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Impact of Gas Pipeline Infrastructure with Variable Renewable Generation

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George Wayne
Director, Market Services
West Region Gas Pipelines

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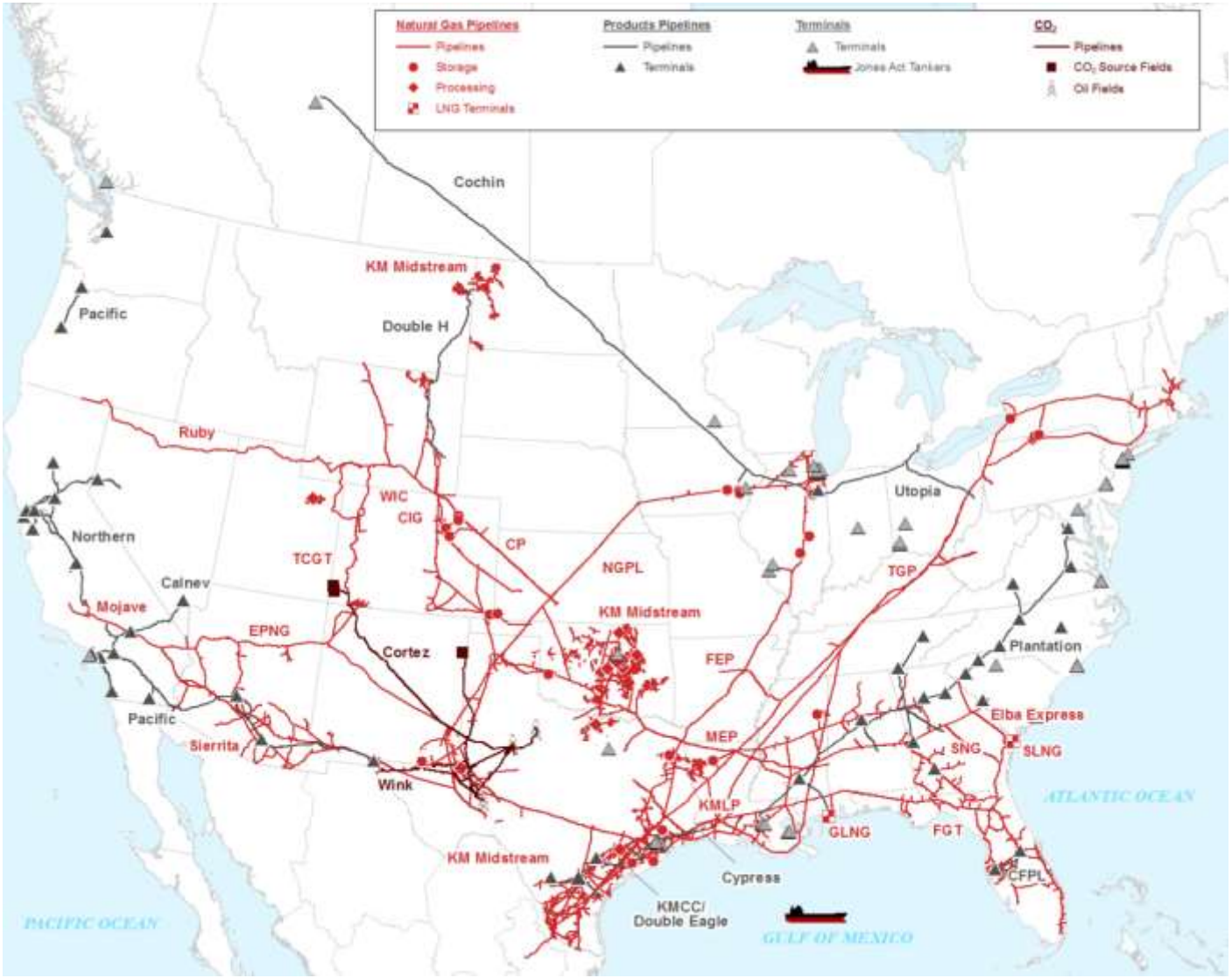
Agenda

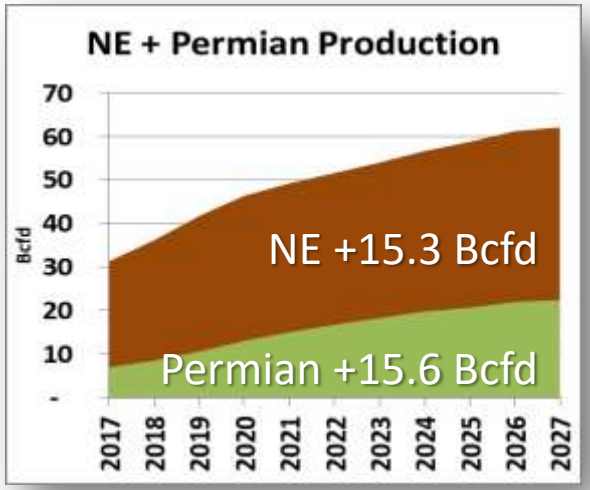
- Key Trends in the US Natural Gas Market
- West Region Power Generation Trends
- Impact of Renewables on Gas Transportation
- Summary

Kinder Morgan Asset Map

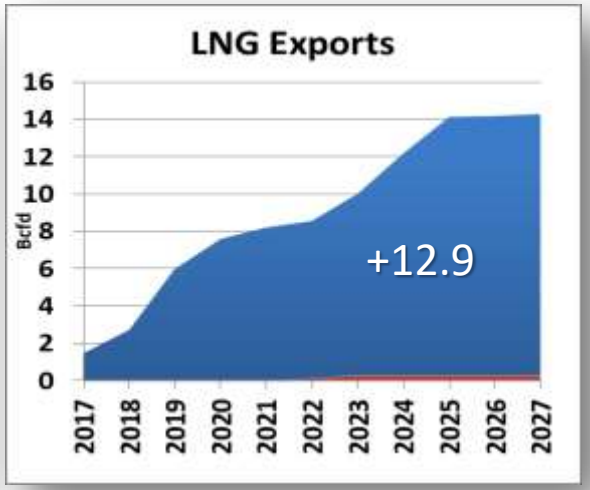
- Largest natural gas network in North America
- Largest independent transporter of petroleum products in North America
- Largest transporter of CO2 in North America
- Largest independent terminal operator in North America



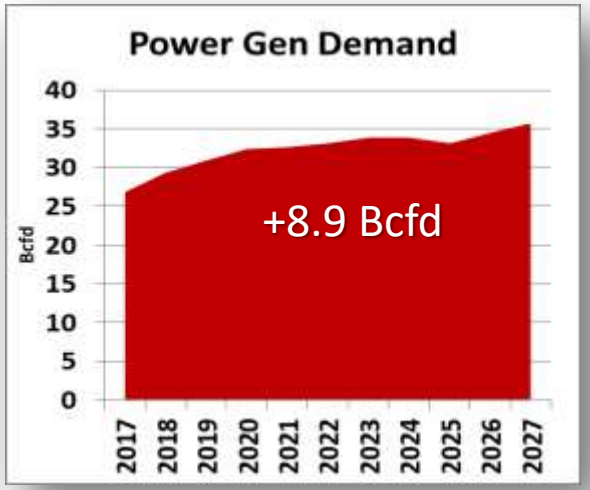
Key Trends



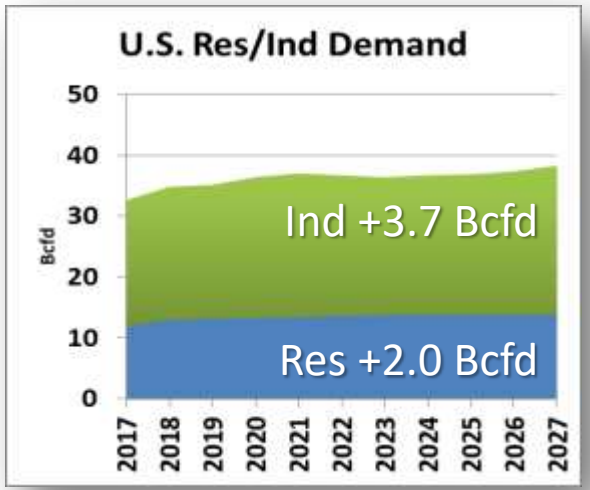
Continued supply increases



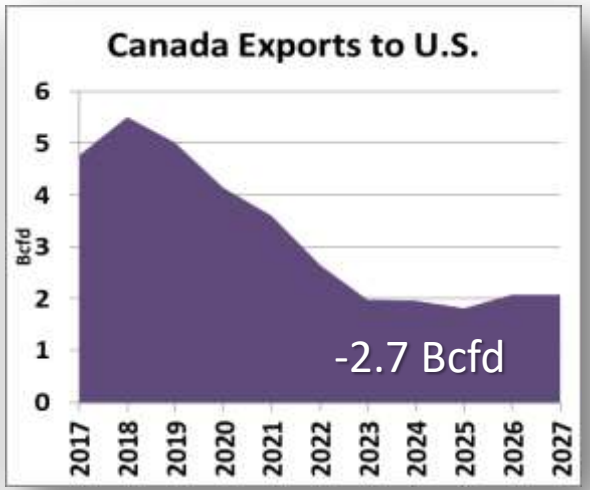
U.S. becomes net exporter



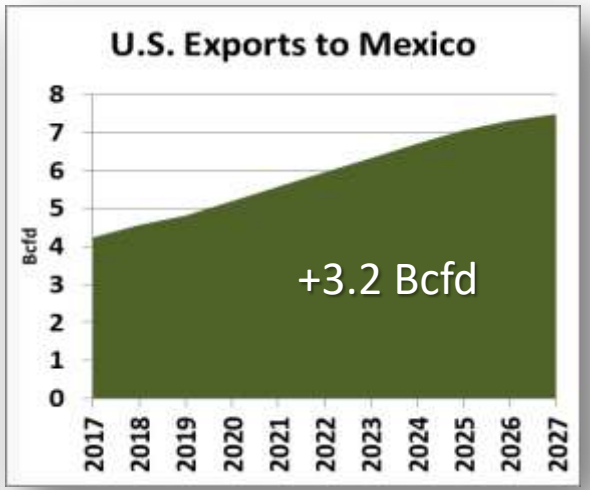
More Gas-fired generation



Industrial demand growth



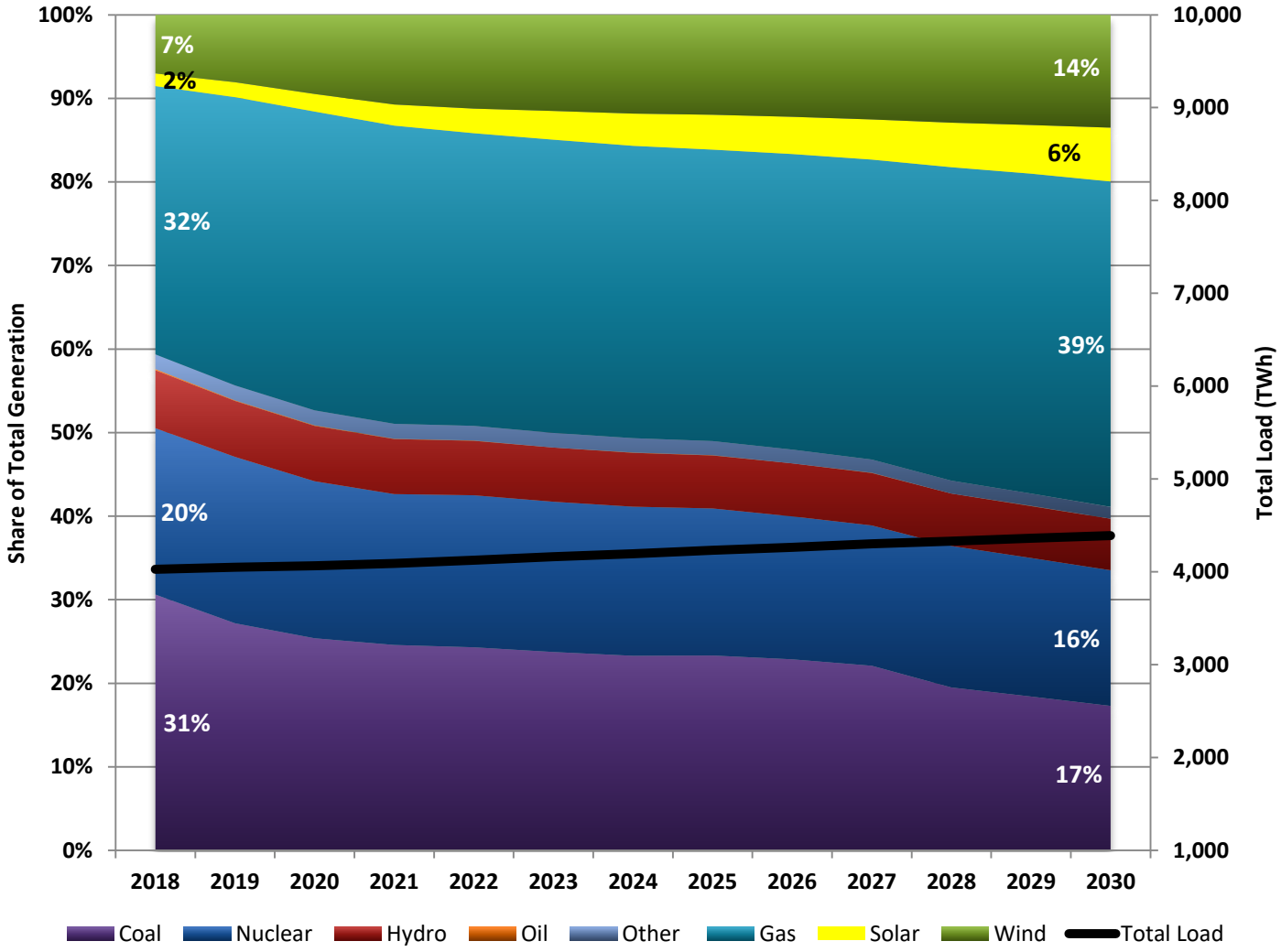
Less Canadian Exports to U.S.



More U.S. Exports to Mexico

Source: ICF International and Kinder Morgan Analysis

U.S. Power Generation Forecast by Source

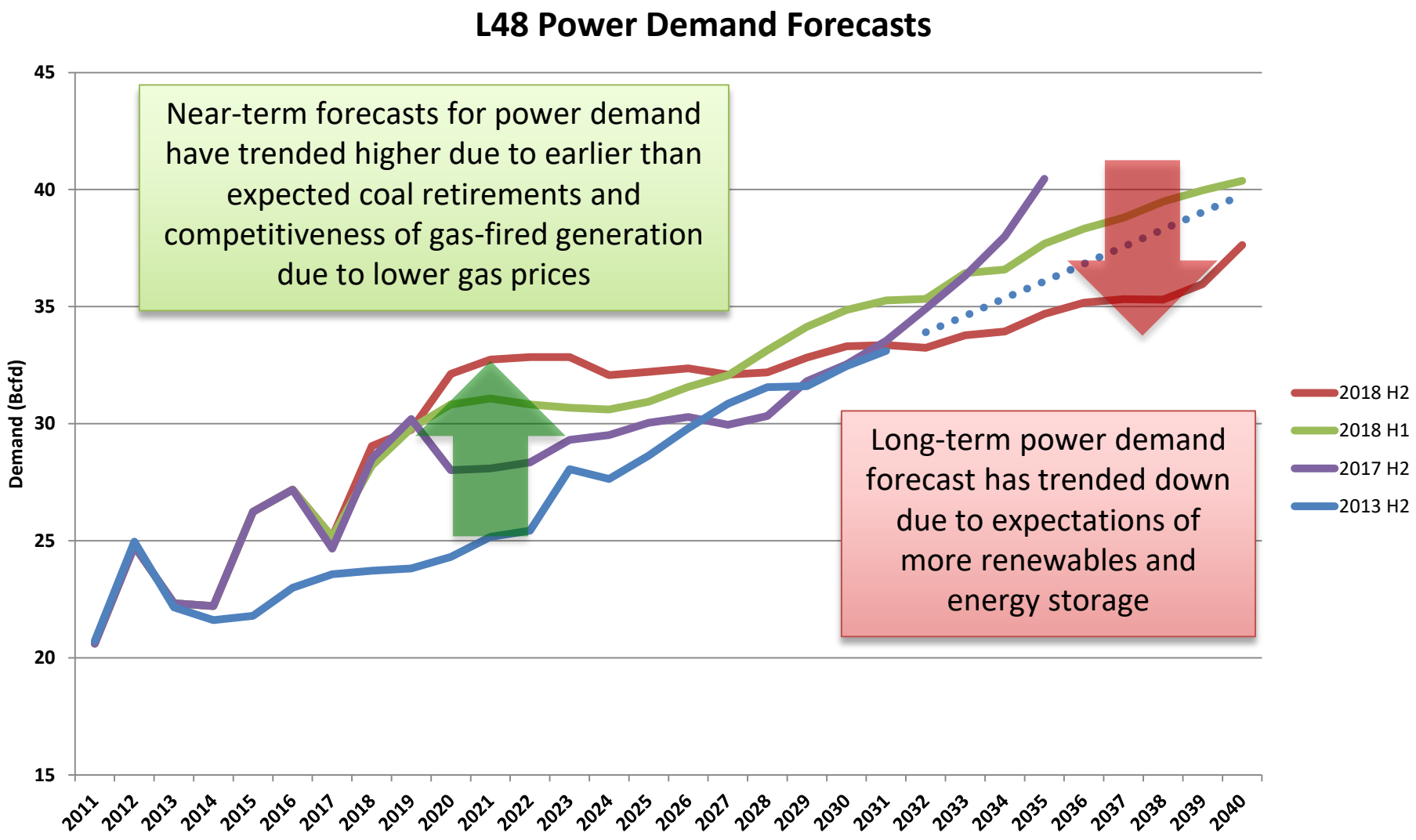


Solar, Wind, and Natural Gas generators are forecasted to increase their share of total U.S. power generation

Coal and Nuclear generators are forecasted to be a shrinking share of total U.S. power generation

Source: WoodMac

Evolving Power Demand Forecast



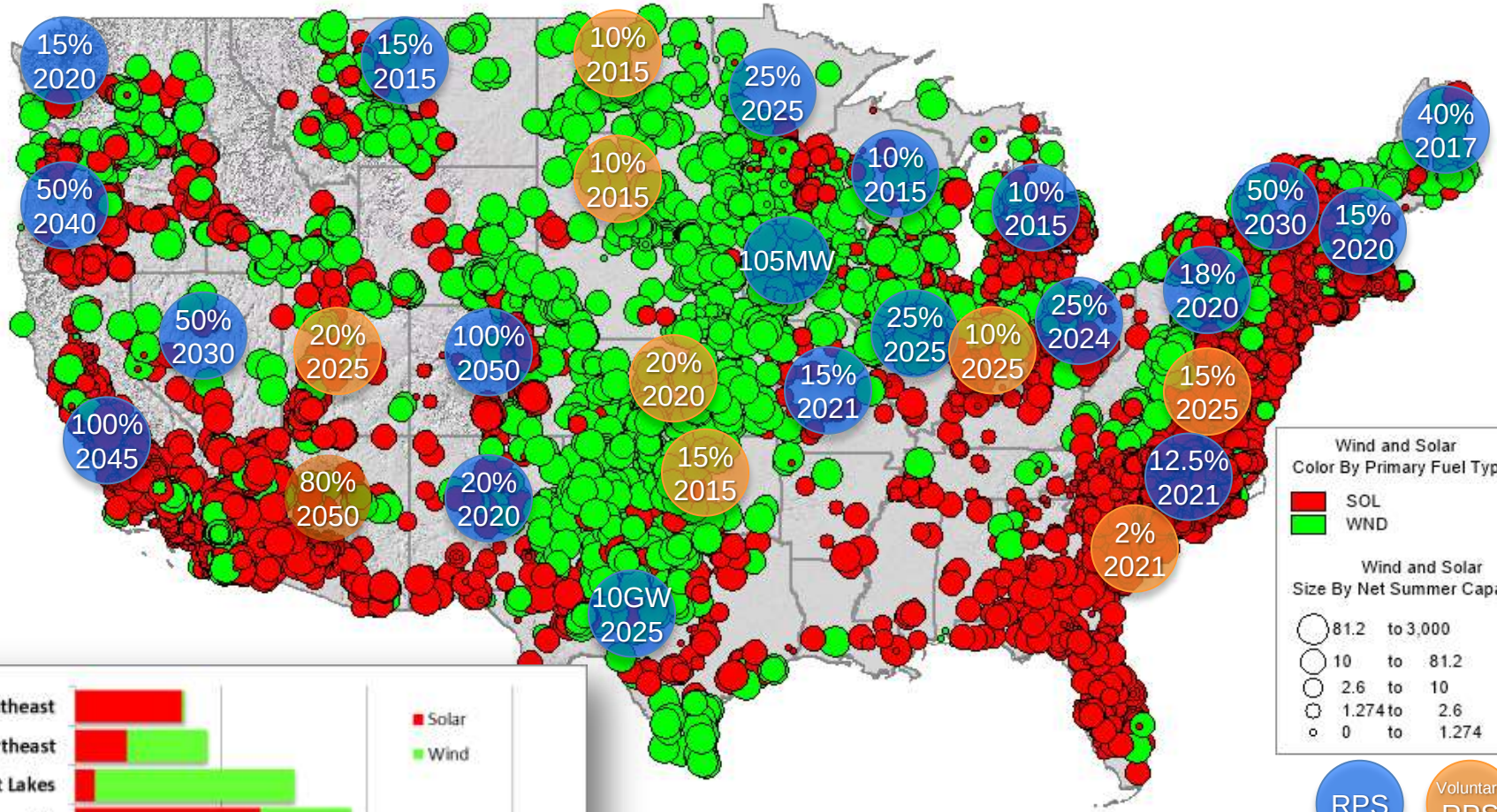
Source: WoodMac

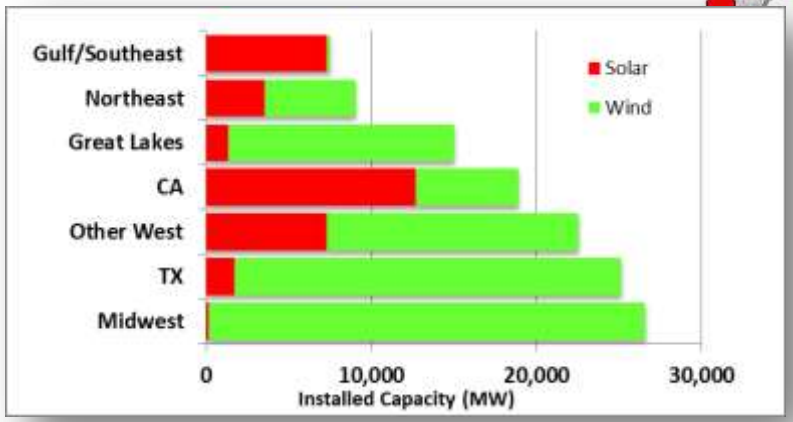
Regulatory Update

- National Trends
  - Investment Tax Credit (ITC) Phase-out
    - Solar phases out in 2022
    - Large wind phases out in 2019
  - Production Tax Credit (PTC) Phase-out
    - 2019 is the last year for wind PTC
  - FERC considering Grid Resiliency Rules Supporting Coal-Fired and Nuclear Generation
- Regional (West) Trends
  - Expanding “Clean Energy“ Targets
    - CA approved SB100 revising 2030 RPS to 40% and 100% goal by 2045
    - ACC (AZ Modernization Plan) proposed 80% clean energy by 2050 target
    - CO’s Xcel energy to reach 100% renewables by 2050
    - NV ballot initiative approved a 50% RPS by 2030

Uncertainty in federal and state regulatory landscape slowing investment, gas demand growth

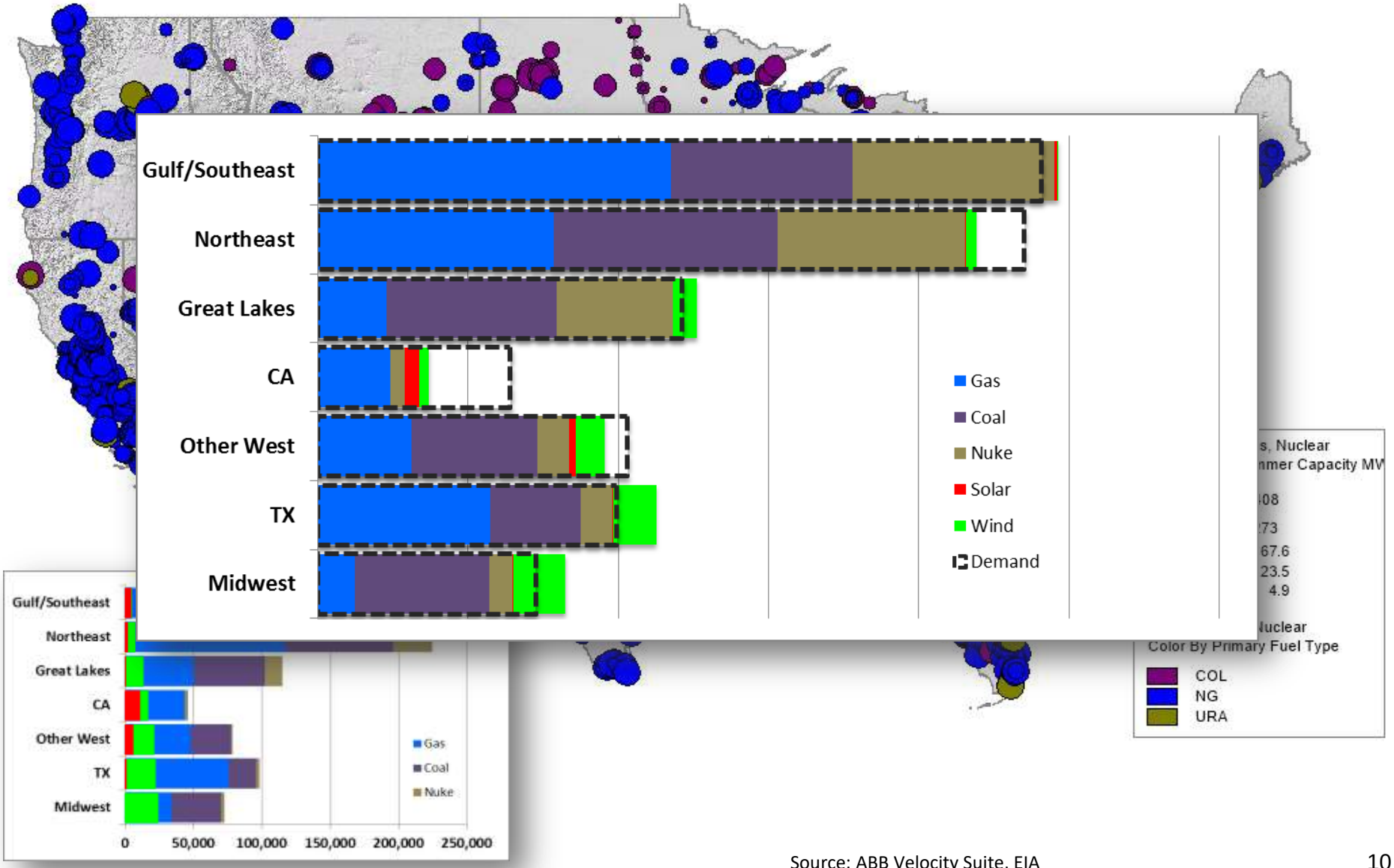
Wind and Solar Generating Capacity





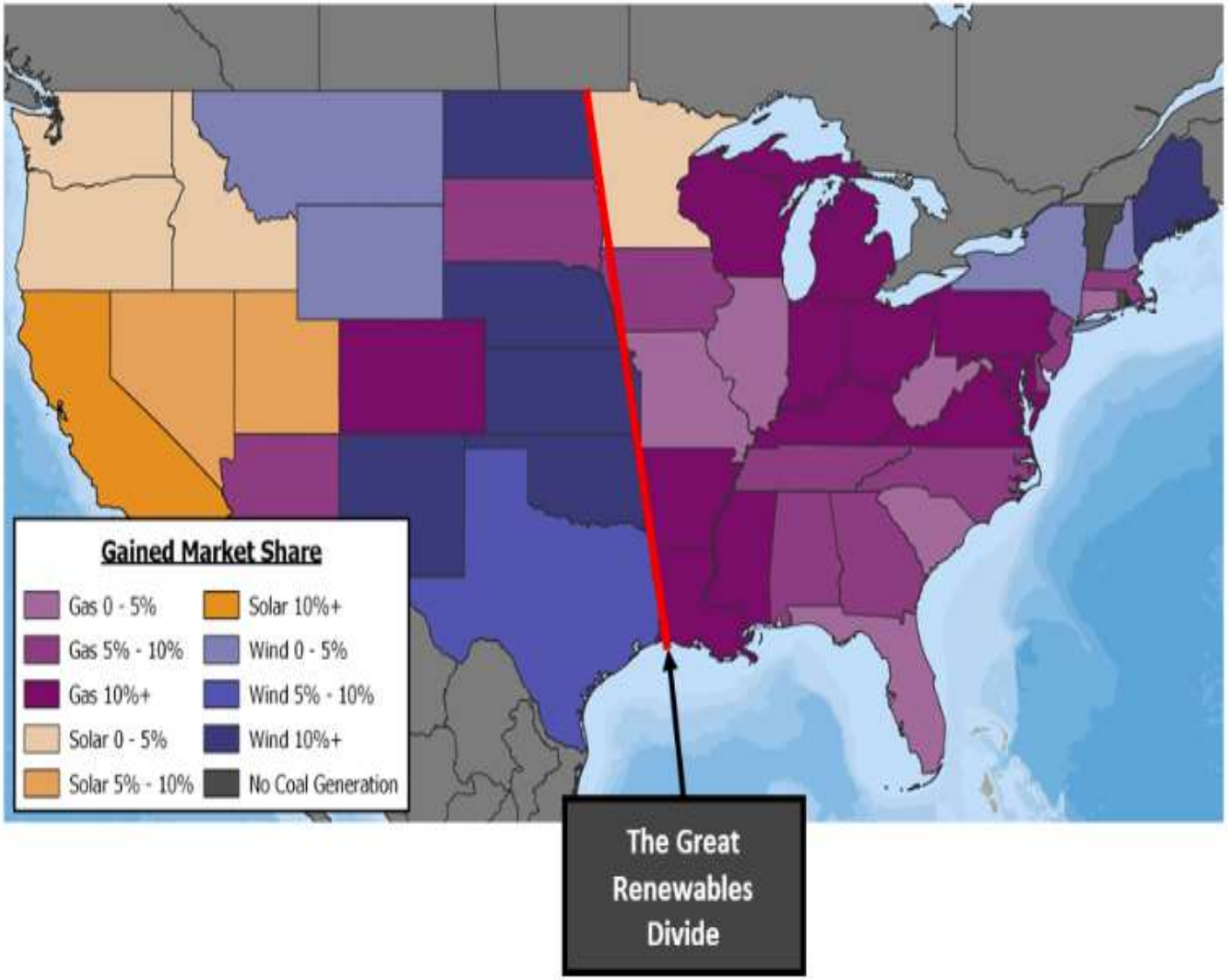
Source: ABB Velocity Suite, National Conference of State Legislators

Gas, Coal, Nuke Generating Capacity



Source: ABB Velocity Suite, EIA

The Renewable Divide

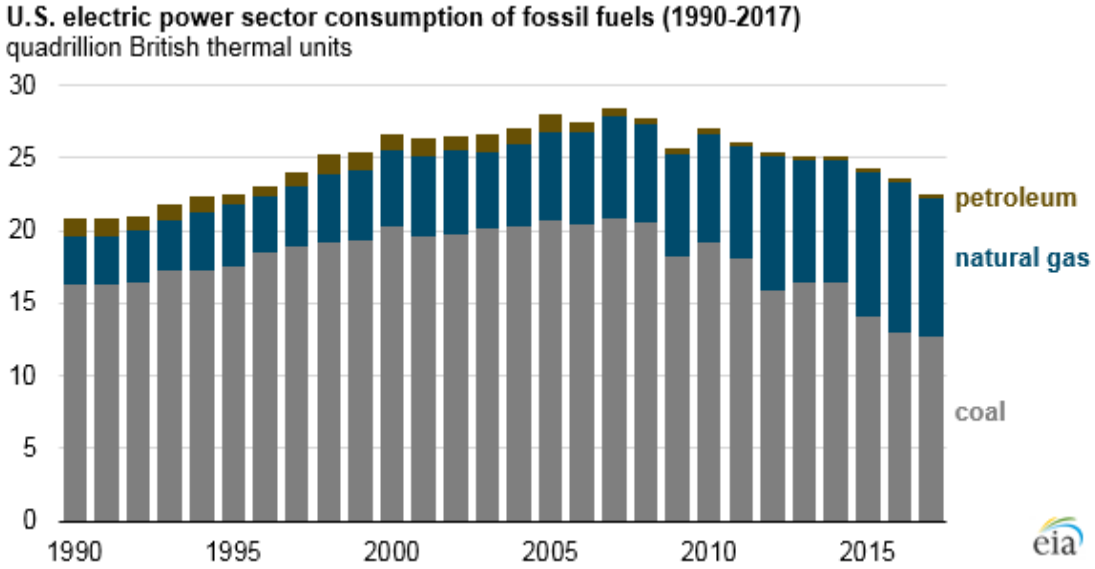


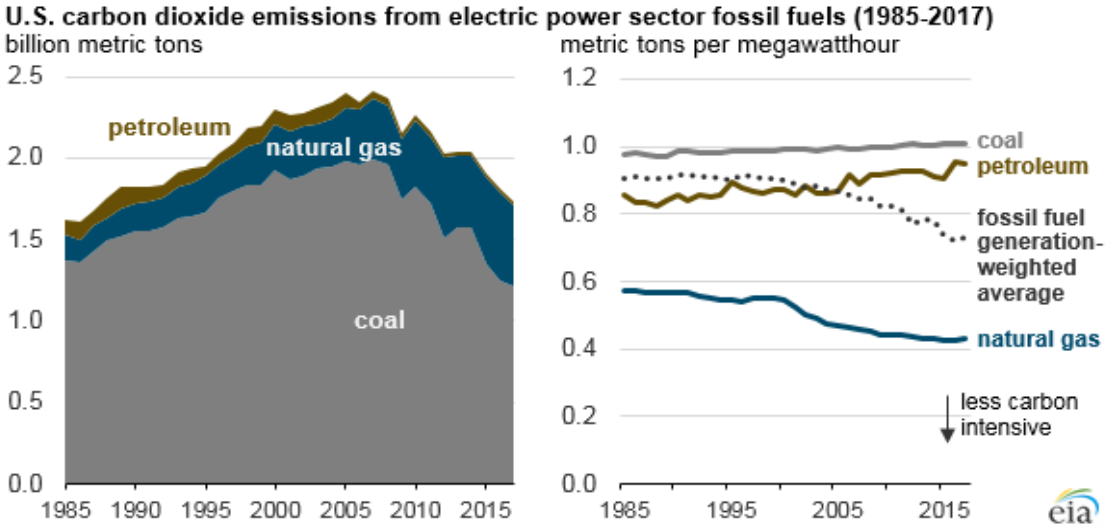
The US has been divided, with wind and solar making the most gains in the Midcontinent and west, while gas generation has made the most gains east of the divide

Source: BTU Analytics, EIA

Implications of Variable Renewable Generation

US Electric Power Sector Emissions Lowest Since 1987

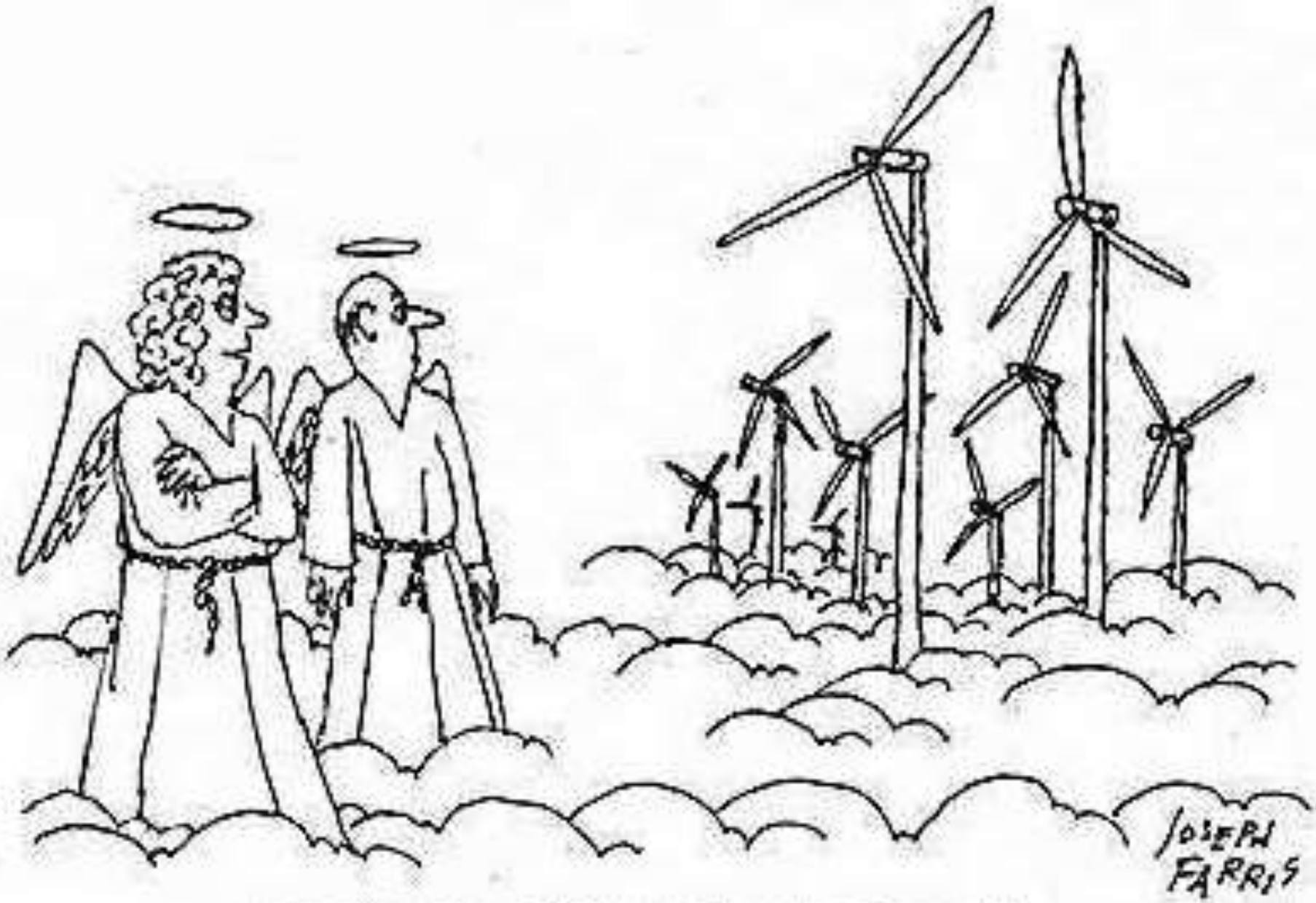




Coal combustion is much more carbon intensive than natural gas combustion, CO_2 emissions from coal were more than double those from natural gas in 2017.

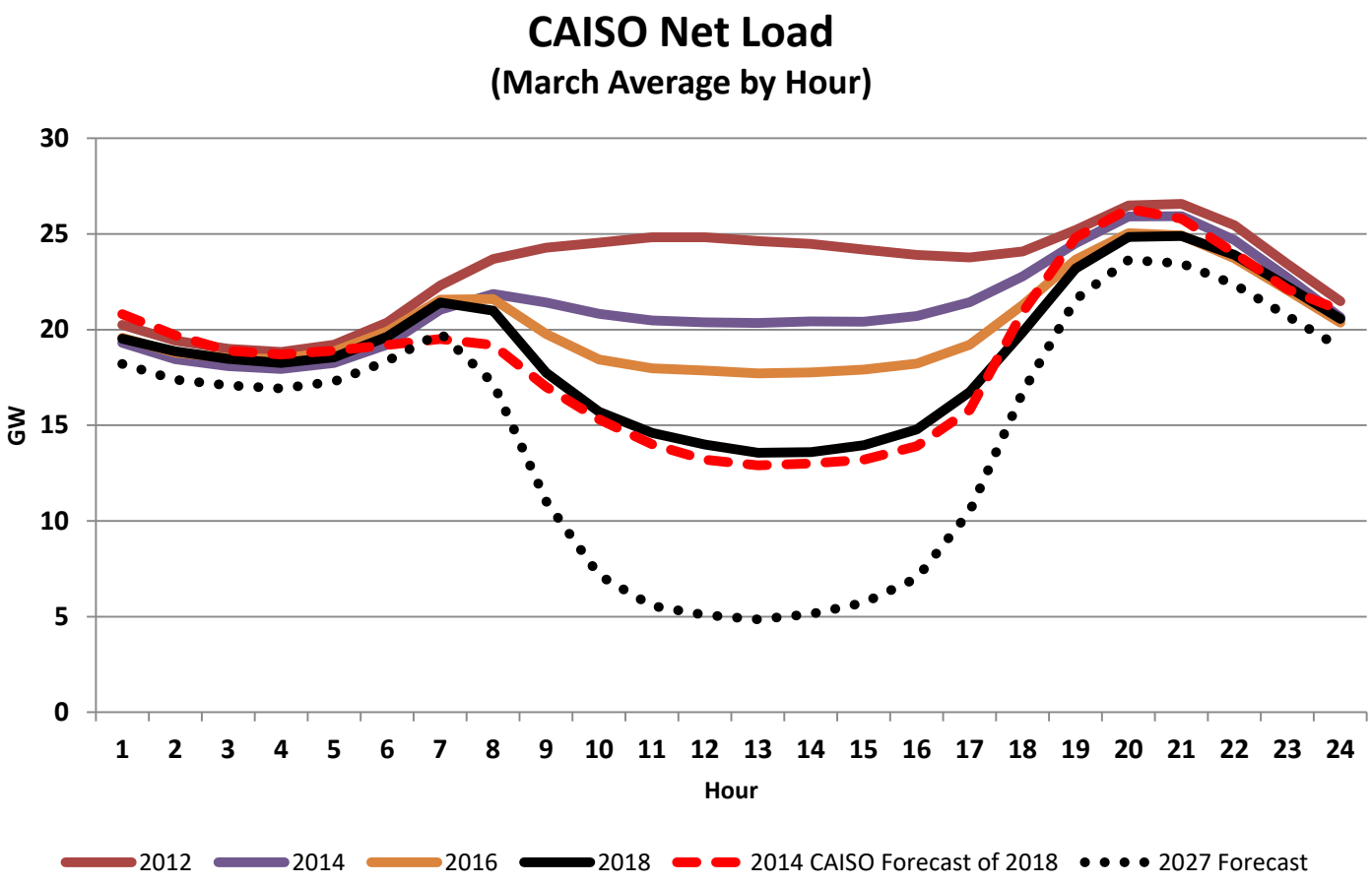
Because the technological advances in upstream production have lowered the cost of fossil fuels, this market dynamic has altered the consumption of coal toward more clean and efficient burning natural gas. Hence, carbon dioxide (CO_2) emissions from the electric power sector in 2017 were the lowest since 1987

Source: US EIA, Monthly Energy Review, May 2018



"Didn't you know? Heaven has turned green."

California ISO "*Duck Curve*"



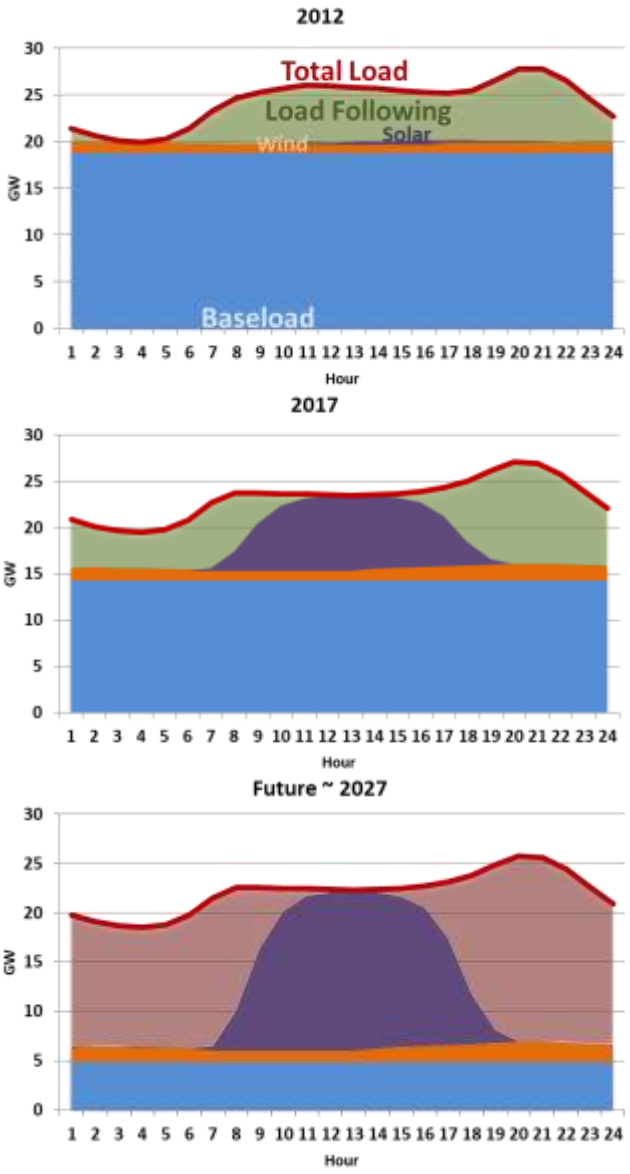
The ramp in gas fired generation due to renewables drives greater need for pipeline deliverability

Natural Gas Deliverability is the ability to deliver gas at the required location, time, pressure and quantity

California has made significant progress towards renewable power but, according to Moody's Investor Service, the cost to reach 100% clean energy for power by 2045 in California far exceeds $100 Billion.

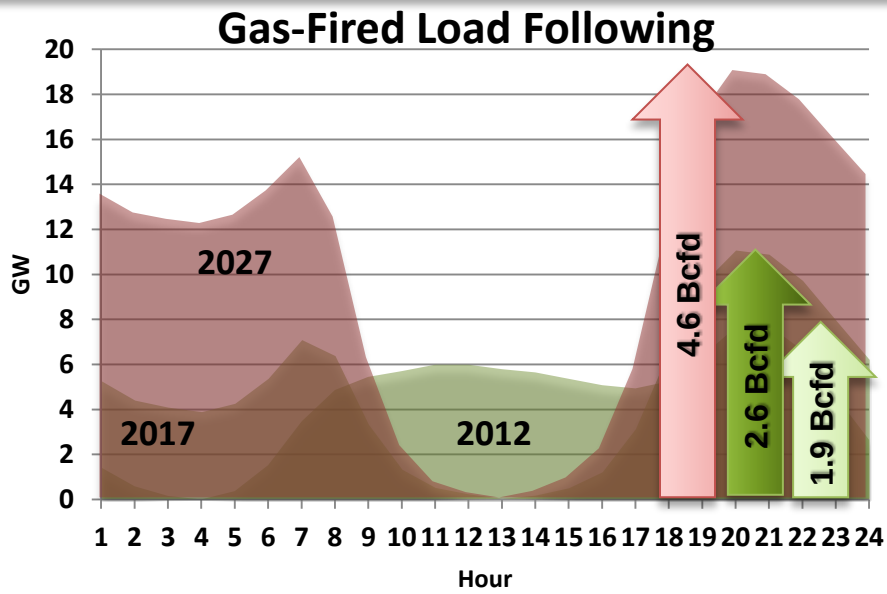
Source: CAISO

Renewable Impacts to Natural Gas



Increasing Renewable Penetration

As renewable generation increases, pipeline deliverability (time, location, pressure) becomes increasingly important to natural gas-fired generation for load following and renewable firming to ensure grid resiliency and reliability

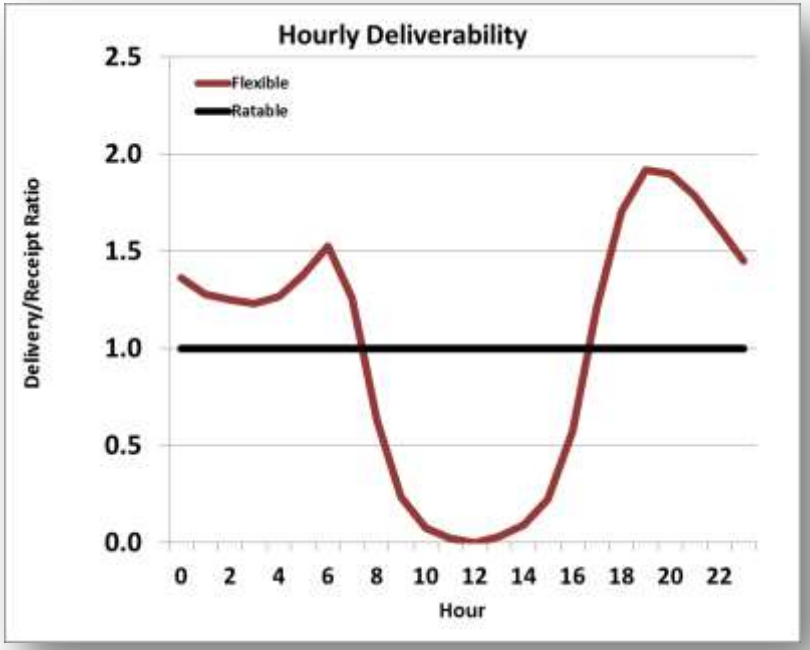


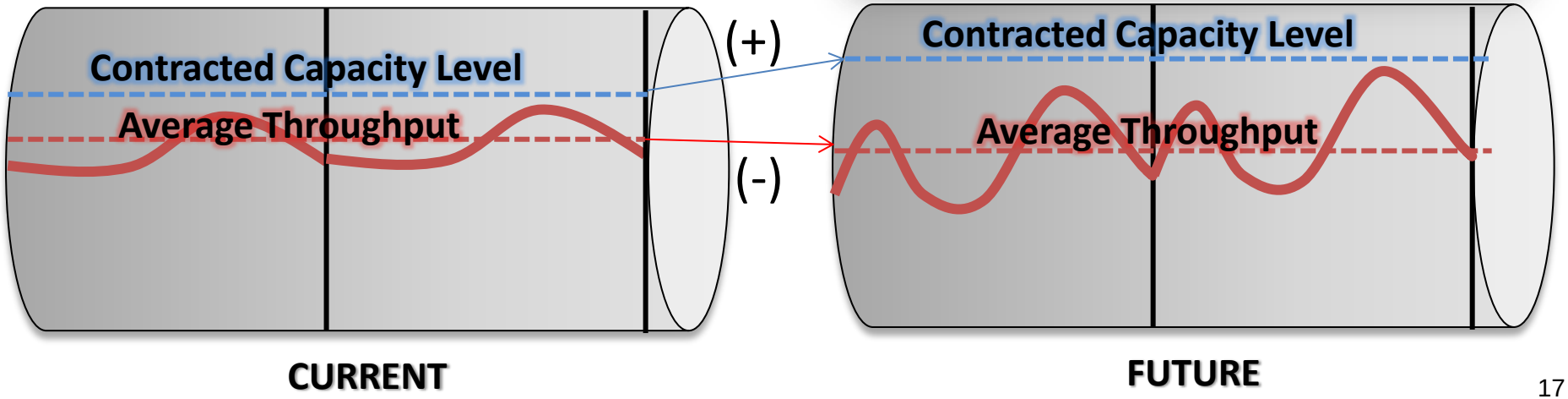
Higher deliverability requires more capacity reservation (No-Notice, Hourly Services), more reliance on pipeline linepack, and/or market area storage

Natural Gas Pipelines with Renewables

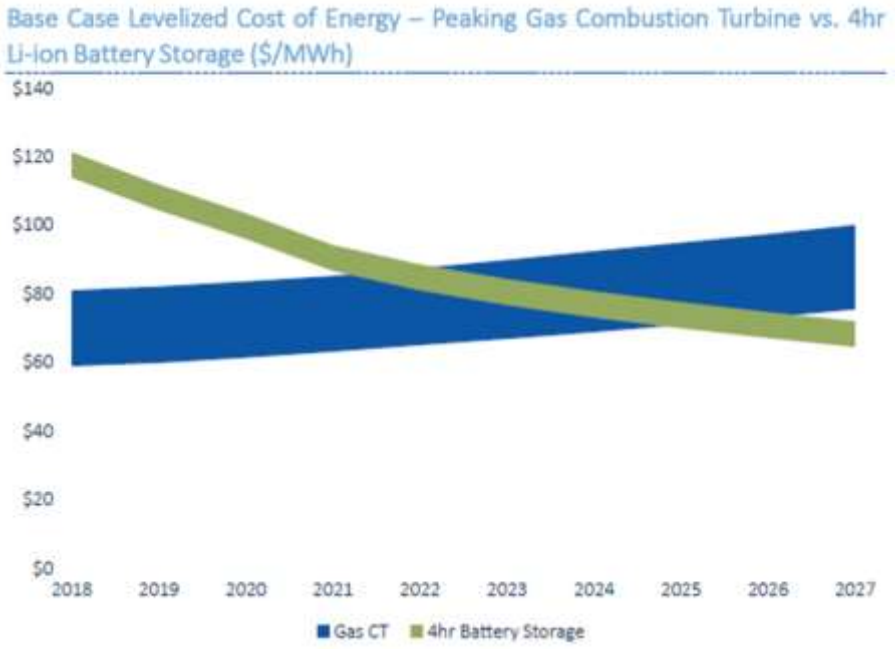
Power customers need more capacity to backstop renewables due to inter-hour variability

Average throughput goes down because the total amount of gas burned for power generation decreases. However, the need for more flexible deliverability increases!





Will Energy Storage Replace Peaking Plants?

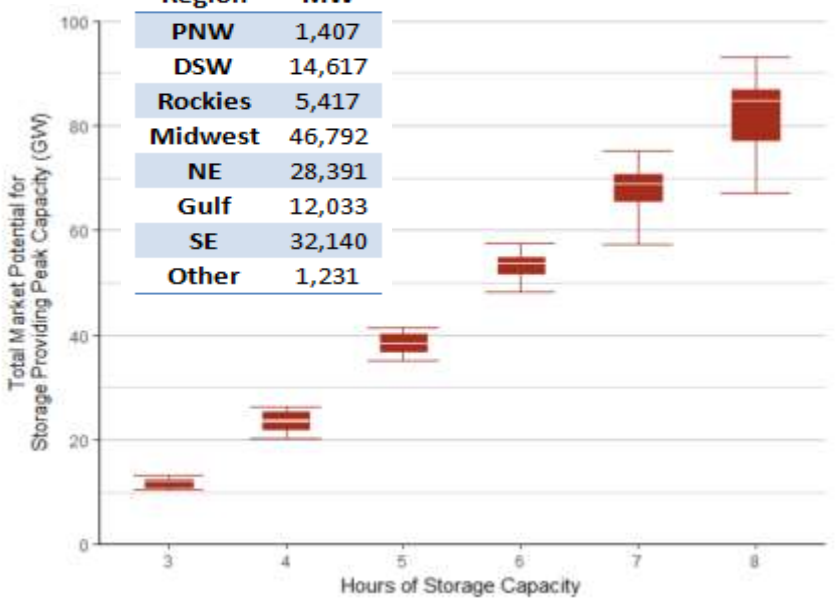


We are at or close to a tipping point for Energy Storage Systems (ESS) as a Gas Peaker alternative.

However, regional markets (RTO/ISO) still need to develop rules and regulations for ESS to capture capacity credits and other sources of revenues.

The Energy Storage market is 10s of GWs for 4-hour storage and could be >90 GW for 8-hour storage assuming continued growth in PV penetration

Region	MW
PNW	1,407
DSW	14,617
Rockies	5,417
Midwest	46,792
NE	28,391
Gulf	12,033
SE	32,140
Other	1,231

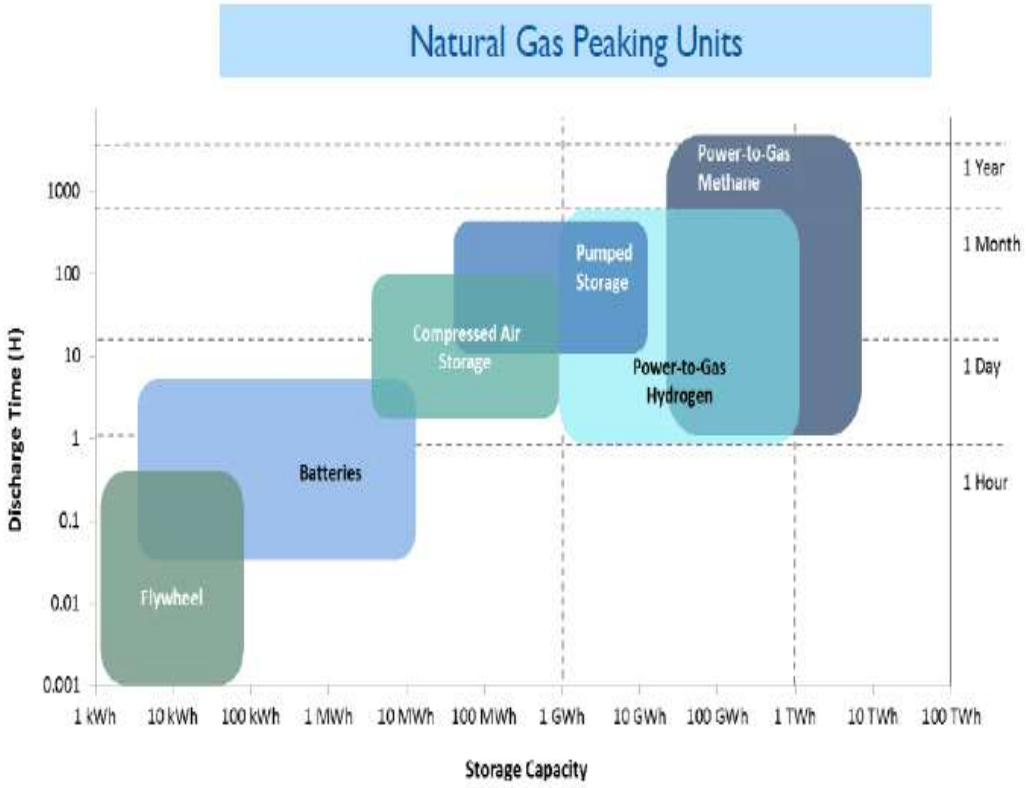


Source: GTM Research; NREL Analysis , March 2018 Annual Meeting)

Batteries and Energy Storage

Fuel type	Energy density MJ/kg
Wind	0.00006
Battery	0.001
Hydro	0.72
TNT	4.6
Wood	5.0
Petrol	50
Hydrogen	143
Nuclear fission	88250000
Nuclear fusion	645000000

The energy density of fossil fuel is over a million times greater than gravity energy density (Wind, Solar).

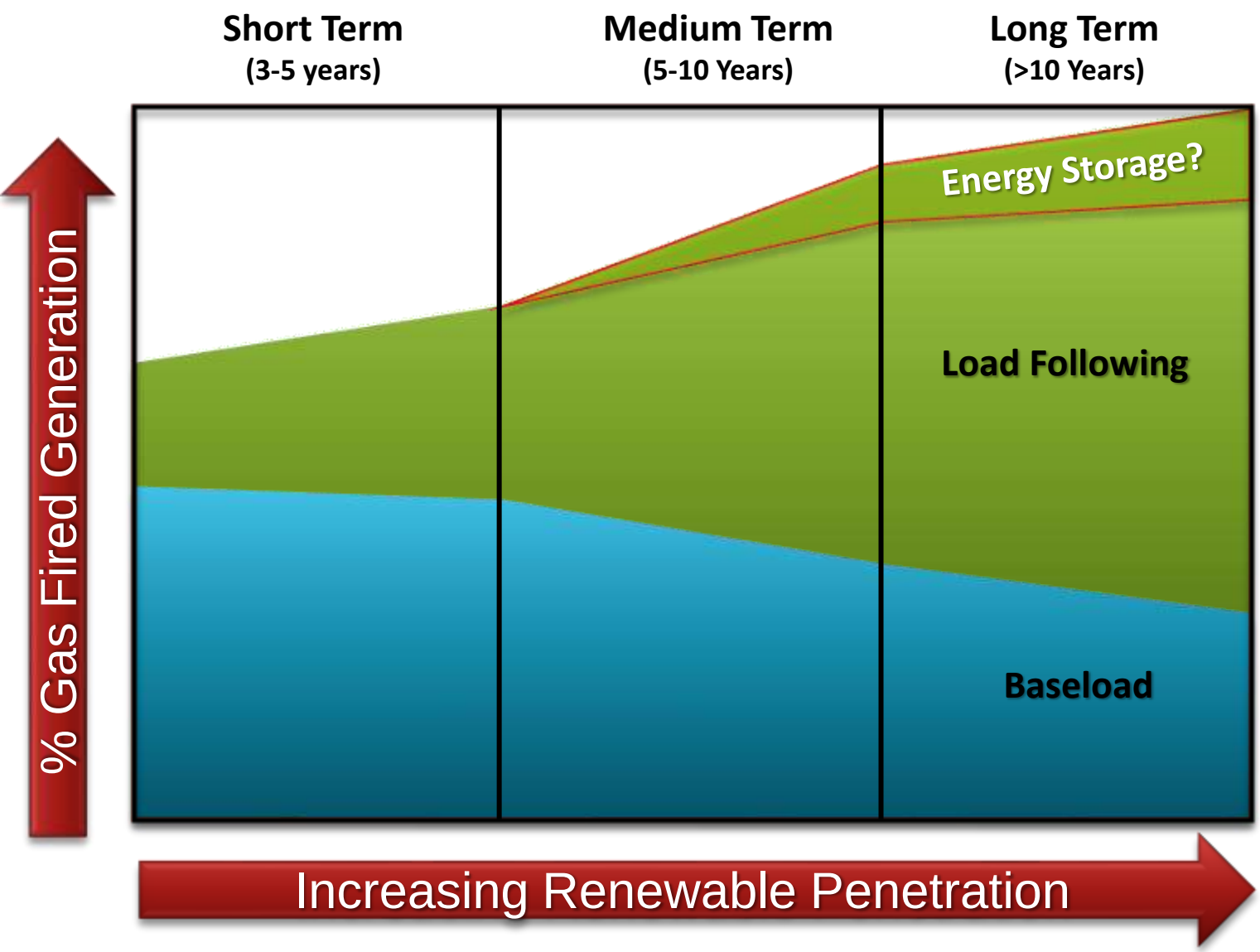


Source: CHBC 2015; NREL 2013b; FCH Jun 2015

The energy stored in hydrocarbons are orders of magnitude more energy dense than energy stored in many other forms of current and future energy storage applications, making natural gas storage an efficient and practical means of storing energy that can be converted to power when needed.

Future of Natural Gas In Power Generation

Impact of Renewable Trends



Renewables push out baseload generation (Coal, Nuke, Natural Gas).

However, this increases the requirement for more a more flexible resource (Load Following) such as natural gas generation.

As Energy Storage cost fall (e.g. Batteries) they will erode the need for natural gas load following

In Summary…

- Renewables are impacting gross natural gas demand and deliverability needs
  - As renewable penetration increases, natural gas pipeline capacity becomes increasingly valuable
  - Storage and pipeline constraints in California and DSW may exacerbate the trend
- Utilities and Power Generators must assess their natural gas deliverability needs
  - Will existing contract levels be enough as renewables grow?
  - What is the risk exposure with insufficient deliverability?

Additional gas infrastructure (market area storage) and natural gas pipeline services are needed

Thank You!