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Framing the Issues:
Natural Gas and Electric System Interdependencies

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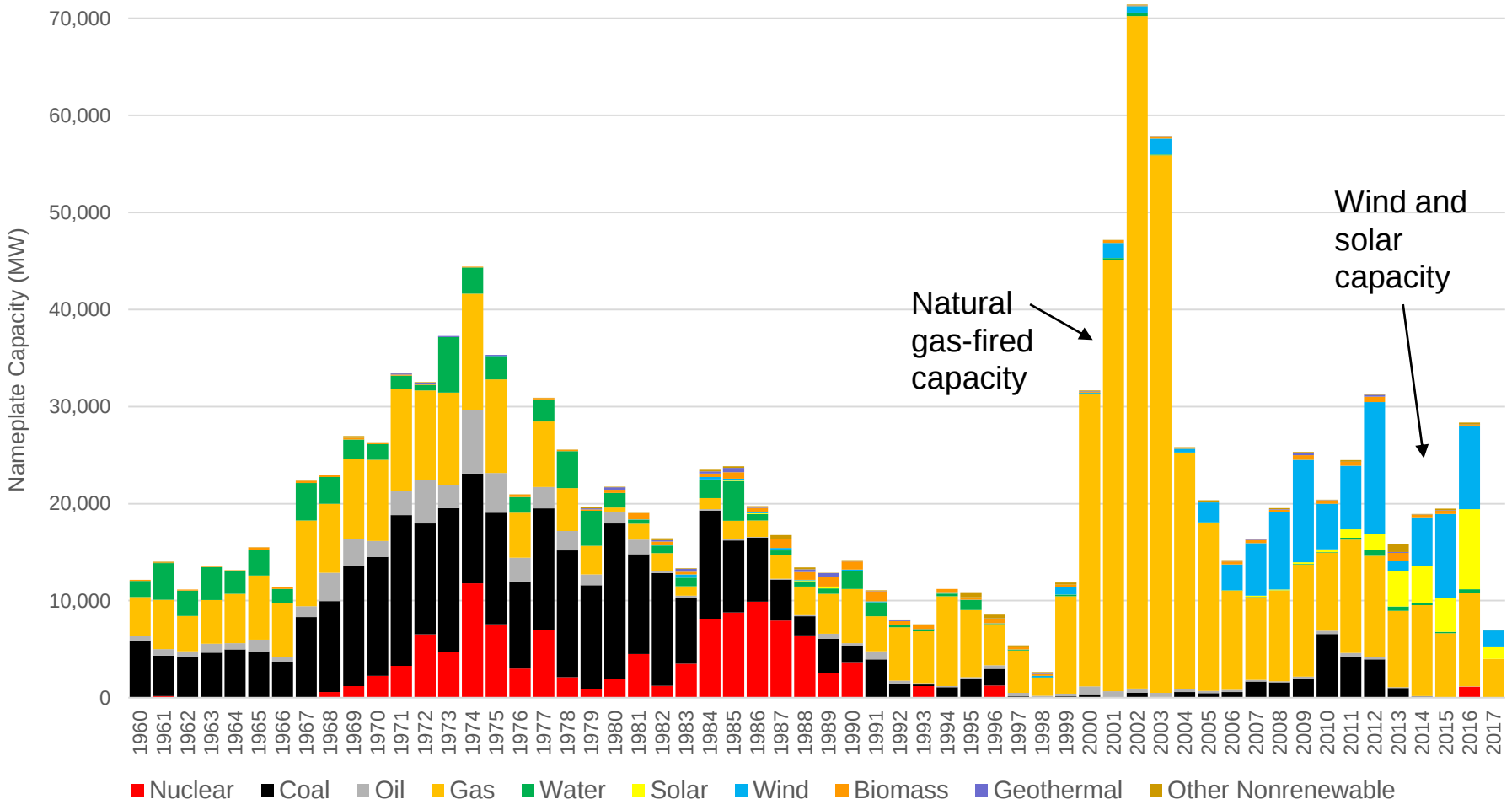
DOE Electricity Advisory Committee Meeting – June 7, 2017

Conventional wisdom

At least in the near term, the U.S. natural gas industry and the U.S. electric industries are and will continue to be highly interdependent:

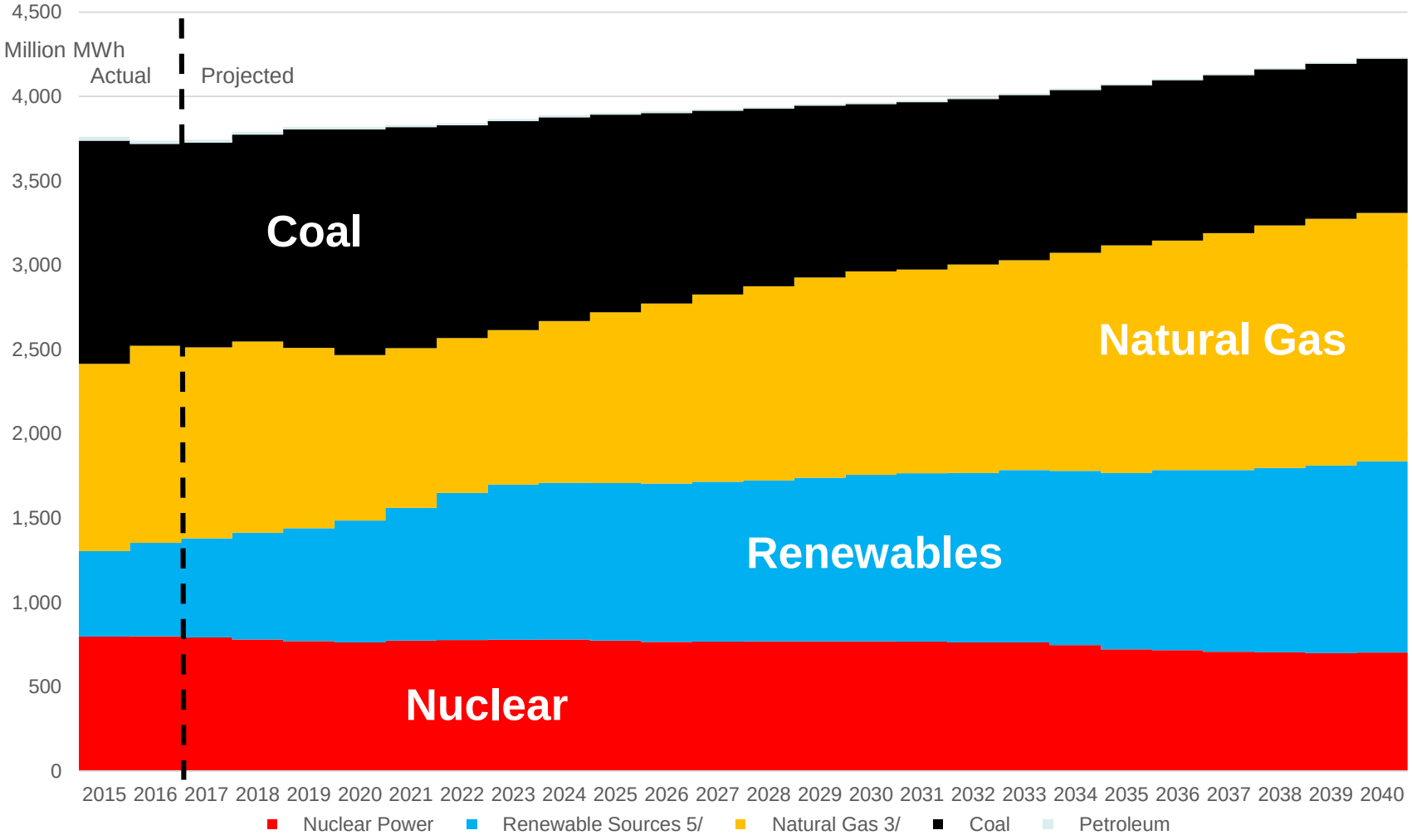
- **The electric industry will become even more dependent upon natural gas than it has been in the past**

Generating capacity additions by fuel type (1960-2017)



SNL data

Electricity generation by fuel (2015-2040) (EIA AEO 2017)



EIA generation data

Conventional wisdom

At least in the near term, the U.S. natural gas industry and the U.S. electric industry are and will continue to be highly interdependent:

- The electric industry will become even more dependent upon natural gas than it has been in the past
- **The natural gas industry will rely on power sector demand for a growing and important share of its market for some years to come**

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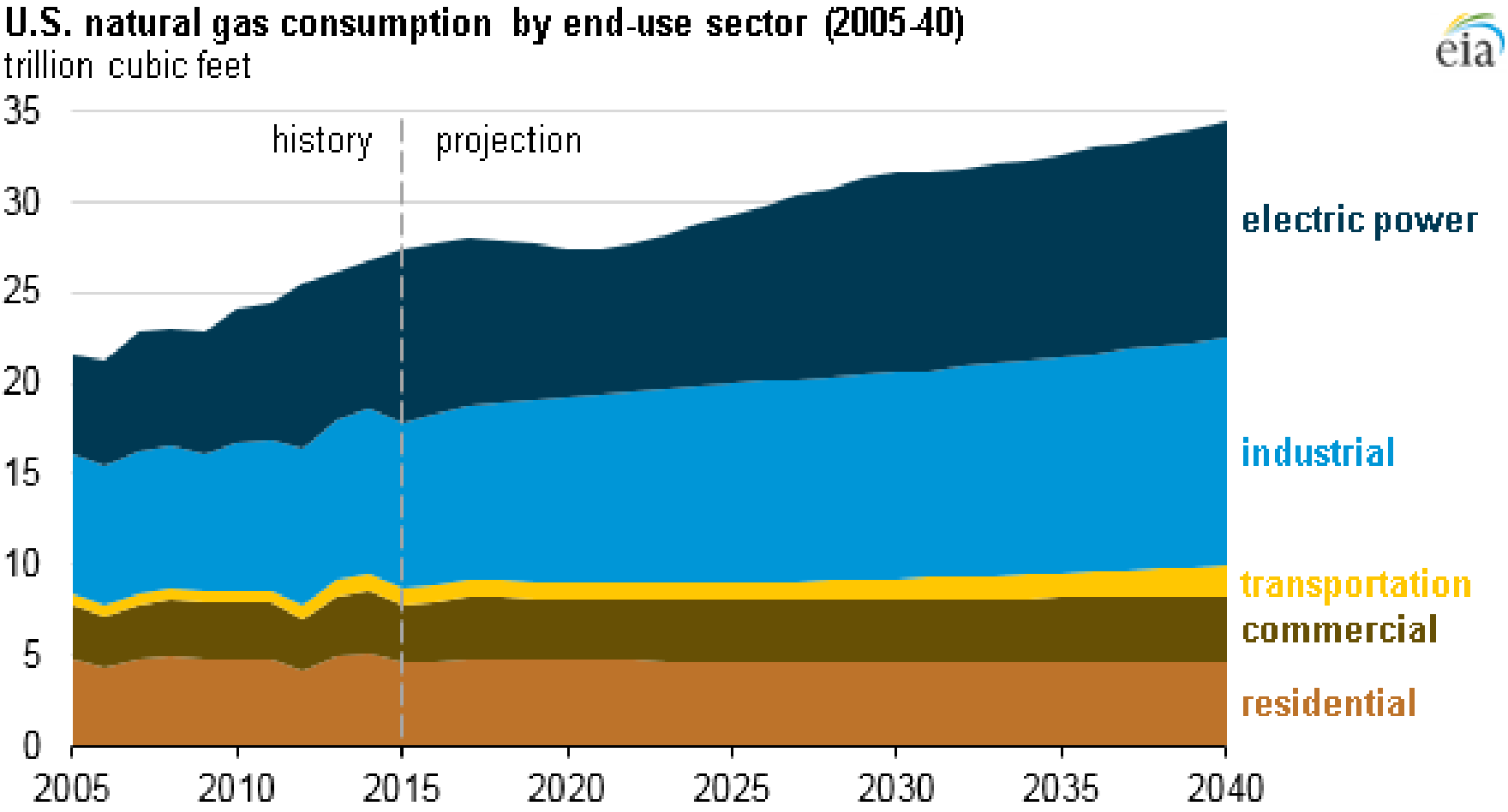
Natural gas:
Estimated consumption by sector (EIA AEO 2017)



https://www.eia.gov/todayinenergy/detail.php?id=26412

This figure does not show the increasing role of LNG exports as part of the industry's market outlook.

Similarities across the electric and gas industries

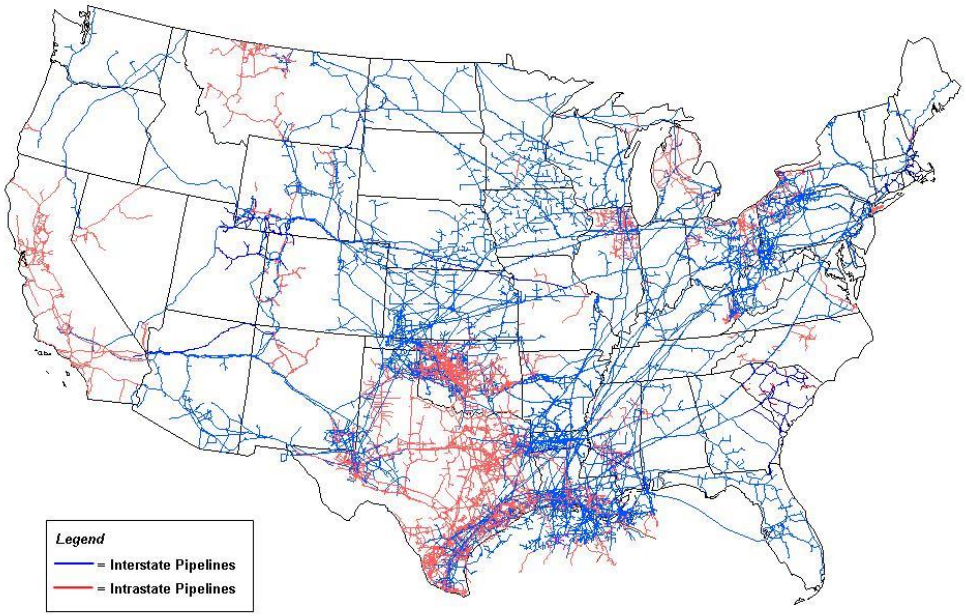
- Both have separated the delivery function from commodity supply
- Both allow for market-based prices for commodity supply with regulated cost-of-service transmission service
- Both have federally regulated transmission service (FERC)
- Both have state-regulated local distribution companies
- Both have predominantly private ownership of assets
- Both have systems that cross the country
- Both have regional markets that are substantially varied

Differences:
Physical footprint with implications for regulatory history

Natural gas:

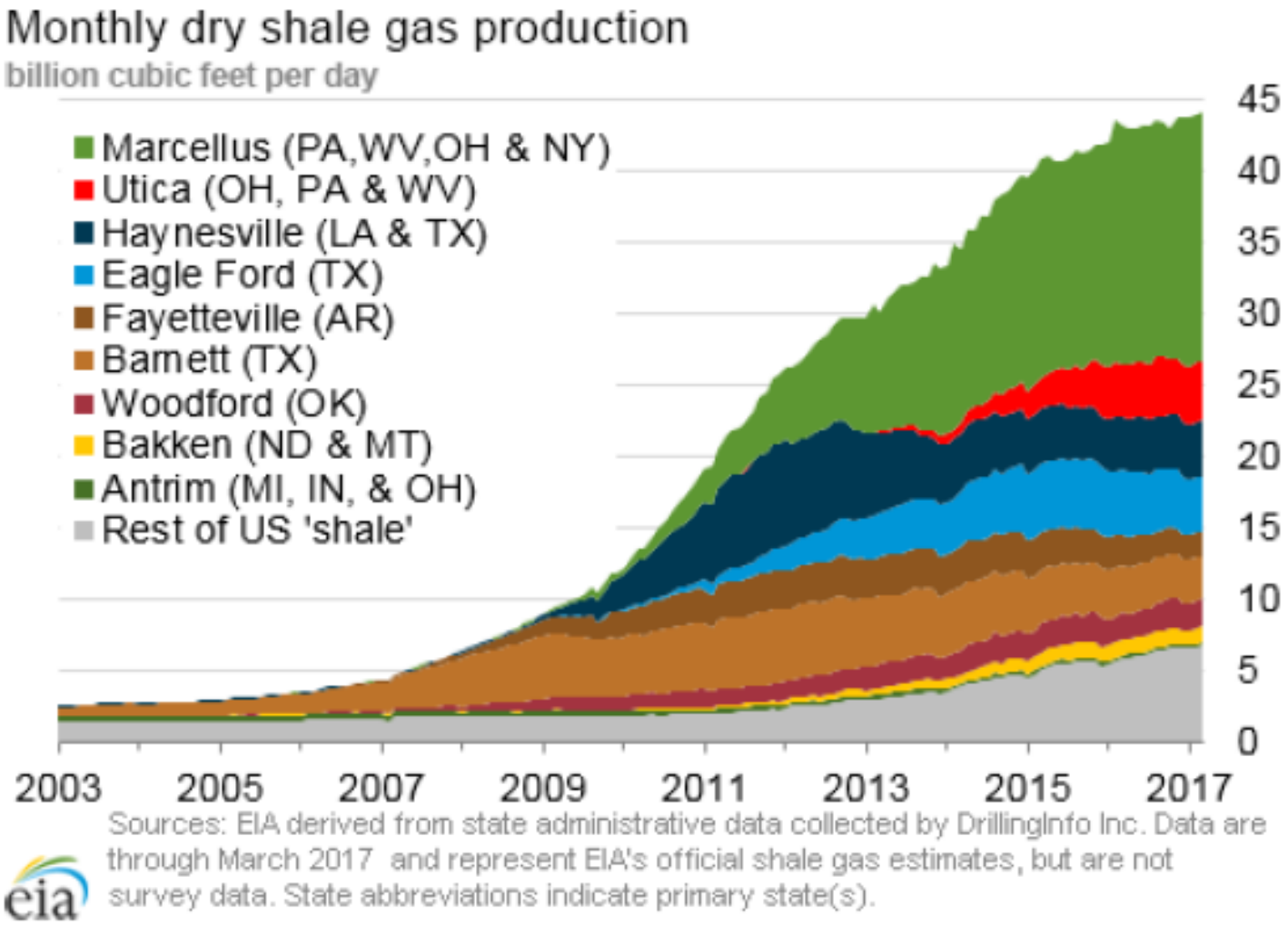
- **Reflects a history of needing to connect production regions to distant consumption regions**
- **Federal siting of interstate pipelines – but increasingly contentious and controversial certification proceedings**

Natural gas pipeline system

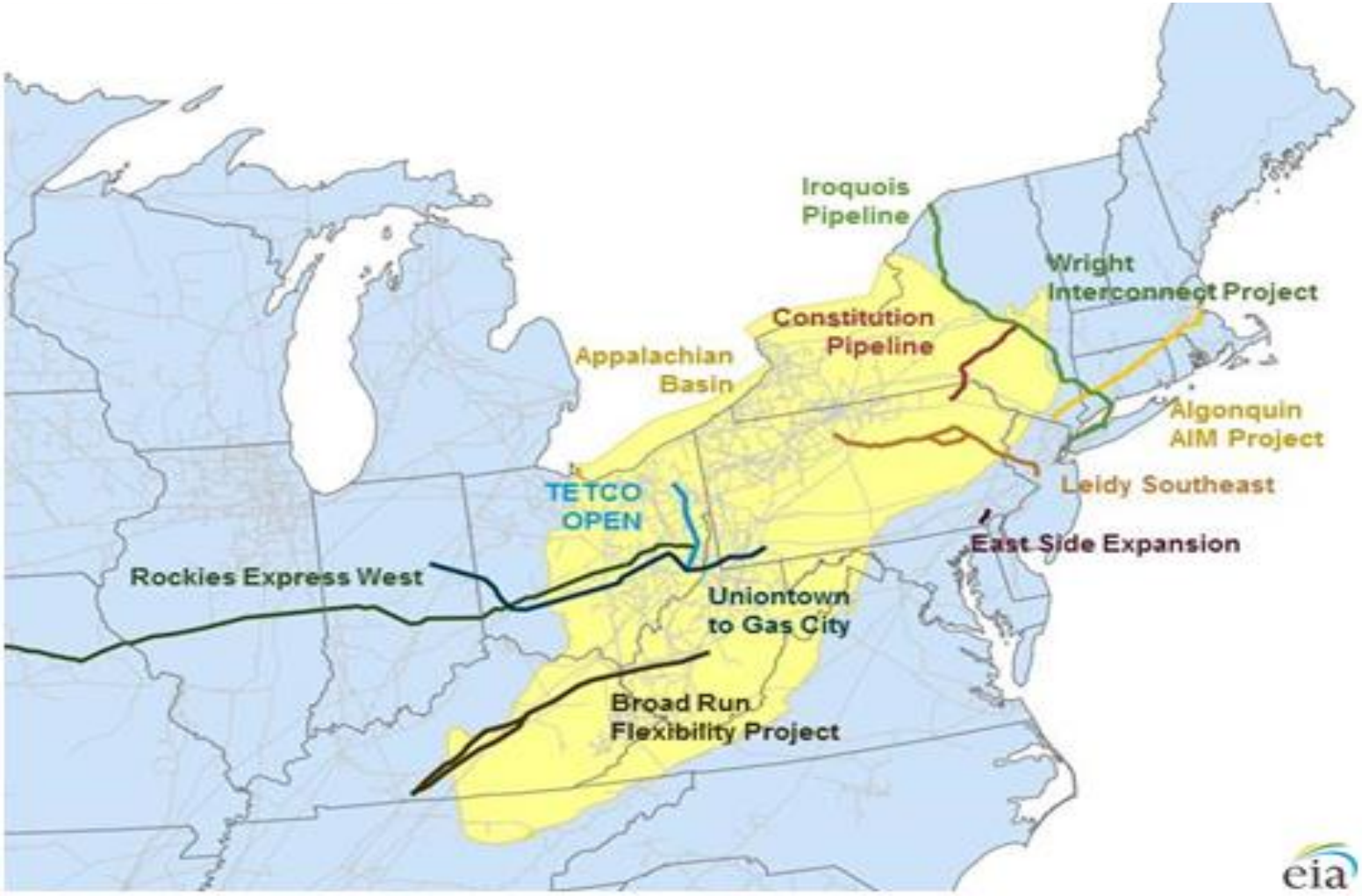


Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System

Natural gas (shale) production: changing regions



Natural gas pipelines: Existing and planned in the Appalachian Basin



https://www.eia.gov/todayinenergy/detail.php?id=24732

Differences:
Physical footprint with implications for regulatory history

Natural gas:

- Reflects a history of needing to connect production regions to distant consumption regions
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Electricity:

- **Rooted in local generation serving local end users (with fuel moved to power plant locations from source)**
- **State siting of interstate power lines – with long-standing challenges to approvals**

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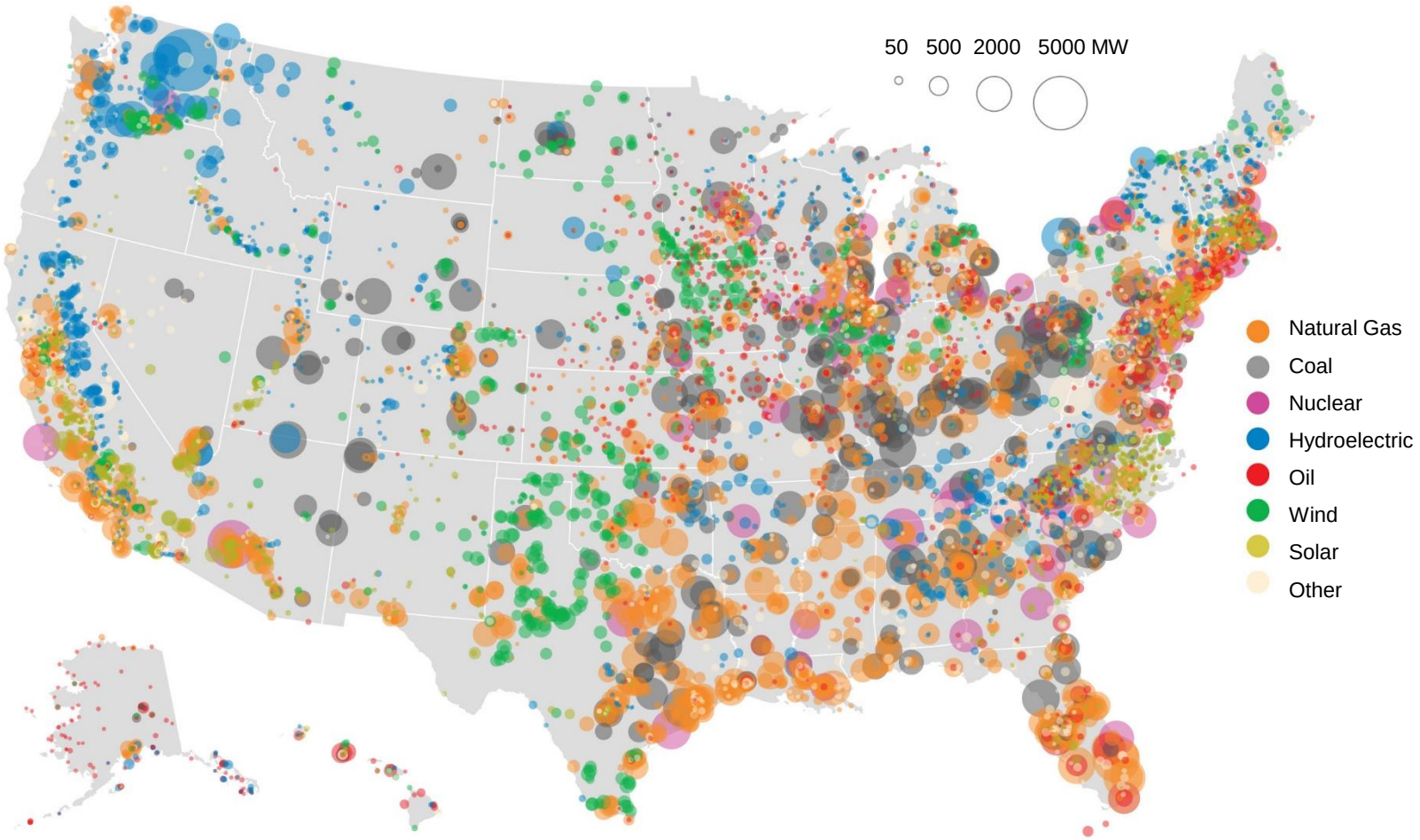
Electric generating facilities



https://www.washingtonpost.com/graphics/national/power-plants/?utm_term=.1081aaa2322d

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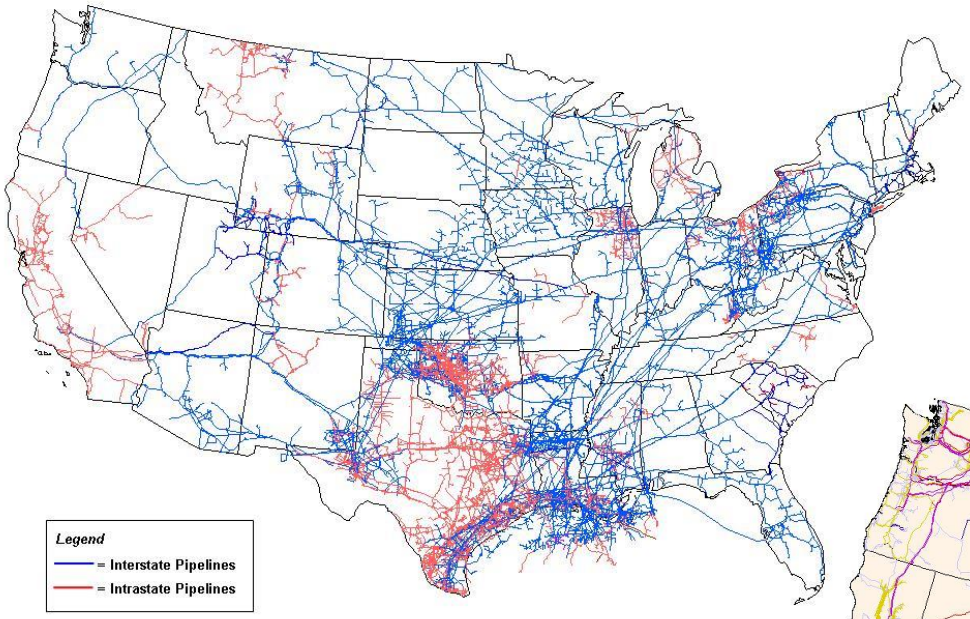
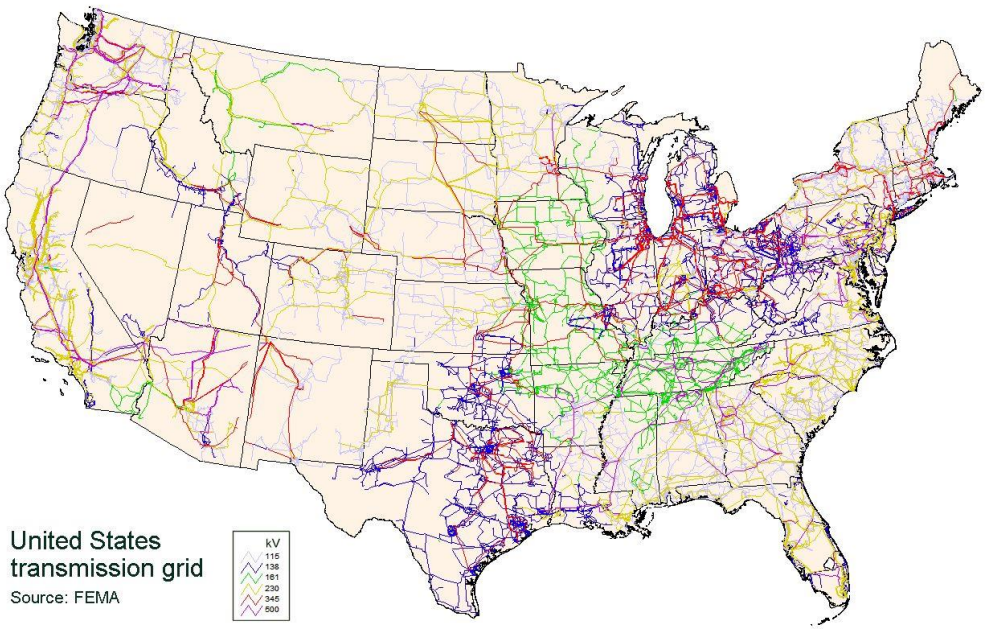
Natural gas pipeline system



Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information Systen

Electric transmission grid



Differences: Network versus lateral systems

Electricity:

- **Physically interconnected and networked bulk-power system with power flows linking supply and demand within each Interconnection (East, West, Texas).**

Natural gas:

- **Long-distance pipeline systems owned by individual companies with end-users served by that company's system, with limited numbers of transfer points along the lateral systems.**

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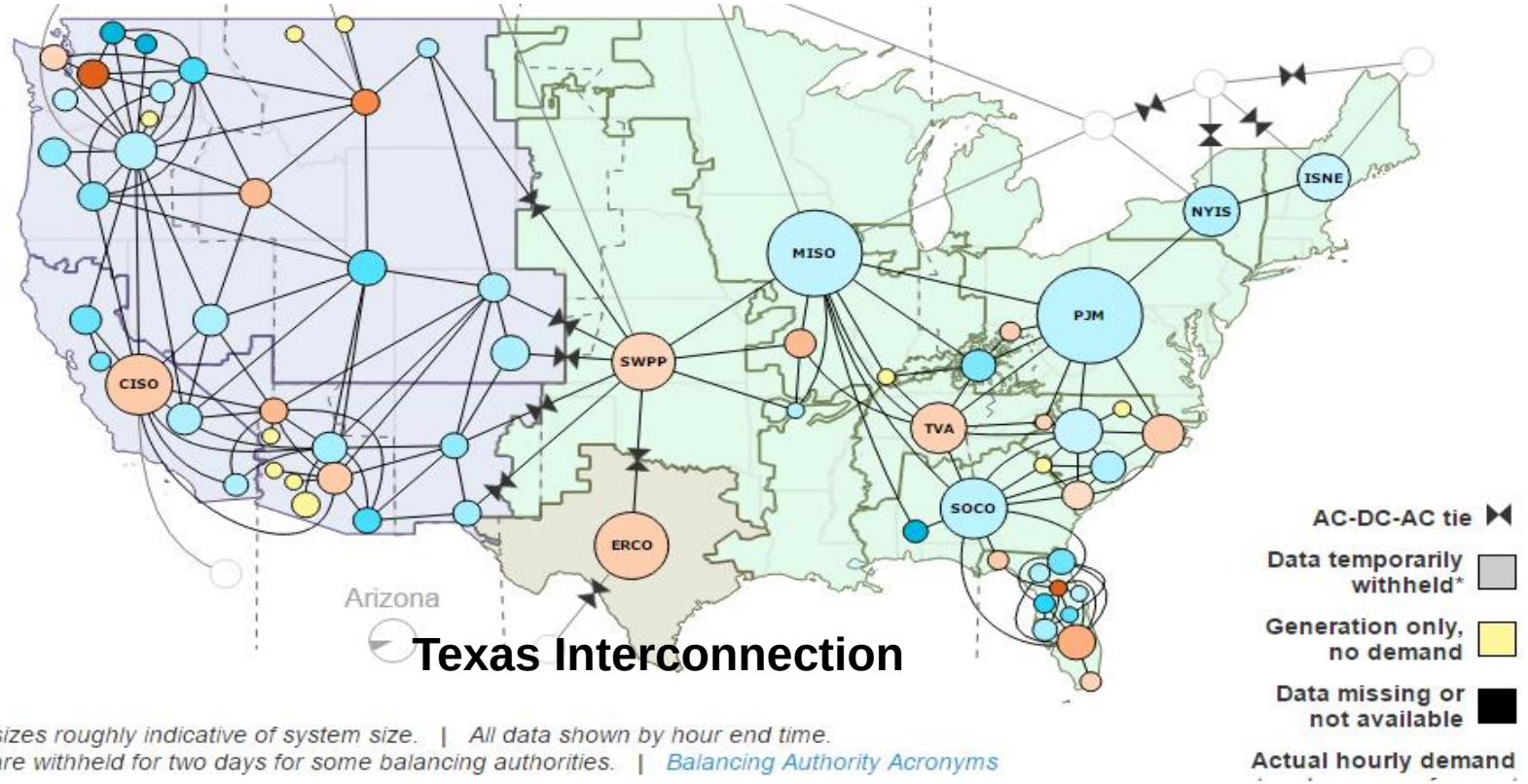
Electricity: Integrated systems in the 3 Interconnections

Western Interconnection

Eastern Interconnection



https://www.weforum.org/agenda/2016/09/united-states-electricity-usage-map-real-time/

Differences: Network versus lateral systems

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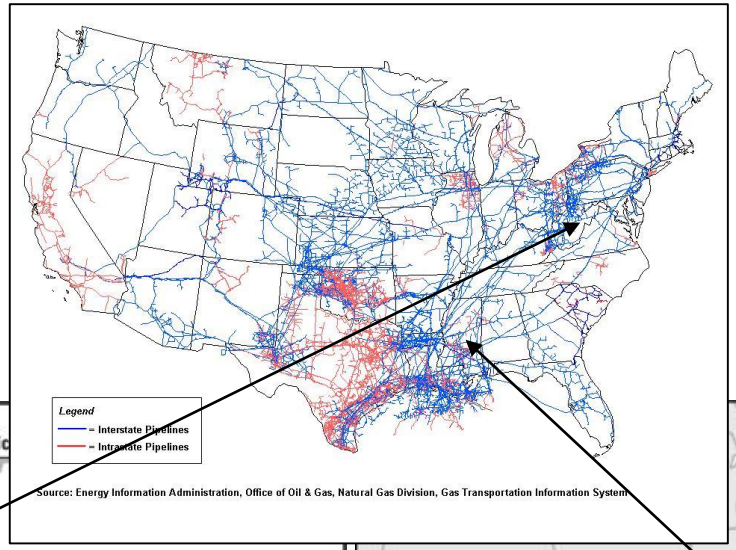
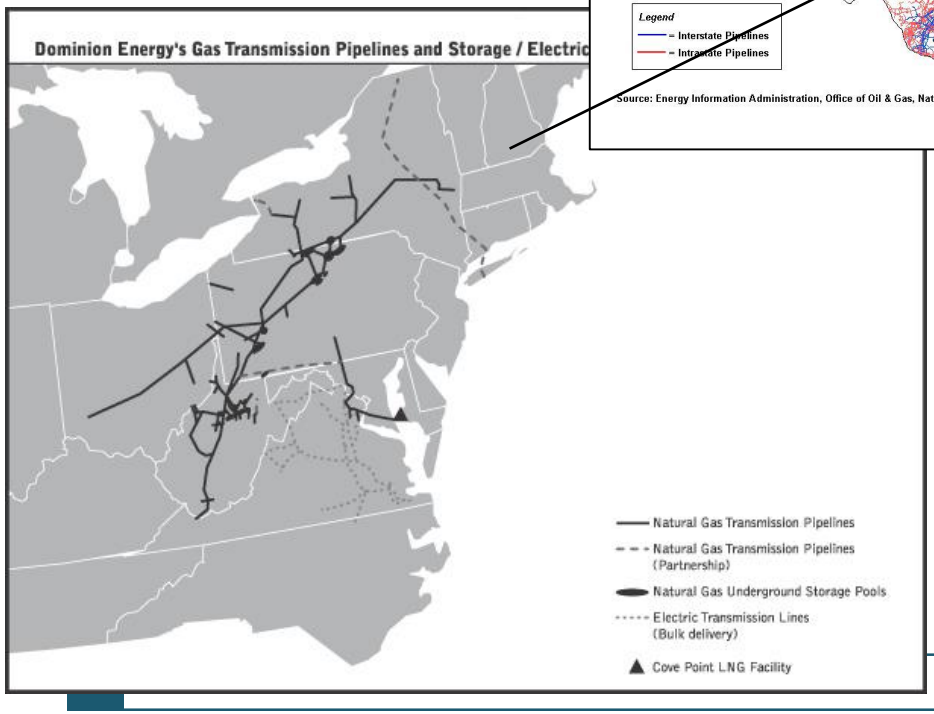
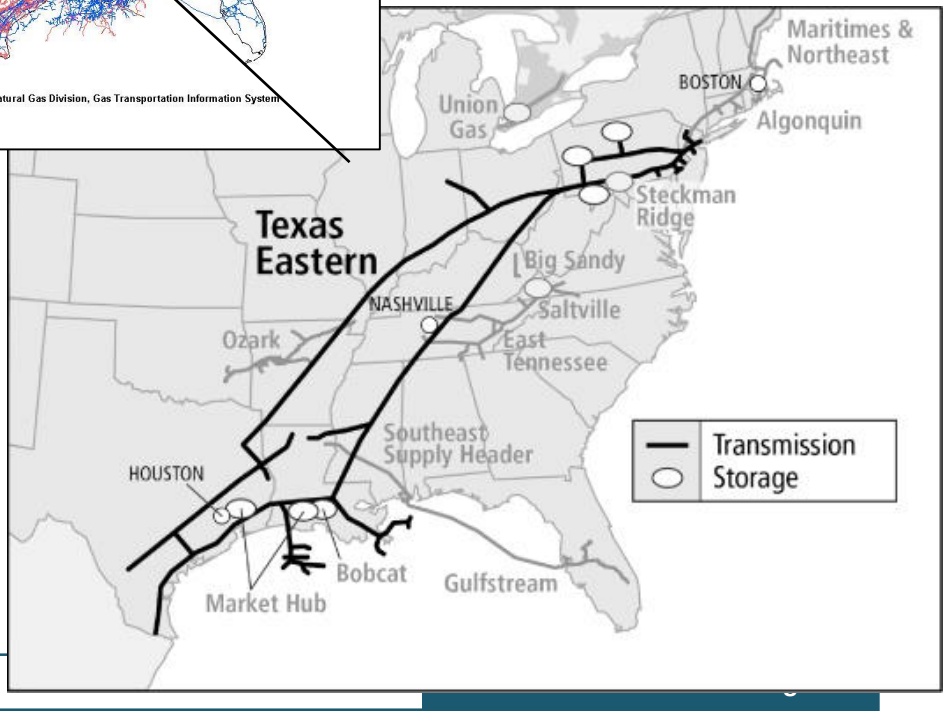
Examples of two interstate pipeline systems: Dominion Energy's and Texas Eastern's (Enbridge/Spectra)



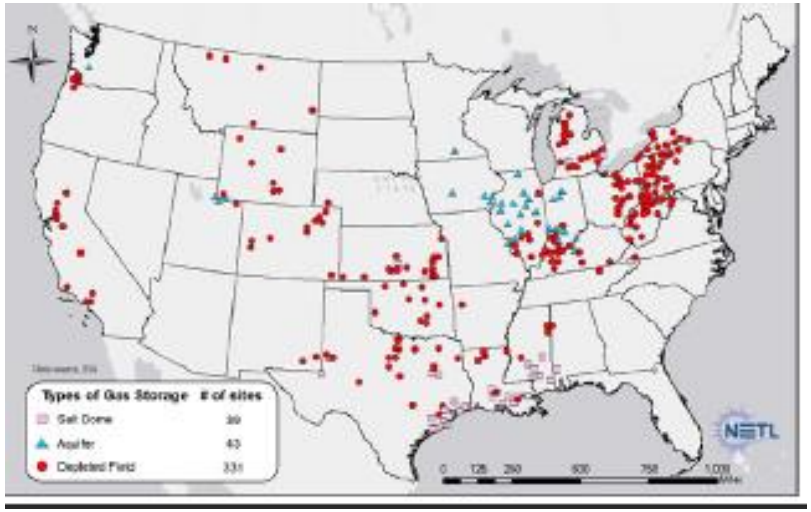




Differences: Storage capability

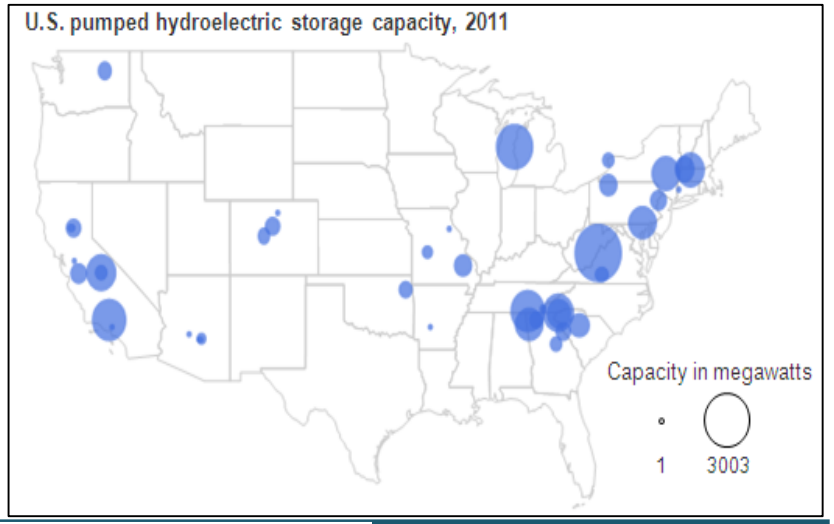
Natural gas:

- **Considerable regional storage allowing for seasonal draw-down**



Electricity:

- **Historically, the primary storage technology was pumped storage – designed for intra-day draw down**
- **Emerging technologies with injections/withdrawals over very different time scales**



Differences: Commodity markets

Natural gas:

- Unregulated upstream production
- Competitive commodity prices
- Demand highly sensitive to price

Electricity:

- Regulation of production through FERC's regulation of sales for resale
- Market-based prices subject to FERC review
- Demand is somewhat sensitive to price

Differences: Many more….

Universal service:

- Natural gas does not have universal service
- Electric utilities have obligation to serve and retail universal service

Demand outlook:

- Natural gas demand is growing overall, but flat demand in LDC markets
- Electricity demand is flat at retail and wholesale levels

Market and operational time scales:

- Natural gas moves at a 15-20 mile/hour pace on the interstate system
- Electricity operates in fractions-of-seconds time scales

Differences: One more….
Industry reliability organizations and standards

Natural gas:

- No mandatory industry-wide reliability organization
- Operating standards reflect a combination of FERC policy, NAESB standards and business practices of companies

Electricity:

- Since EPACT 2005, FERC/NERC mandatory reliability standards cover a wide range of planning, operational, communications, cyber and other issues
- Utilities and other industry participants have numerous voluntary agreements for cooperative support for reliability purposes
- States largely hold resource adequacy requirements – with FERC's role in RTO markets with a capacity market design

Some implications for electricity:

Issues relating to market design, operational schedules and coordination issues – e.g.,:

- **In some regions – incentives vary for generators' committing to firm transportation on interstate pipelines**
  - **Vertically regulated markets with rate-based generation: more likely to elect firm transportation service on pipelines**
  - **Merchant generators with at-risk investment in RTO markets: less likely to have financial incentives to invest in firm gas transportation service, and may rely on alternatives**

Some implications for electricity:

Issues relating to market design, operational schedules and coordination issues – e.g.,:

- **In some regions – chicken-and-egg timing problems**
  - **Generators need to commit to move gas volumes before knowing whether their offers into organized daily power markets have been accepted**
  - **Generators need to offer prices into such energy markets without fully knowing the price of their natural gas**
  - **Instances where gas customers with firm gas transportation service face potential (or real) curtailments under certain circumstances**
  - **FERC, NAESB, industry participants have been considering and are still wrestling with how to address these issues**

Final thoughts on implications for electricity:

To date, the industries have evolved and adapted to changing conditions:

- **Entities responsible for electric system reliability continue to evolve market designs, practices, agreements to assure system reliability.**

There will be continuing need to stay ahead of changing conditions in the two industries

- **On the gas-industry and the electric-industry sides**

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