Power Sector Trends and Resilience

Presented at the Aspen Institute Clean Energy Forum

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Aspen, CO
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Webber Energy Group
THE UNIVERSITY OF TEXAS AT AUSTIN

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 CO_2 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

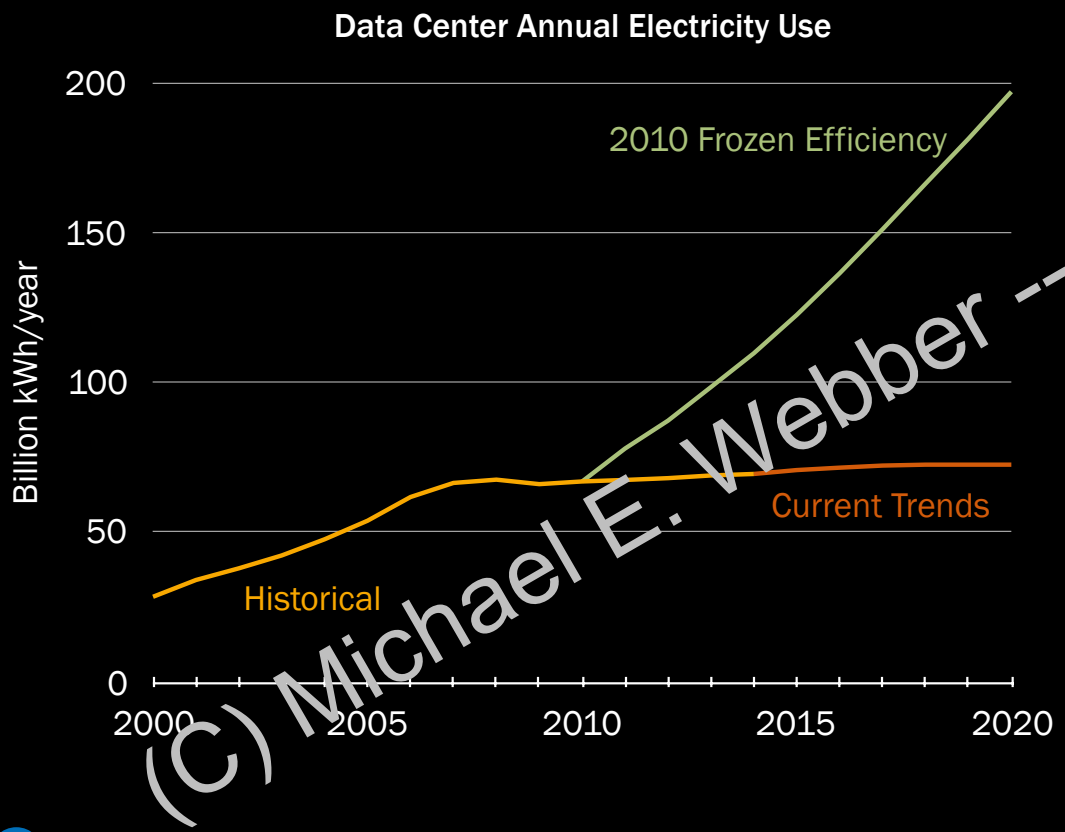
Utility DIVE

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 print

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

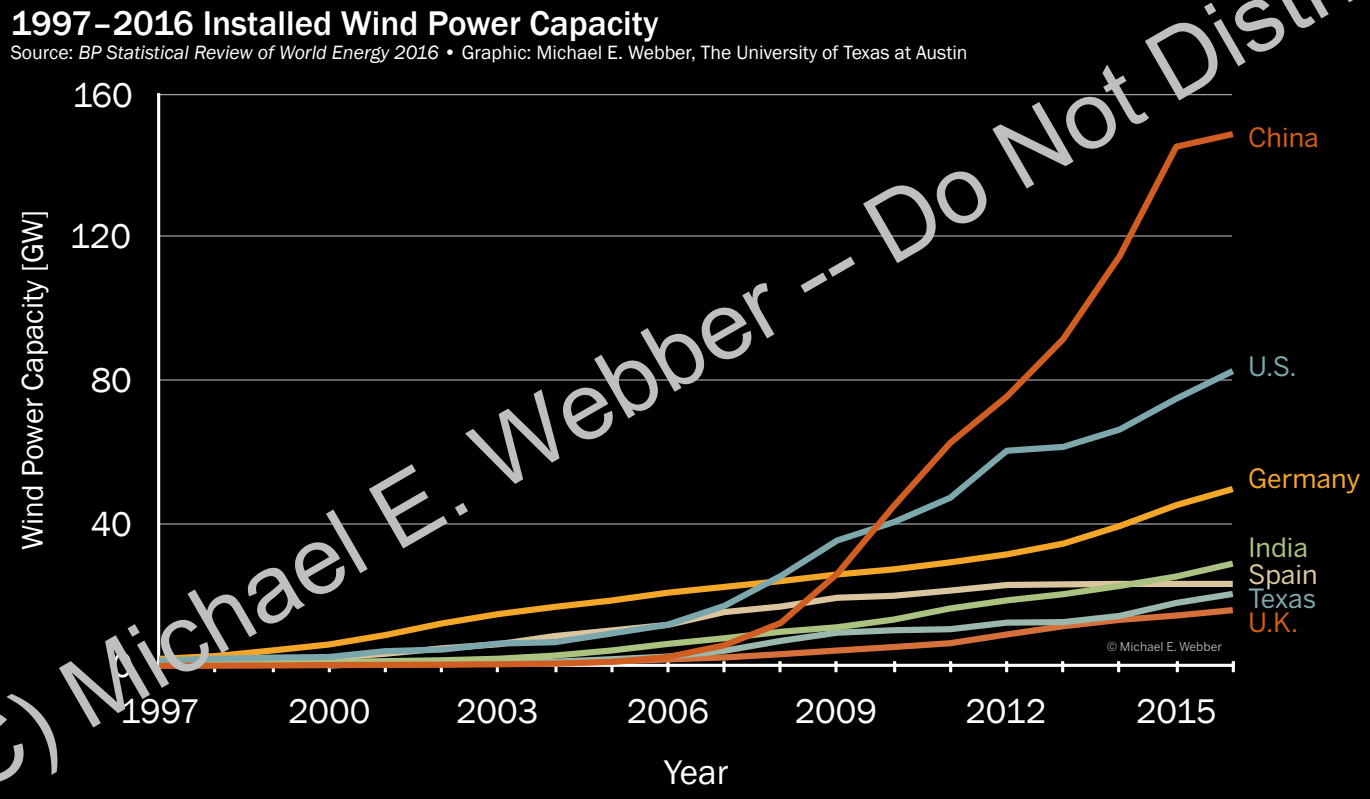
Source: Berkeley Lab, 2016

Electrification of Everything (beyond EVs)

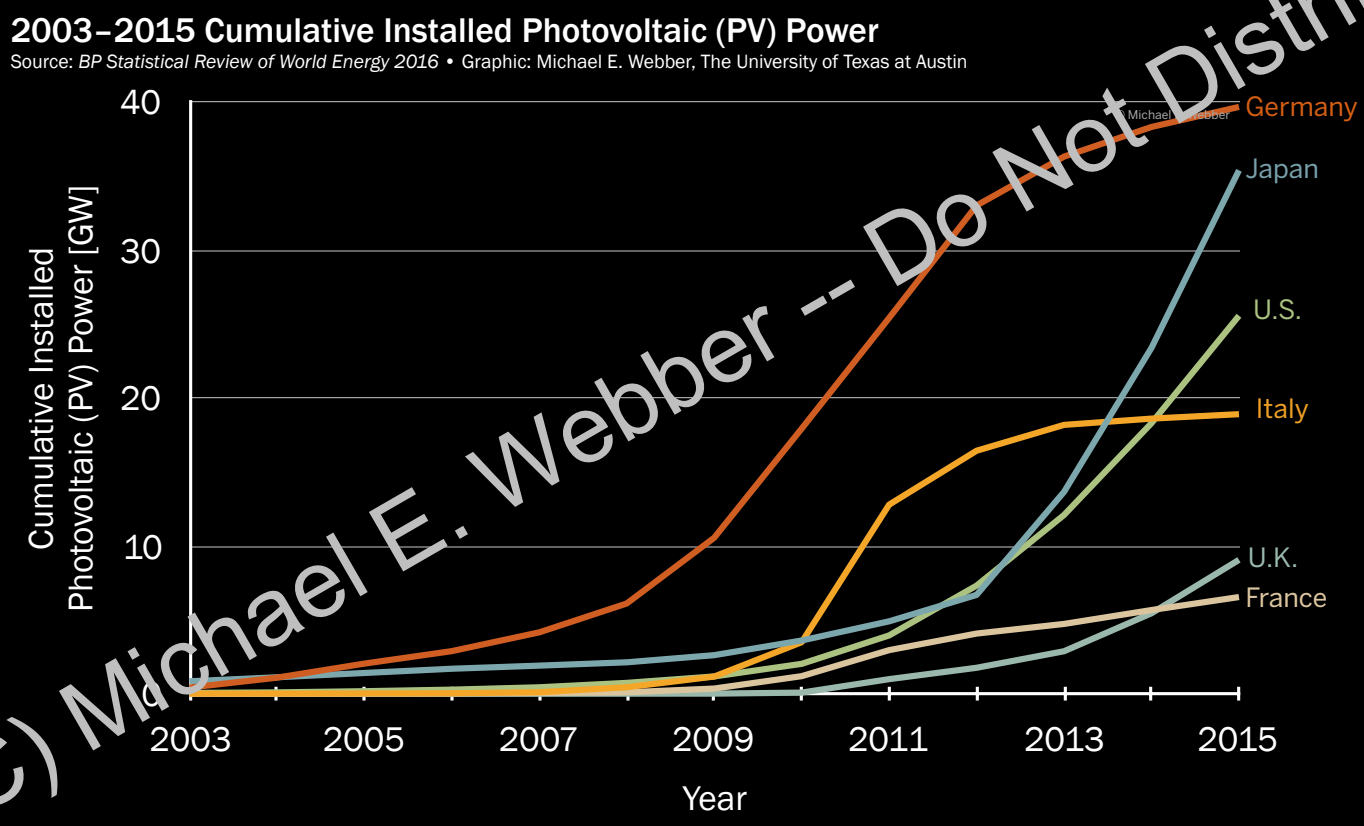
- Heat-intensive industrial processes
  - Smelting
  - Refining
- Oil & gas extraction
  - Improves productivity
  - Reduces methane emissions
- Agriculture
  - High value crops: greenhouses, hydroponics, aquaponics, aeroponics
  - Commodity crops: electrified equipment

The Rise of Renewables Is Ongoing

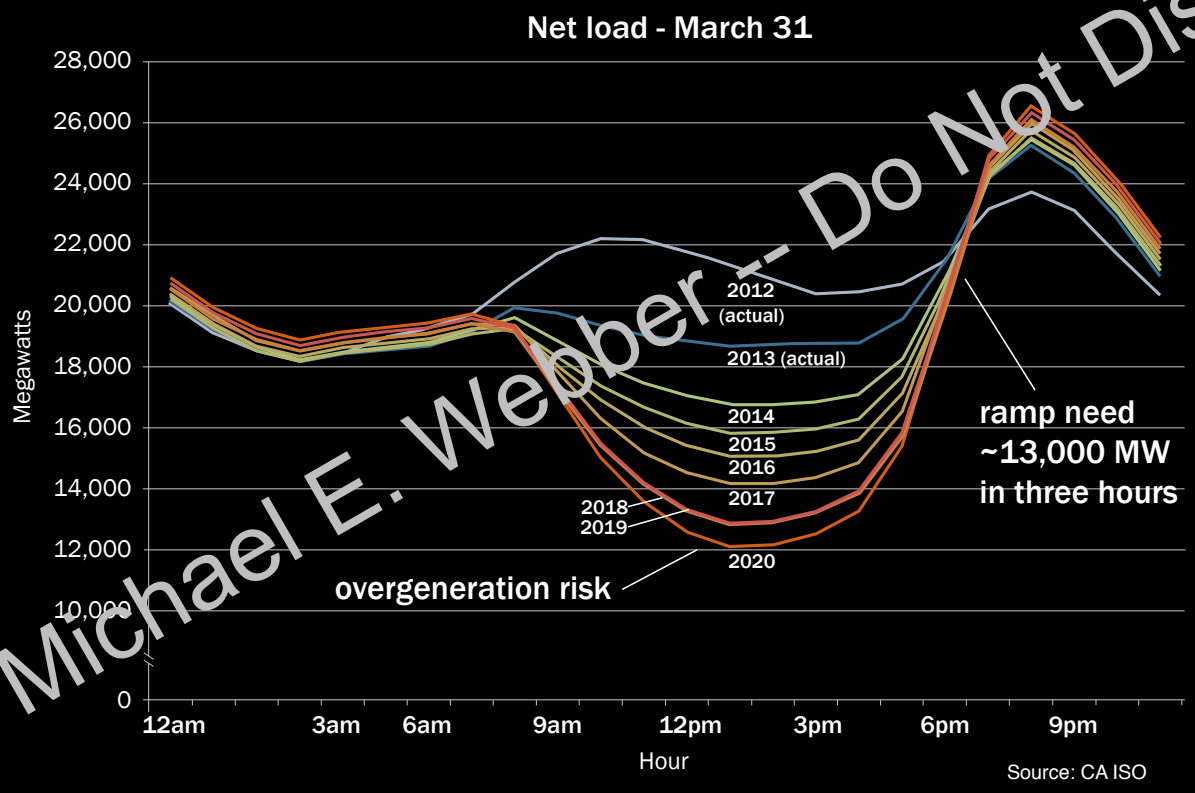
Wind Has Enjoyed Phenomenal Growth



Solar Installations are Growing



The Duck Curve Is On People's Minds



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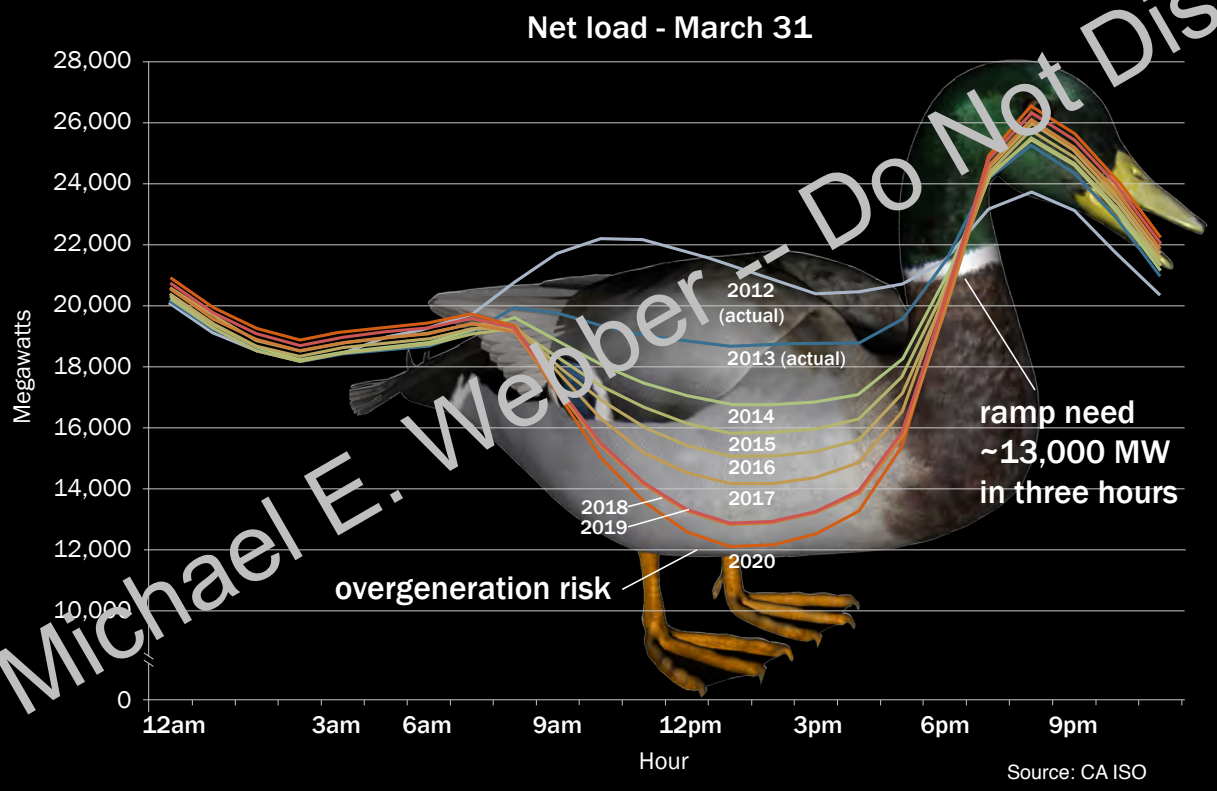
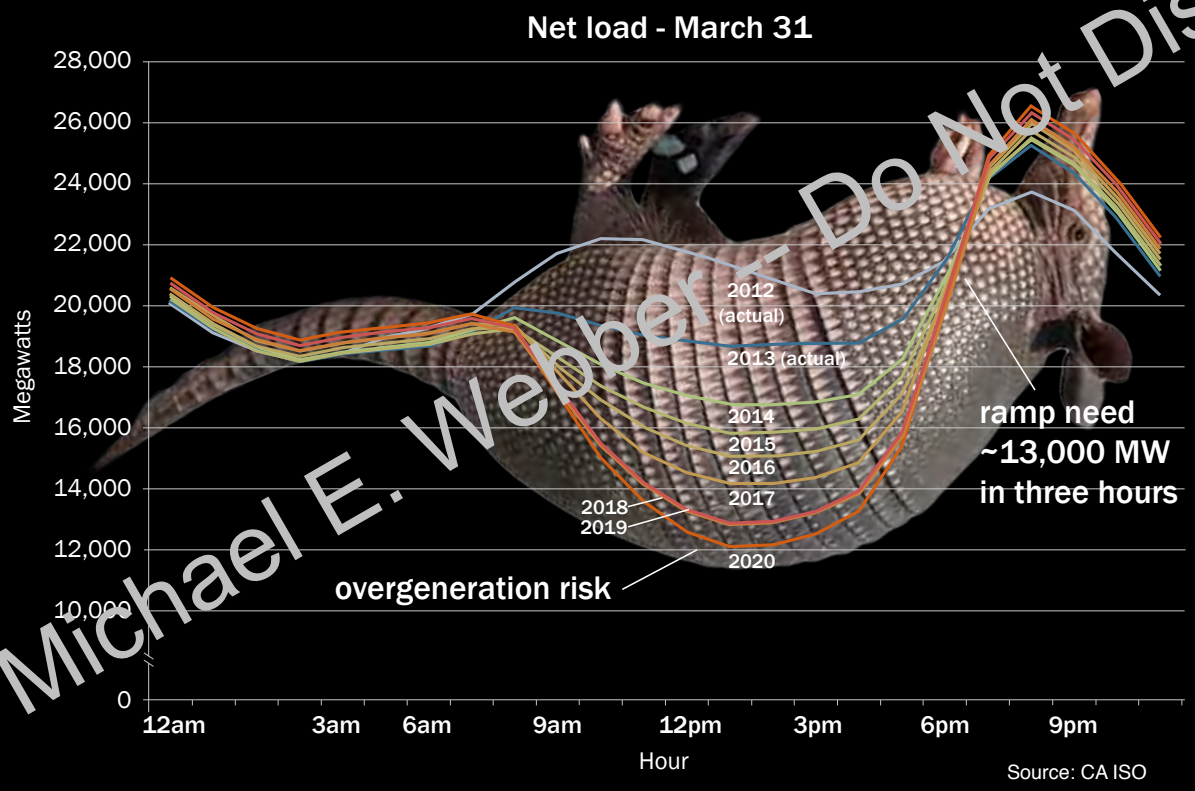


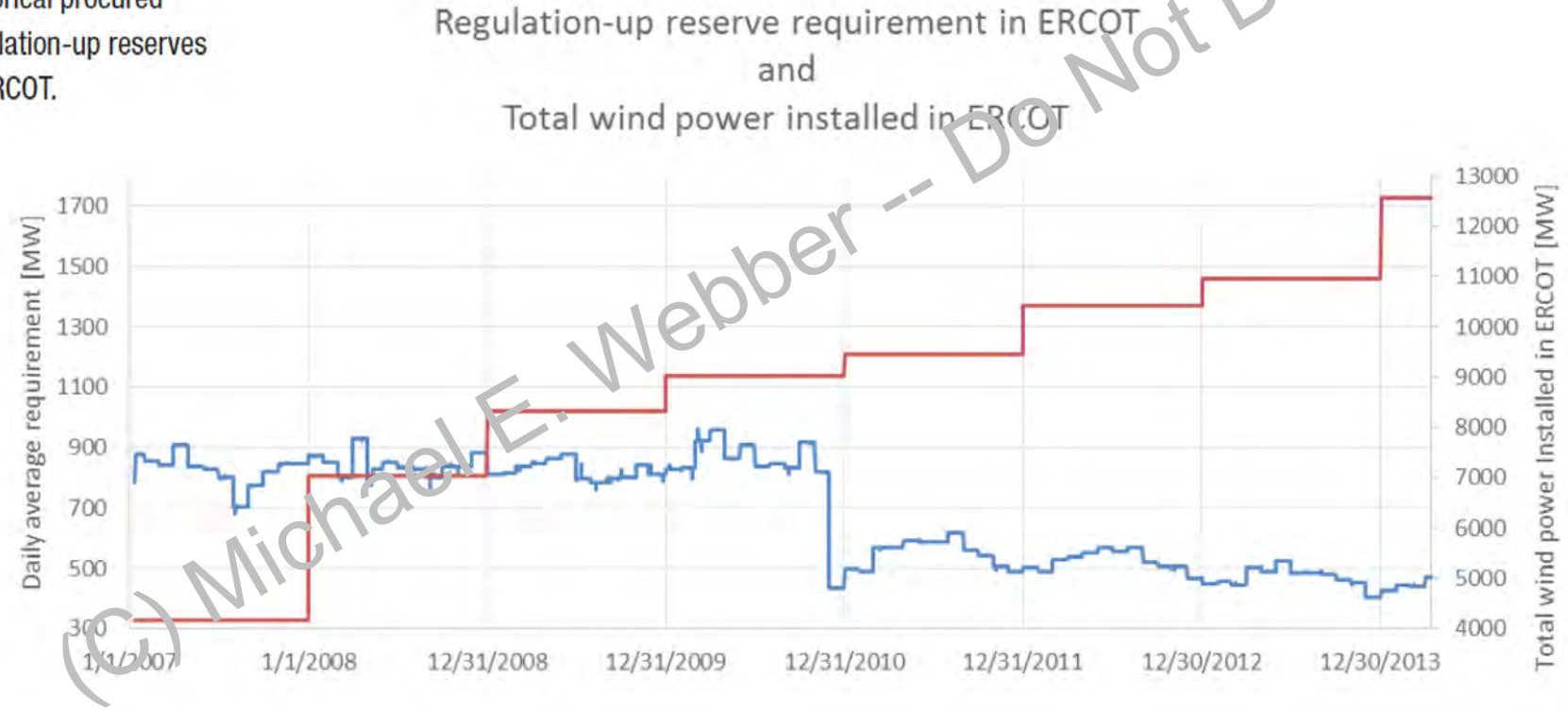
In Texas We Call It The Dead Armadillo Curve



Regulation Procurements Went Down In ERCOT Despite Increasing Wind Capacity

FIGURE 7

Historical procured regulation-up reserves in ERCOT.



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

AP PHOTO

- 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

Forbes / Energy

Perry Says NOPR; FERC Says Nope (To Propping Up Coal)

Joshua Rhodes, January 8, 2018

Power Sector Can't Agree On Language Such As "Baseload"

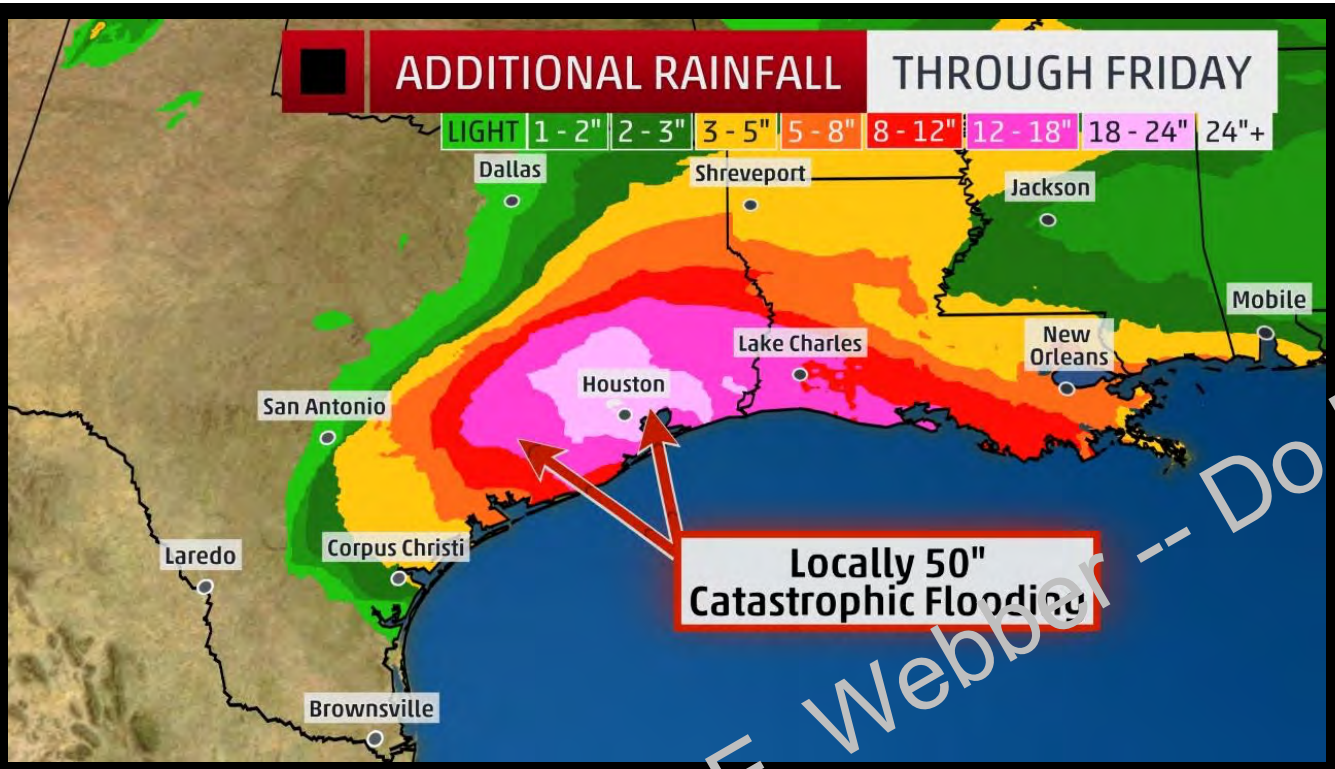
- Baseload = lowest demand over course of year
- Baseload = paid-off plant that gives intangible value, must be saved
- Baseload = power plants that ramp slowly
- Baseload = coal, nuclear
- Baseload = resource w/ least levelized long-run marginal cost
- Baseload = resource w/ least short-run marginal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



Harvey dumped record-setting 34 trillion gallons of rain

By Dug Begley, Houston Chronicle | September 17, 2017 | Updated: September 17, 2017 8:51pm

What if money rained from the sky? What if it were heavy?

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

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)


USA TODAY

Harvey may have wrecked up to 1M cars and trucks

Nathan Bomey and Aamer Madhani, USA TODAY Published 12:41 p.m. ET Aug. 31, 2017 | Updated 5:10 p.m. ET Aug. 31, 2017


Bloomberg View

Harvey Can Help Houston Rethink Its Car Culture

An opportunity to change the way people commute.

By F. Todd Davidson And Michael E. Webber

47 September 15, 2017, 12:18 PM CDT

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