Power Sector Trends and Resilience

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The Power Sector Is Enduring Several Key Trends and Policy Context

• Continuing Uncertainty for Carbon Policy
• Flat Demand...except for a few areas of growth
• Rise of Renewables
• Electrification of...everything
The Power Sector Is Facing Several Challenges

• Bad news:
  – Deep decarbonization will be difficult (but easier than for transport)
    • Existing nukes are shutting down
    • New nuclear and coal w/carbon capture are expensive, slow, over-budget
  – Environmental controls (mercury, acid rain, etc.) are still looming
  – Business models are changing quickly, regulators are changing slowly
  – Demand for electricity is flat/dropping
  – (For producers): Wholesale electricity prices are declining in real terms

• Good news:
  – (For consumers): Retail electricity prices are declining in real terms
  – Shallow decarbonization is easy: Power emits less CO₂ than transportation
  – Growing demand from EVs, pot-growing operations, and data centers
Decriminalization of Recreational Marijuana Use Might Be A Bright Spot for Electricity Providers

Pot power: How utilities and regulators are dealing with the budding marijuana industry

Growing marijuana requires so much power that electric utilities across the nation are taking notice

By Gavin Bade | November 13, 2015
Data Center Electricity Consumption Is Growing

1.8%
Percentage of total U.S. electricity consumption that went to data centers in 2014

620 billion kWh
Electricity saved between 2010–2020 thanks to efficient practices

45%
Potential energy savings in 2020 with additional energy efficiency measures

Source: Berkeley Lab, 2016
Electrification of Everything (beyond EVs)

- Heat-intensive industrial processes
  - Smelting
  - Refining
- Oil & gas extraction
  - Improves productivity
  - Reduces methane emissions
- Agriculture
  - High value crops: greenhouses, hydroponics, aquaponics, aeroponics
  - Commodity crops: electrified equipment
The Rise of Renewables Is Ongoing
Wind Has Enjoyed Phenomenal Growth

1997–2016 Installed Wind Power Capacity
Source: BP Statistical Review of World Energy 2016 • Graphic: Michael E. Webber, The University of Texas at Austin
Solar Installations are Growing

2003–2015 Cumulative Installed Photovoltaic (PV) Power
Source: BP Statistical Review of World Energy 2016 • Graphic: Michael E. Webber, The University of Texas at Austin

- Germany
- Japan
- U.S.
- Italy
- U.K.
- France

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The Duck Curve Is On People’s Minds

![Graph showing net load on March 31 with hourly data from 2012 to 2020, highlighting ramp need and overgeneration risk. Source: CA ISO.]

Source: CA ISO

Dr. Michael Webber  Power Sector Trends  February 26, 2018
The Duck Curve Is On People’s Minds

Net load - March 31

ramp need ~13,000 MW in three hours
overgeneration risk

Source: CA ISO
In Texas We Call It The Dead Armadillo Curve

Net load - March 31

ramp need
~13,000 MW
in three hours

overgeneration risk

Source: CA ISO
Regulation Procurements Went Down In ERCOT Despite Increasing Wind Capacity
Renewables Aren’t That Big of A Problem for Conventional Utilities; Distributed Generation is

• Grid management costs went DOWN in TX despite rise in wind
  – Market design improvements
  – Better wind forecasting
  – Geographic dispersion
  – Availability of fast-ramping natgas generators

• Utility-scale solar is probably harder than wind to accommodate

• DG is mysterious because it’s behind-the-meter

• Maybe DER become baseload/primary & grid moves to the margin
What to do? Mixed signals...

• Consider new market signals to reward cleanliness and reliability
  – Put a price on carbon (helps nuclear...)
  – ZECs (Zero Emission Credits) (helps nuclear...)
  – Capacity payments, etc. (helps nuclear, coal...)

• Re-regulate the markets
  – After decades of calls to de-regulate power markets to achieve efficiency and cost-savings, power sector now openly ponders re-regulation as a way to avoid stranded assets and to achieve deep decarbonization
  – “Cash for Coal Plant Clunkers”, etc.

• Conclusion: markets, technology and policy are required
  – No single dimension gets us all the way there in an elegant fashion
Because of These Concerns Secretary Perry Pushed for Subsidies for Coal and Nuclear

- NOPR = Notice of Proposed Rulemaking
- Includes payments for conventional thermal power plants
- The proposed payment program could be called Grid Resilient Infrastructure That Ensures Reliable Service
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Perry Says NOPR; FERC Says NOPE

Joshua Rhodes, January 8, 2018

Forbes / Energy

Perry Says NOPR; FERC Says Nope (To Propping Up Coal)
Power Sector Can’t Agree On Language Such As “Baseload”

• Baseload = lowest demand over course of year
• Baseload = paid-off plant that gives intangible value, must be saved
• Baseload = power plants that ramp slowly
• Baseload = coal, nuclear
• Baseload = resource w/ least levelized long-run marginal cost
• Baseload = resource w/ least short-run marginal (dispatch) cost

• Conclusion: “baseload” is now obsolete and possibly even damaging
Action item: switch to a supply-following mindset rather than a load-following mindset.
In A Dynamic, Low-Marginal-Price World, Flexibility Is Key

- Storage (primarily for ancillary services and load-shifting)
- Electrofuels manufacturing as flexible load AND storage
  - Hydrogen, natural gas, ammonia
- Data centers as flexible load
- Water treatment as flexible load
What if money rained from the sky? What if it were heavy?

- Water: ~$4/1000 gals
- Total Value: ~$136B
- Damage: ~$136B

Harvey dumped record-setting 34 trillion gallons of rain

By Dug Begley, Houston Chronicle | September 17, 2017 | Updated: September 17, 2017 8:51pm
Floods Threaten the Power Sector

Nebraska Nuclear Power Plant along the Missouri River
Source: Reuters, June 24, 2011
Floods Threaten the Fuels Sector

- Hurricane Harvey shut in 4.4M bpd of refining (25% of national capacity)
- Crude production mostly unaffected
- Oil prices stayed flat, gasoline prices increased
Hurricane Harvey Might Be The Impetus For Rethinking Our Relationship With Cars
Hurricane Harvey Is The Largest Single Incident Of Automobile Destruction In The History of Humankind
Hurricane Harvey Might Be The Impetus For Rethinking Our Relationship With Cars

• Personal cars, fleets, and trucks were ruined
• Biggest incident of automobile destruction in history
• Perhaps those cars should not be replaced one-for-one
  – Micro-Transit (Chariot)
  – Mass-customized transit (Uber & Lyft)
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