity demand:

- **1x**
- **1.5x**
- **2x**

These levels are influenced by factors such as AI and edge computing, which are indicated by the question mark (?). The upper bound of future electricity use is also shown.
Power Increases in Deep Decarbonization Studies

2050 Electricity Demand in Selected Regions: Forecasts from Deep Decarbonization Studies

Electricity Sales in 2050 as a Multiple of Today's Use

- United States
- Canada
- Germany
- United Kingdom
- Mexico
- Portugal
- South Africa
- New England
- California
- Pacific Northwest
- Portland, OR
How Much Electricity Can Distributed Sources Contribute?

% of city power use available from rooftops

To power an all-solar Phoenix, current storage would need to occupy 23% of the city’s land.

Part II
The Big Grid
How Large Power Grids Enable Cheaper Decarbonization

- Scale effects in power production and delivery
- Aggregated loads are “smoother” -- cheaper to serve
- Natural geographic diversity of wind & solar;
- Benefits of trading power
- Lower costs of preventing/repairing large blackouts
The Big Grid Faces Big Challenges

Large Grids Will Be Vulnerable to Strong Political Localization and DG Breakthroughs

Large Grids Must be Resilient to Climate and Other Disruptions (ex: PG&E) – Key Industry Priority

Large Grids Must be Built to Minimize Environmental Damage and Maximize Shared Benefits
And the Biggest: Large-Scale Energy Balancing

Hourly Generation and Load for NorthWestern Energy – Feb. 2019

Source: NorthWestern Energy (2019), used by permission
Supply Side of A Carbon-Free Big Grid

Wind
Solar PV
Nuclear
Gas Power With CCS/RNG
Solar Thermal
Small Hydro
Geothermal
Distributed Storage
Fuel Cells
CHP and District Energy
New Technologies
Large-Scale Storage
Flexible Load
...And a Grid to tie it all together
What’s Not Working Well Enough on the Big Grid?

- **More Large Storage Needed.** Hydroelectricity challenged; Battery and hydrogen storage too expensive

- **Demand response** potential is huge but highly variable and mechanics are complex

- **Transmission** is underplanned and underbuilt

- **The financial mechanisms** for getting Big Grid facilities built aren’t working well enough to meet carbon targets

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- Continue R&D and diversify options
- Market and regulatory reforms
- Regional energy planning
- Reform power markets
The Power Market Reform Debate in One Slide

The Four Schools of Thought on Reconciling Strong Climate Policies and Capacity Markets

**Carbon Pricing is Essential**

- **All-of-the-Above**
  
  Price carbon and make better capacity markets, but allow contracts and other climate policies

- **Maximize Markets**

  Capacity markets, carbon pricing and energy reforms should all be pursued in an integrated way.

- **Policies Plus Markets**

  Allow bilateral contracts and enforce climate policies through measures such as RPS, electrification mandates, etc.

- **Better Capacity Markets**

  Capacity markets should be disaggregated into attribute markets even if carbon pricing isn’t part of them

**Don’t rely only on capacity markets**

**Prioritize capacity market prices to induce new plant**

**Carbon Pricing isn’t adequate (or not likely)**
Part III
The Retail Sector and the Utility of the Future
Distribution Utilities in the United States

Source: Image reproduced with permission from Platts (2014)
"Utility Service Areas of North America"
Business Pressure on Distribution Utilities

Low-to-Negative kWh Deliveries (Short Run)

Increased Capex to Build Smart, Resilient Grid

Far More Complex and Demanding Operating Environment
- Severe Weather Events
- Accommodate DG/DR
- Customer service expectations

Risk of Fragmenting into Microgrids and Other Defections
Dimensions of Distribution Utility Strategy

- Geographical Span:
  - Go global
  - Stay local
  - Divest

- Services:
  - Renewable Energy
  - Sell new competitive services through affiliates
  - Energy efficiency

Regulated Grid Business Model
The Regulated Grid Business Model Spectrum

**Exit the distribution business entirely**

**Passive Distribution**
Distribution utility owns but does not operate its own system—instead operated by independent DSO

**Smart Integrators**
Utilities that continue to serve as platforms and network orchestrators, but have stepped back from being the primary branded transactor with customers

**Hybrid Business Models**
Not the primary provider of services, but an integral, engaged partner in delivering energy services from other providers

**Energy Service Utilities**
Sell the full range of energy services to customers, mainly from closely-associated partner companies

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Rare thus far and not recommended

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**nrg**
**ComEd**
An Exelon Company
**Southern Company**
**Seattle City Light**

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Electrification: An Essential Frontier

- Transportation electrification: Strong market support
- Building Thermal Decarbonization: Public and private capital and strong policies
- Industry – specific RD&D collaboratives
Summary

Energy efficiency should be maximized, but this takes real work.

A completely clean power industry ~ 50% larger is necessary and achievable.

Decarbonized Big Grids need storage, regional planning and reformed markets.

The downstream sector needs PBR, new business models and dynamic pricing.

Cost-effective electrification of transport, heat, and industry needs action NOW.

This is a 20-year project. Full speed ahead!
Acknowledgements and Thanks:

CONFLICT OF INTEREST DISCLOSURE
Dr. Fox-Penner holds equity in Energy Impact Partners, a utility-backed energy investment and innovation firm, and consults for Energy Impact Partners and The Brattle Group on energy technologies. Dr. Fox-Penner also conducts research in areas of interest similar to the business interests of Energy Impact Partners and The Brattle Group. The terms of this arrangement have been reviewed by Boston University in accordance with its financial conflicts of interest in research policies.
Thank you for attending our webinar

Warren Leon
Executive Director, CESA
wleon@cleanegroup.org

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An Introduction to Virtual Power Plants
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