

Greater Philadelphia Chapter of the Association of Energy Engineers

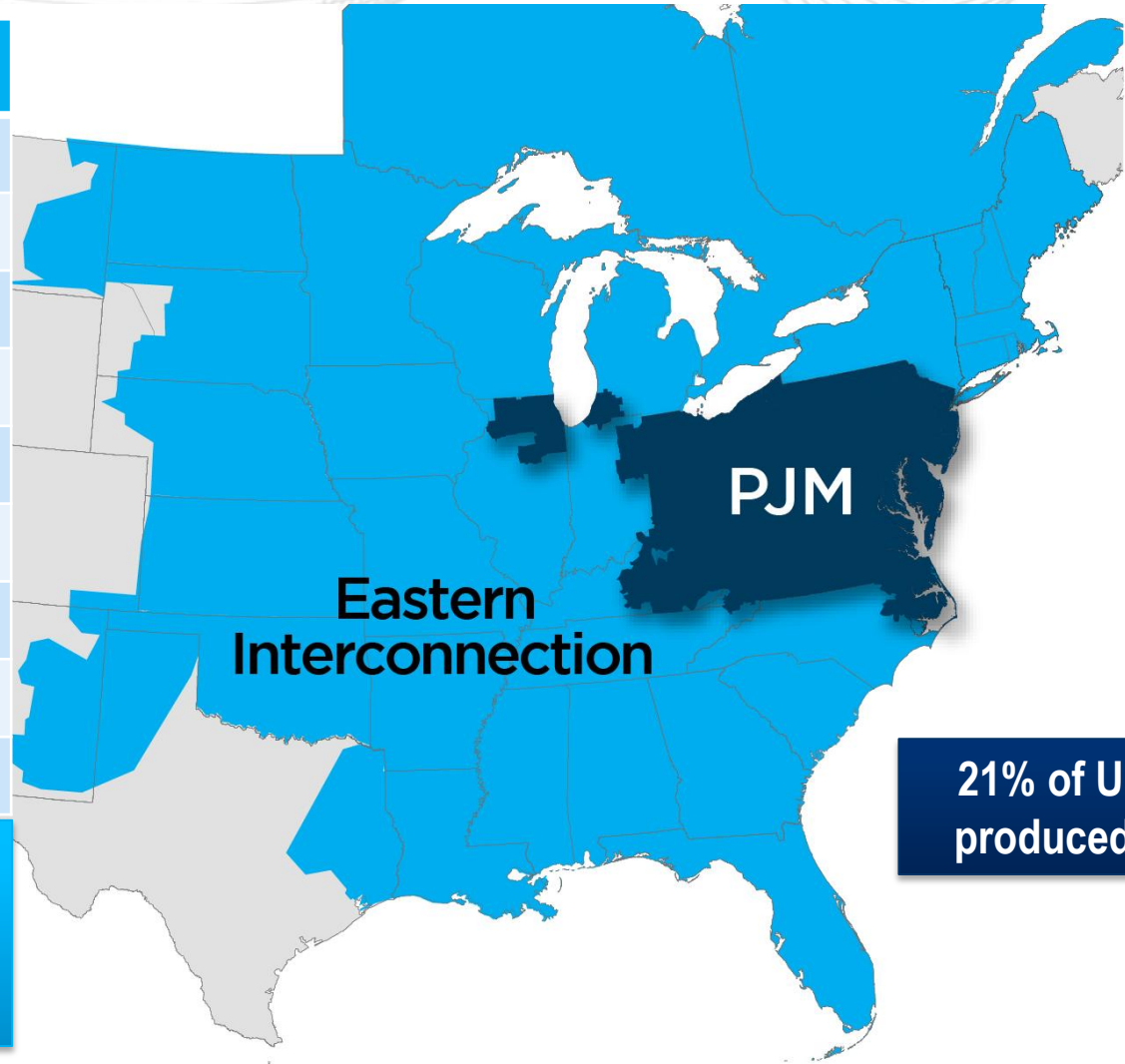
Stephen Boyle
Director, State Gov. Affairs
PJM Interconnection

January 20, 2016

Key Statistics

Member companies	960+
Millions of people served	61
Peak load in megawatts	165,492
MW of generating capacity	171,648
Miles of transmission lines	72,075
2014 GWh of annual energy	792,580
Generation sources	1,304
Square miles of territory	243,417
States served	13 + DC

- 27% of generation in Eastern Interconnection
- 28% of load in Eastern Interconnection
- 20% of transmission assets in Eastern Interconnection

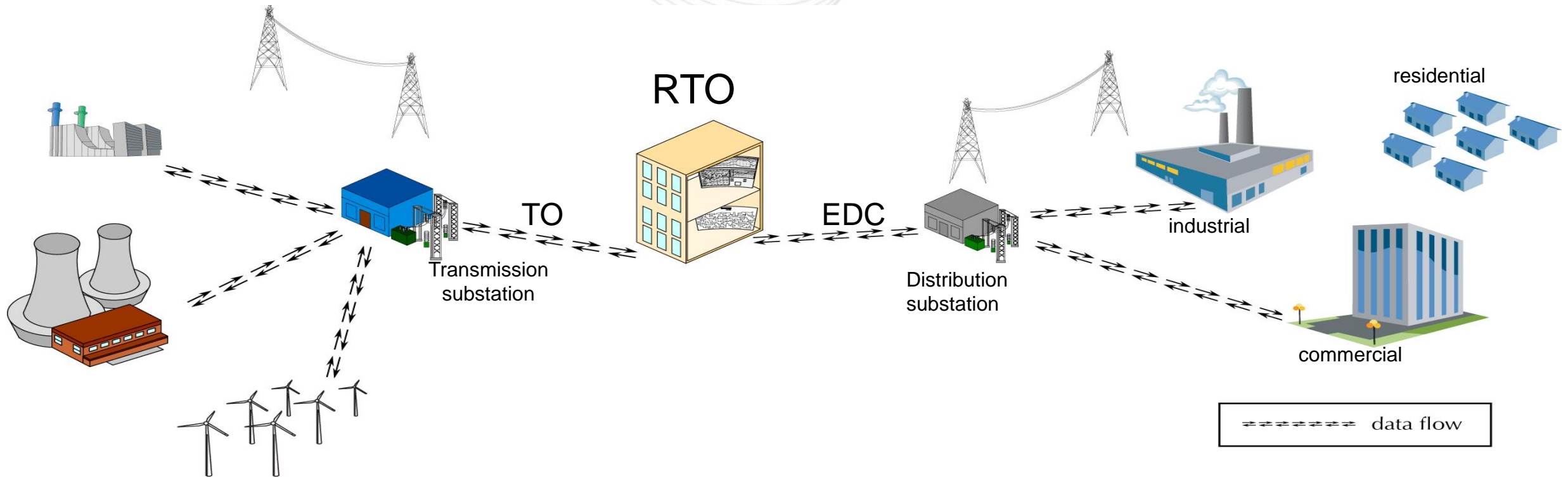


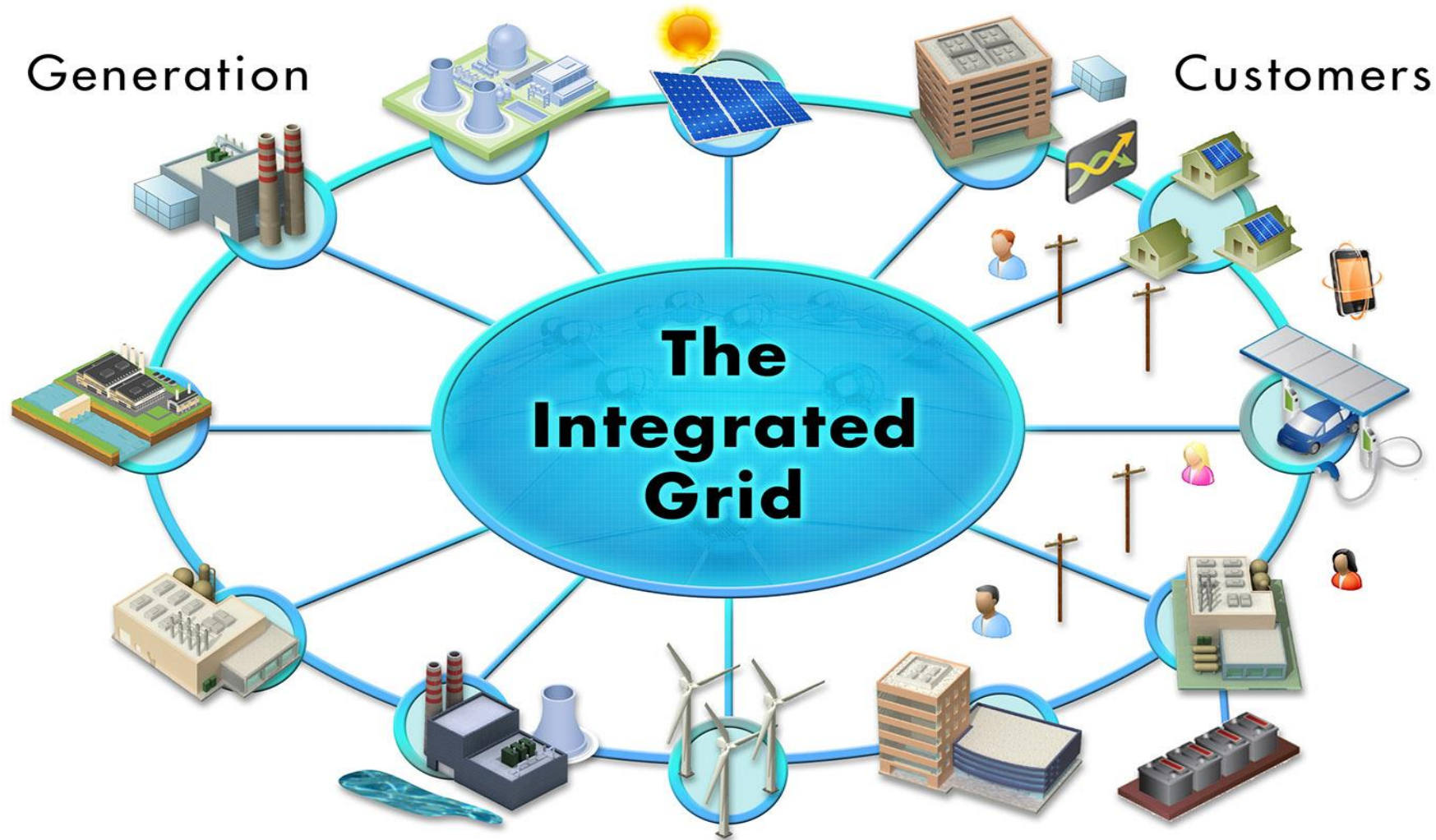
**21% of U.S. GDP
produced in PJM**

As of 1/2016

Generation

Load





Source: EPRI

- Electricity demand
- Extreme earth and space weather
- World's largest fuel switch:
Reliably managing switching to low-carbon fuel sources
- Natural gas operations coordination
- Integration of intermittent and demand side resources

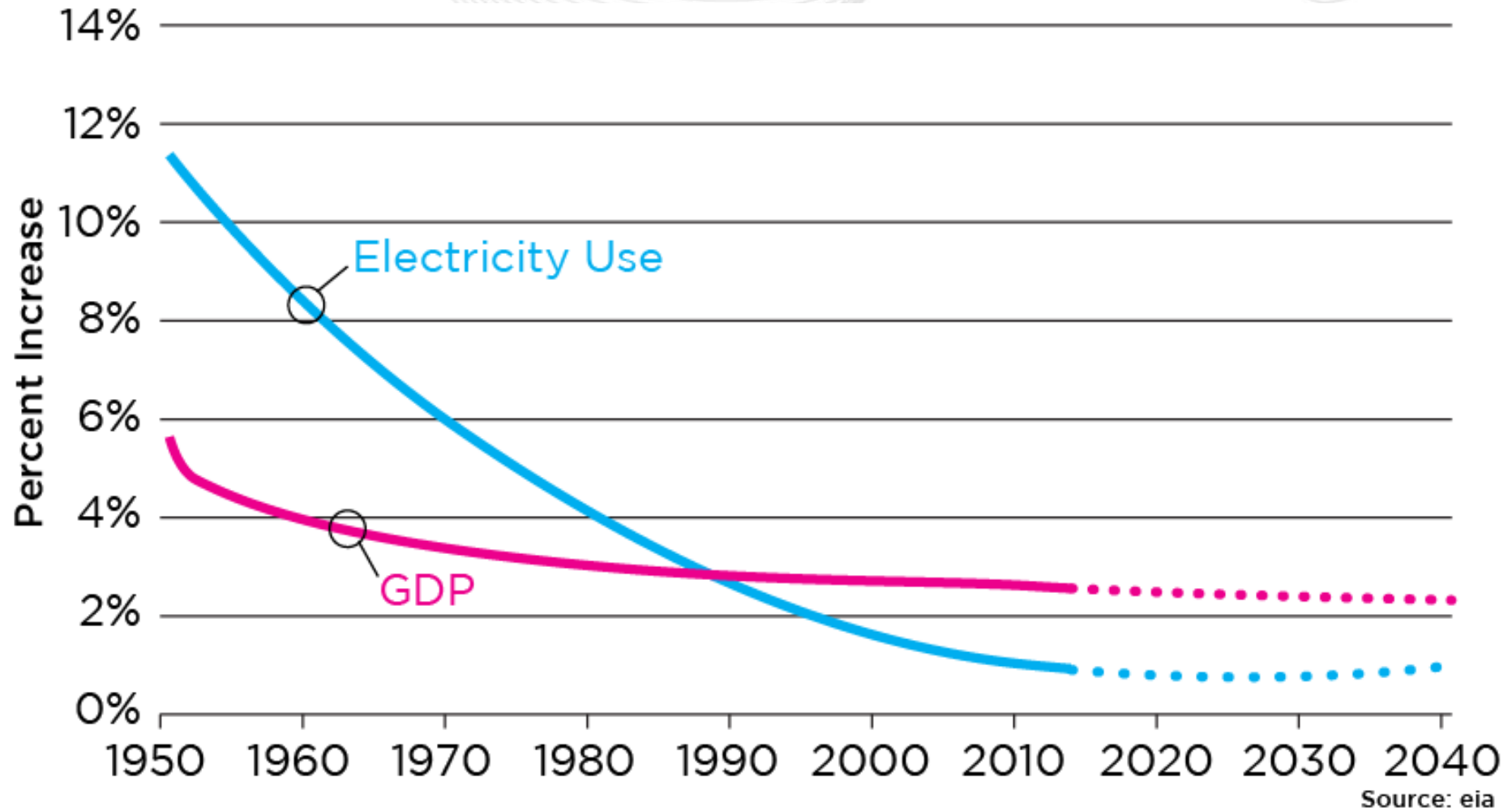


Each Challenge is Also an Opportunity

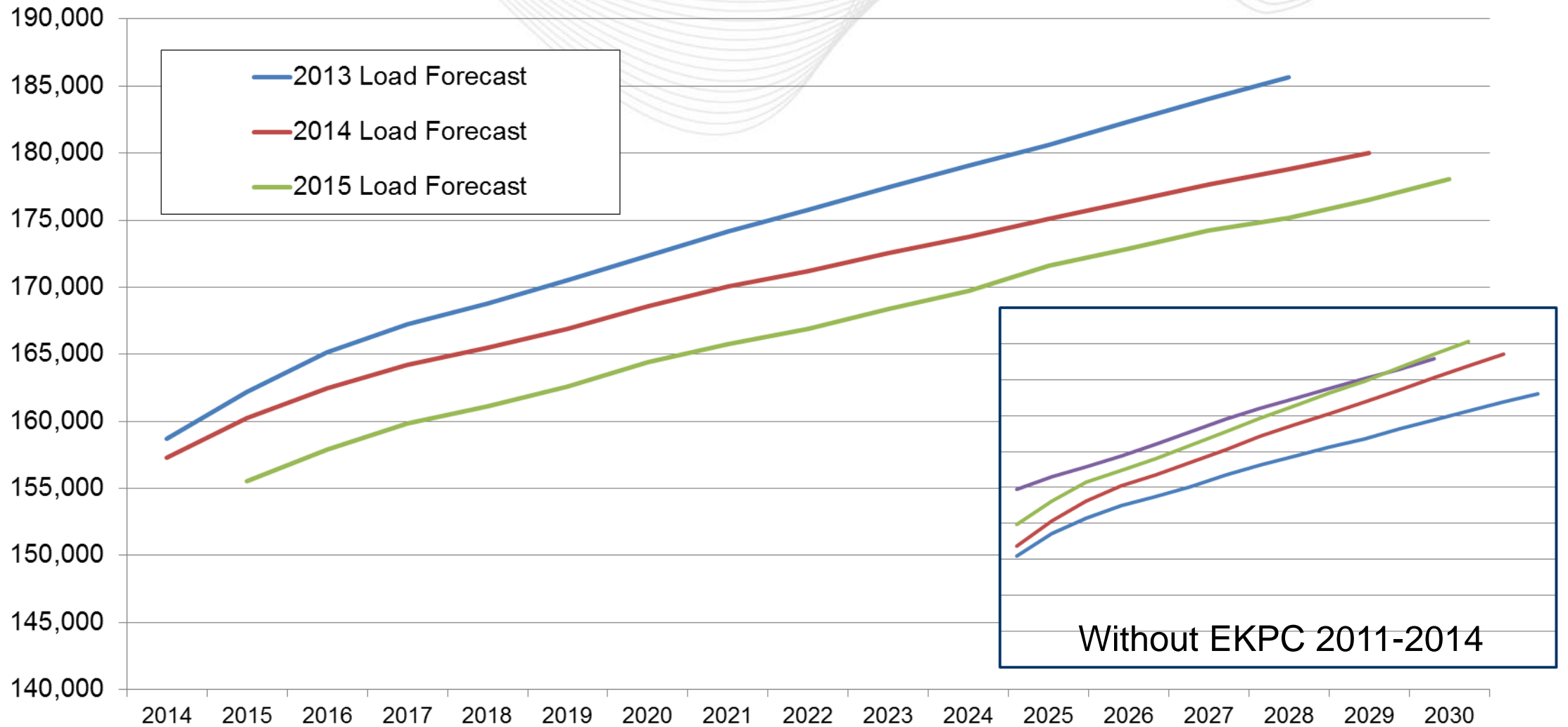
Adapted from: EPRI

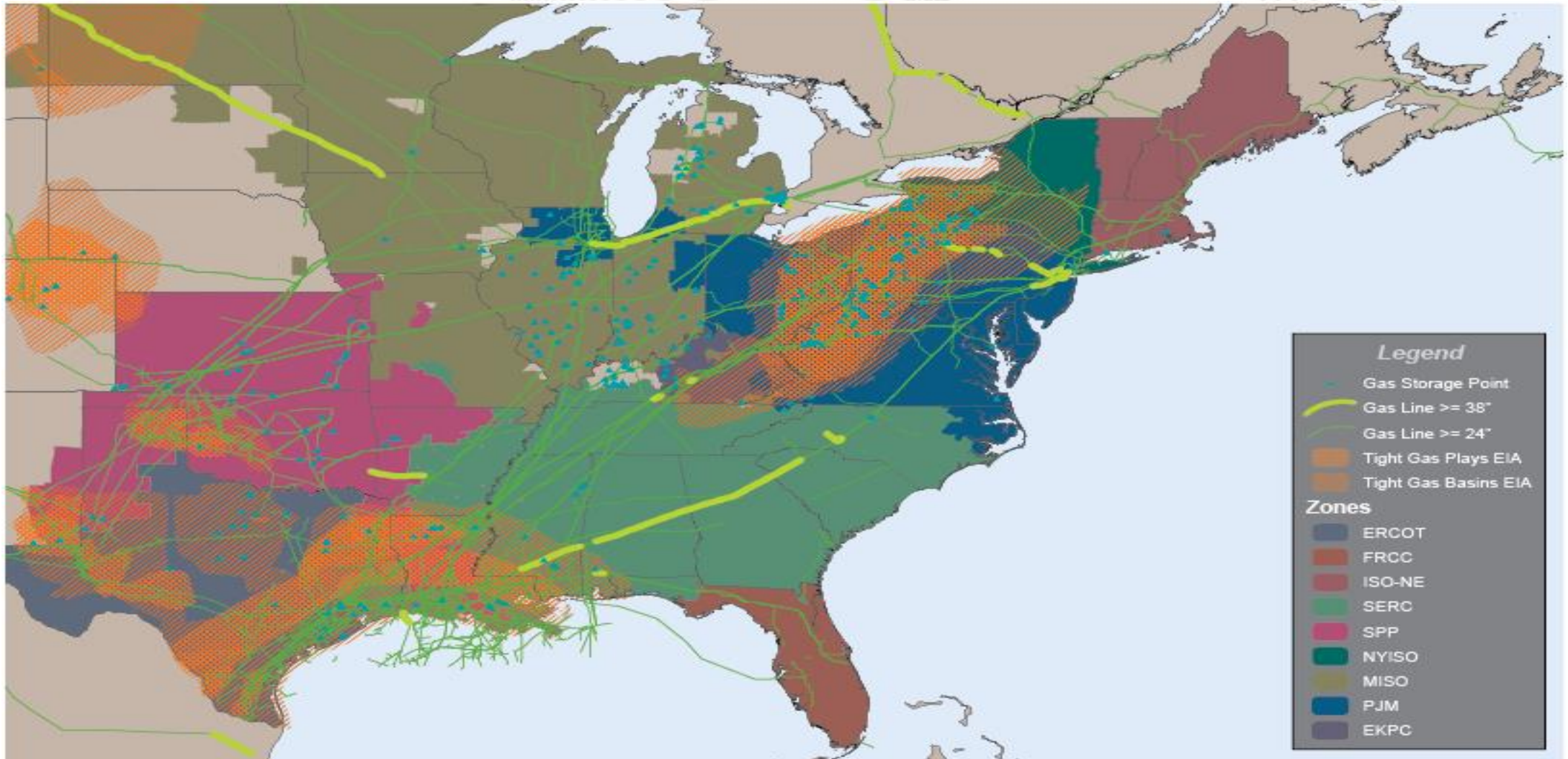
Regulators

- PJM coordinates the grid and administers the wholesale power market according to federal laws and regulations as well as within the requirements of each state which it serves.
- Federal Energy Regulatory Commission
- OPSI: State public utility commissions



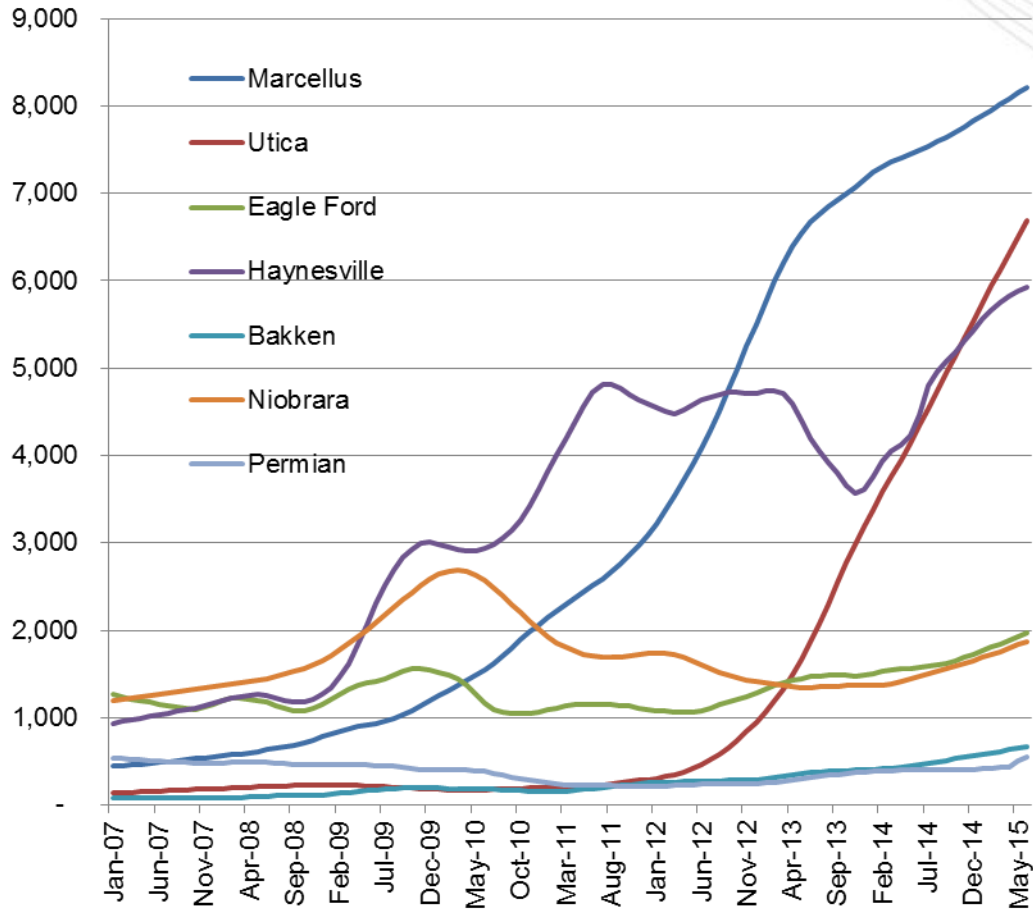
Declining Electricity Demand Growth



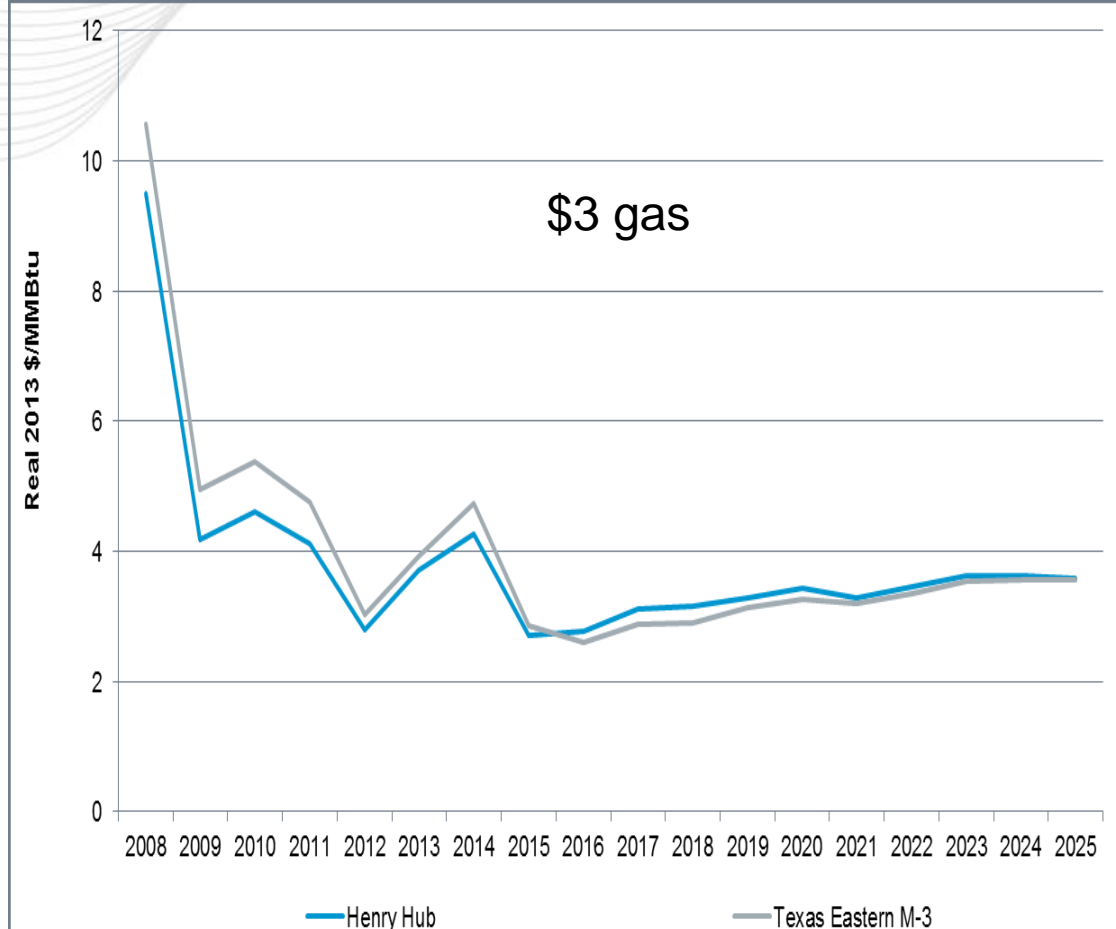


Increasing Productivity of Unconventional Gas Reserves

**Rig Productivity
(mcf/rig/day)**



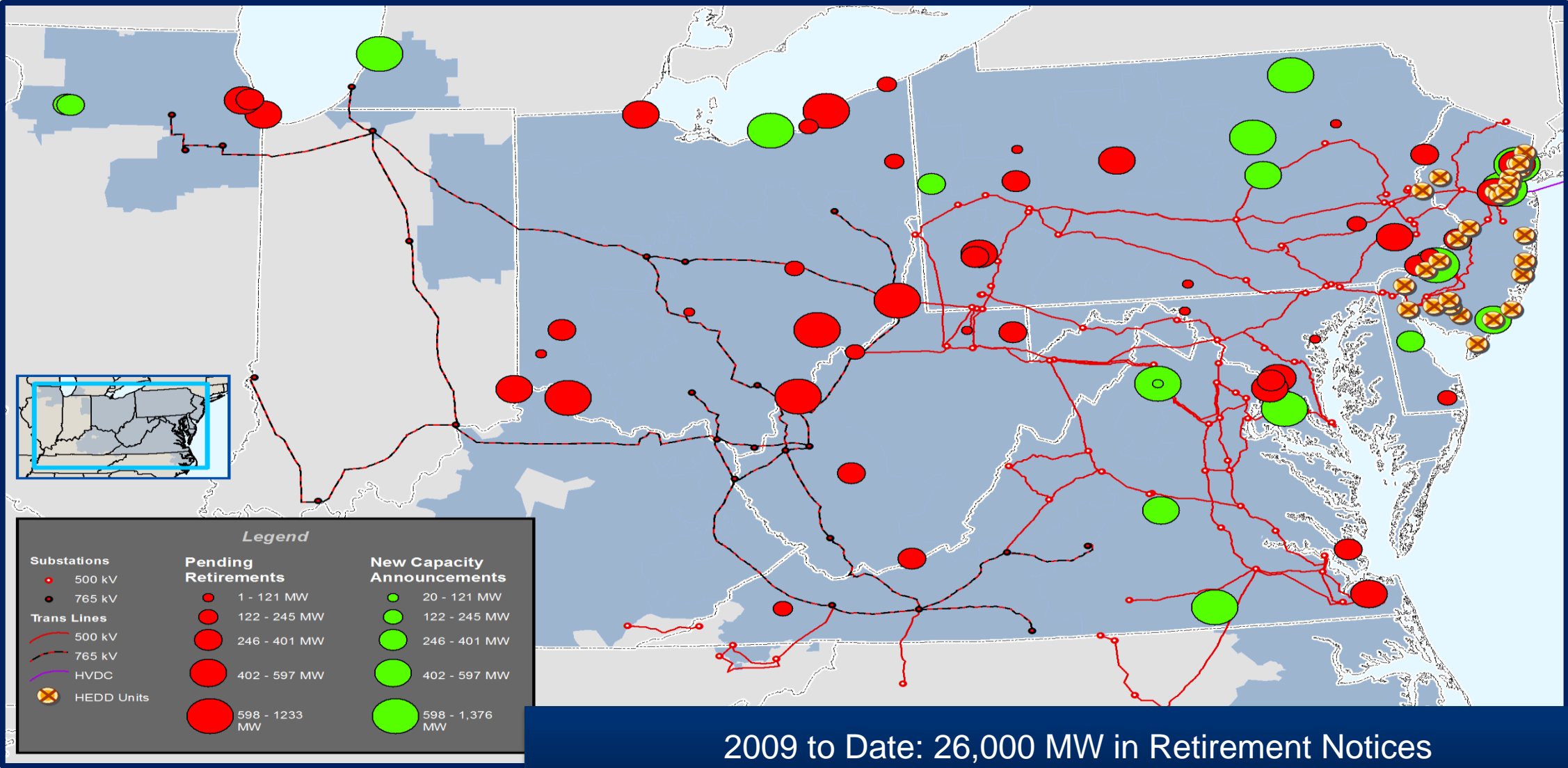
Annual average natural gas prices, 2008–25



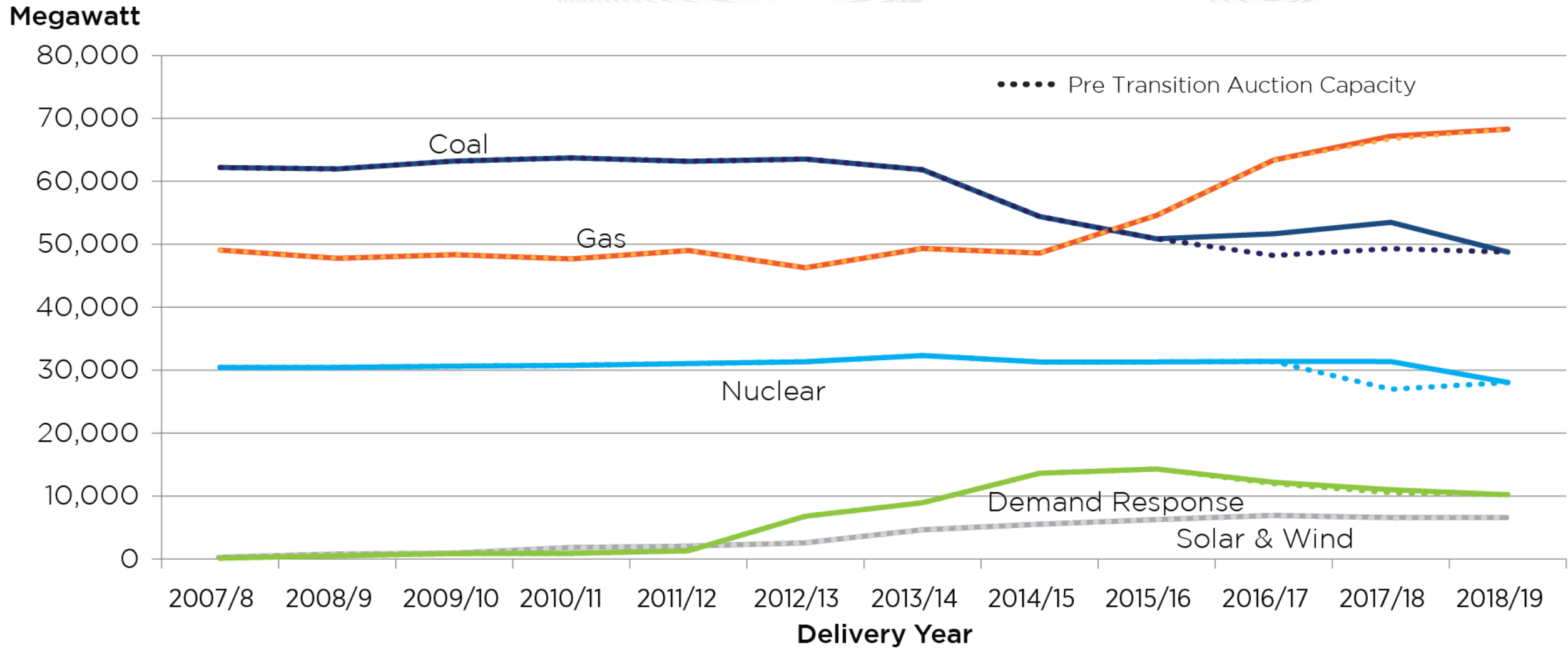
Notes: Natural gas prices are based on the April 2015 edition of the IHS North American Natural Gas Advisory Service's "North American Natural Gas Market Outlook."
Source: IHS; Intelligence Press for historical data

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Transitioning from Coal to Gas...

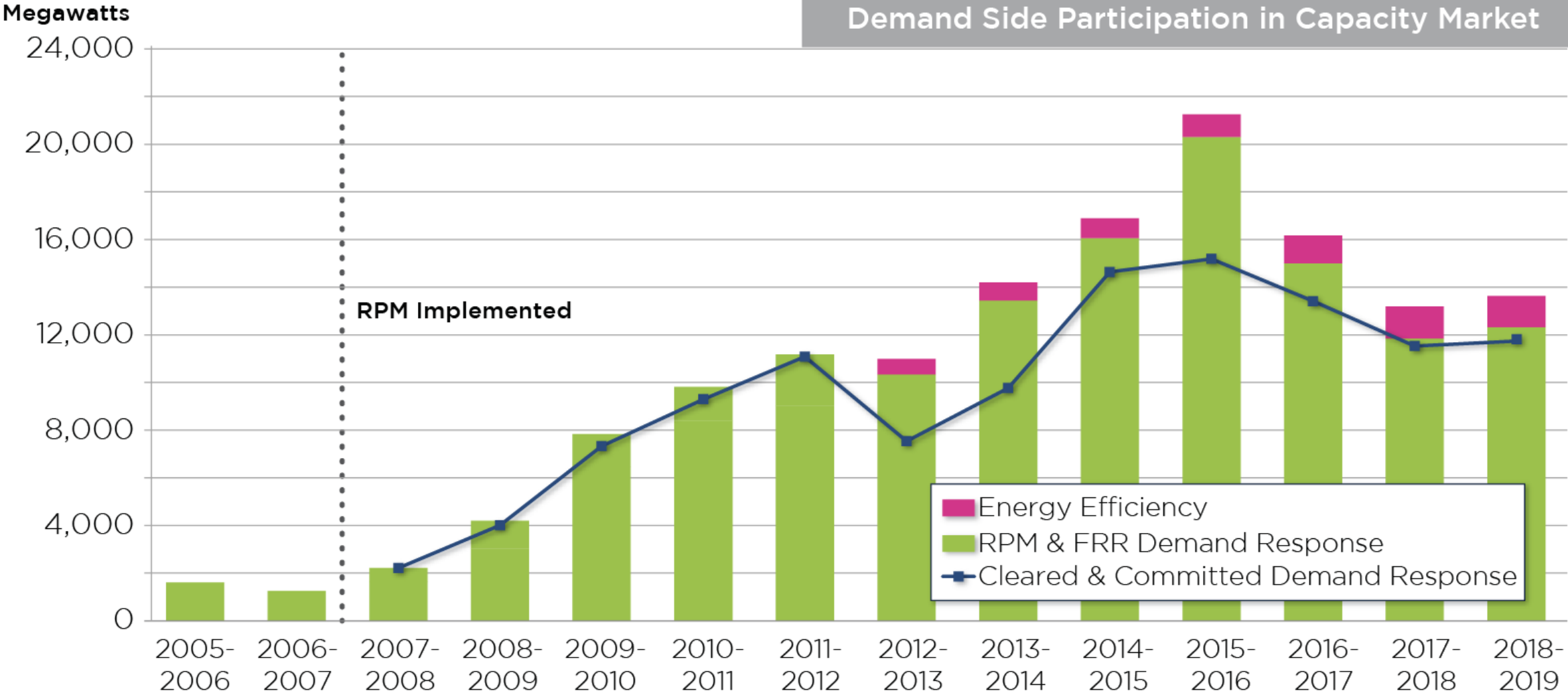


2009 to Date: 26,000 MW in Retirement Notices

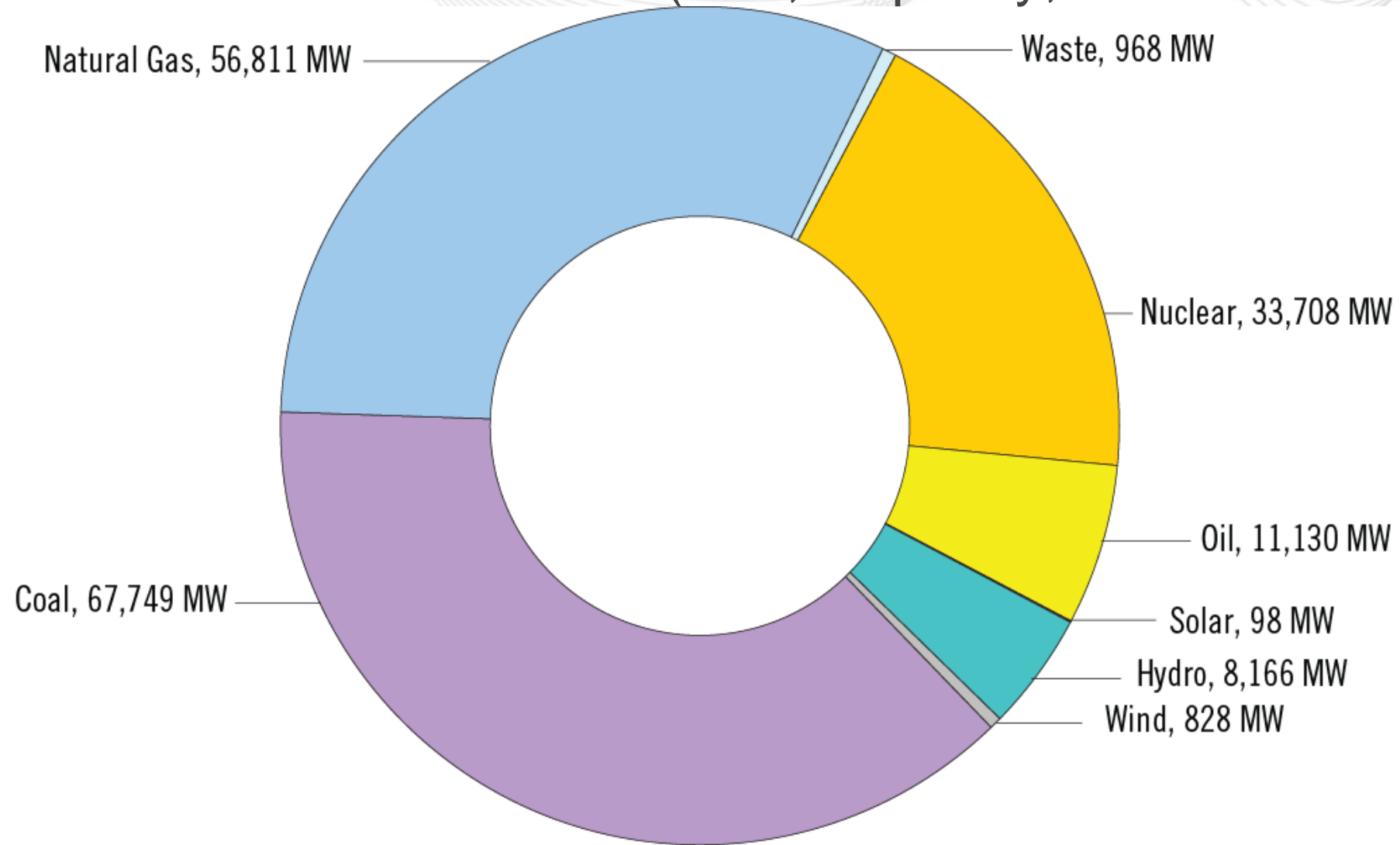


Capacity Market Enables Demand Resources

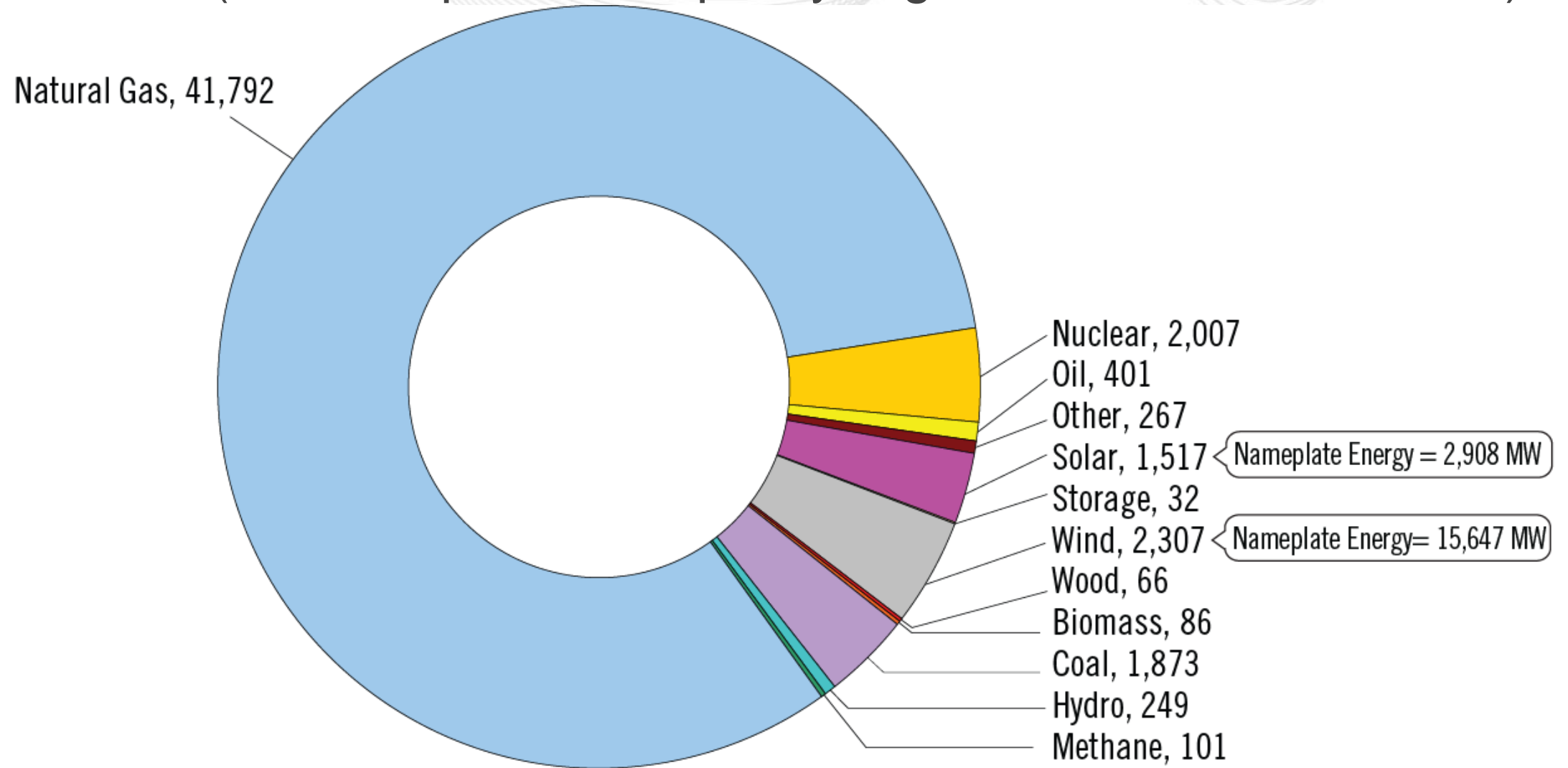
Demand Side Participation in Capacity Market

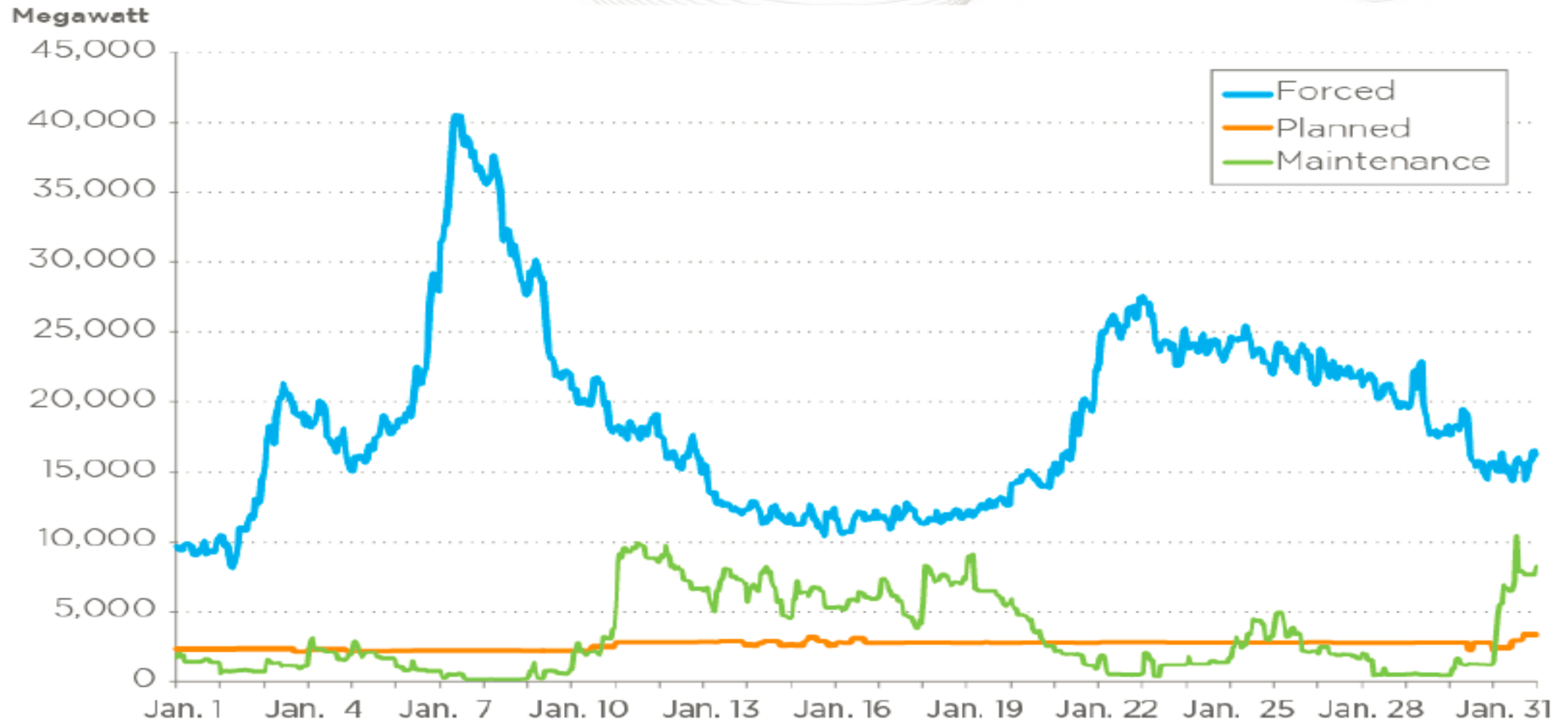


Fuel Mix – Existing PJM Installed Generating Capacity (MW, Capacity, December 31, 2014)



Fuel Mix – Queued Interconnection Requests (MW, Requested Capacity Rights, December 31, 2014)





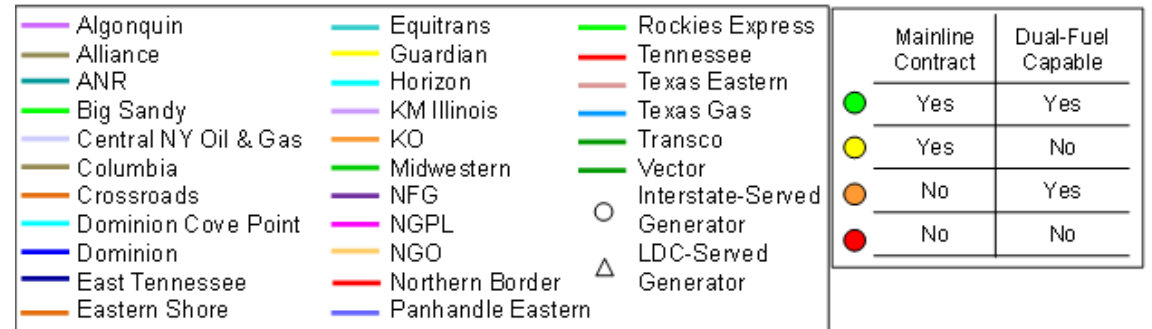
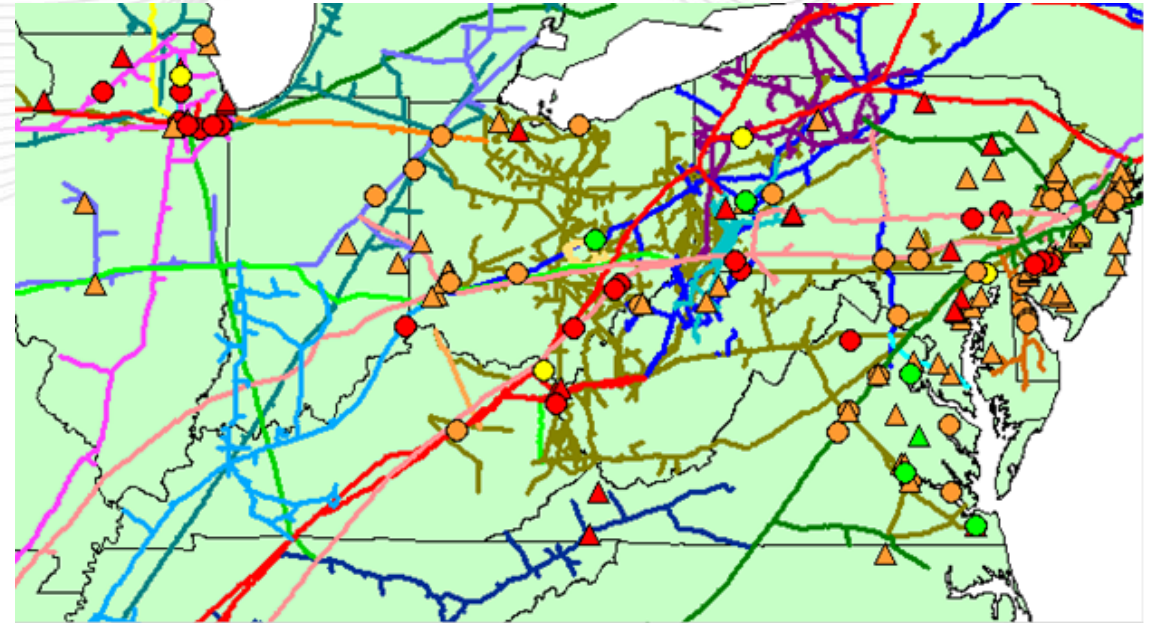
Capacity Performance Features

Obligation to deliver
energy when PJM calls
for it

Over-performers
rewarded;
under-performers pay

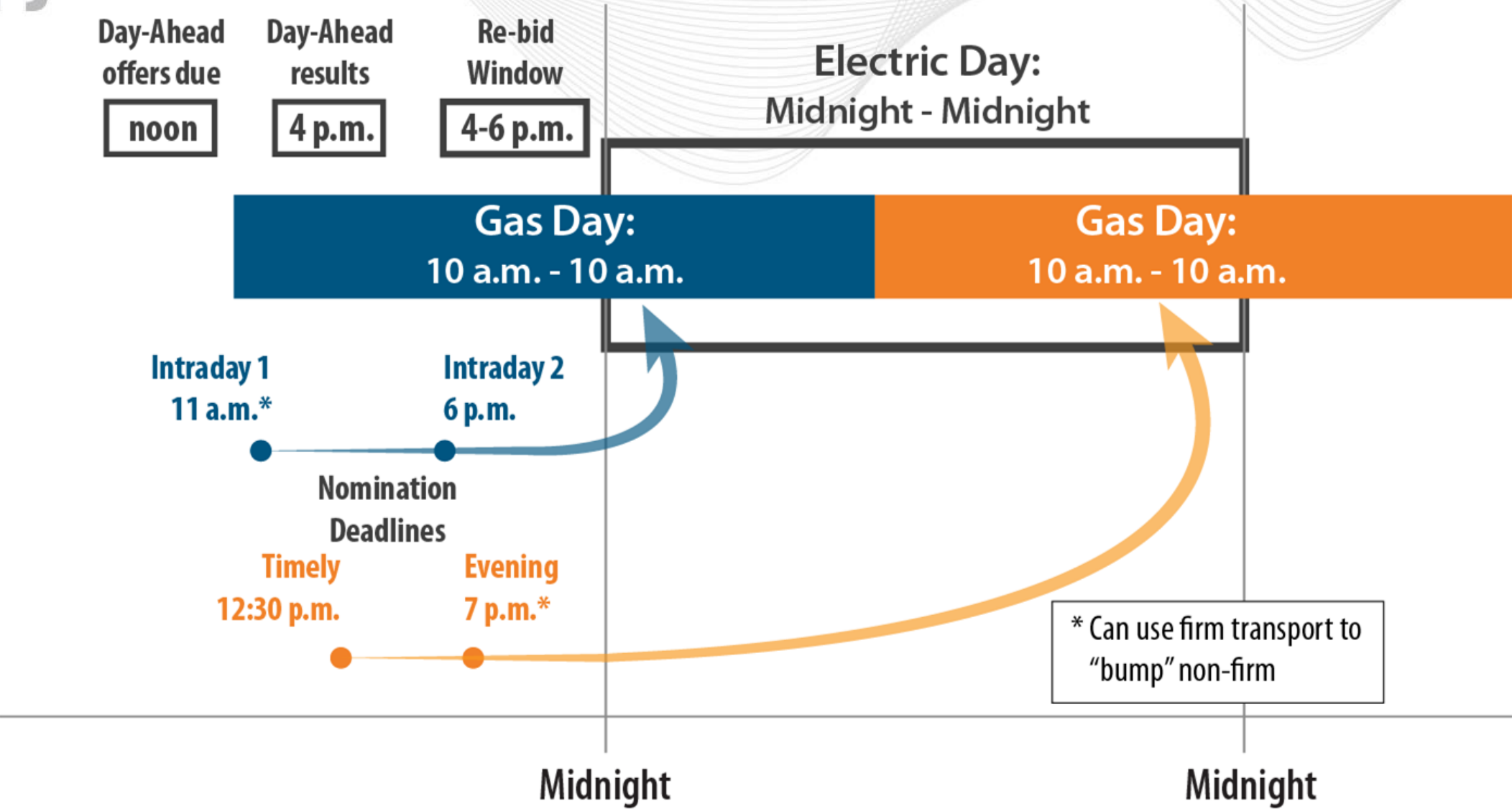
Small net cost for improved
reliability/price stability

- ~ 42,000 MW connected to interstate pipelines
 - 7 primary interstate pipelines
- ~ 21,000 MW connected to LDCs

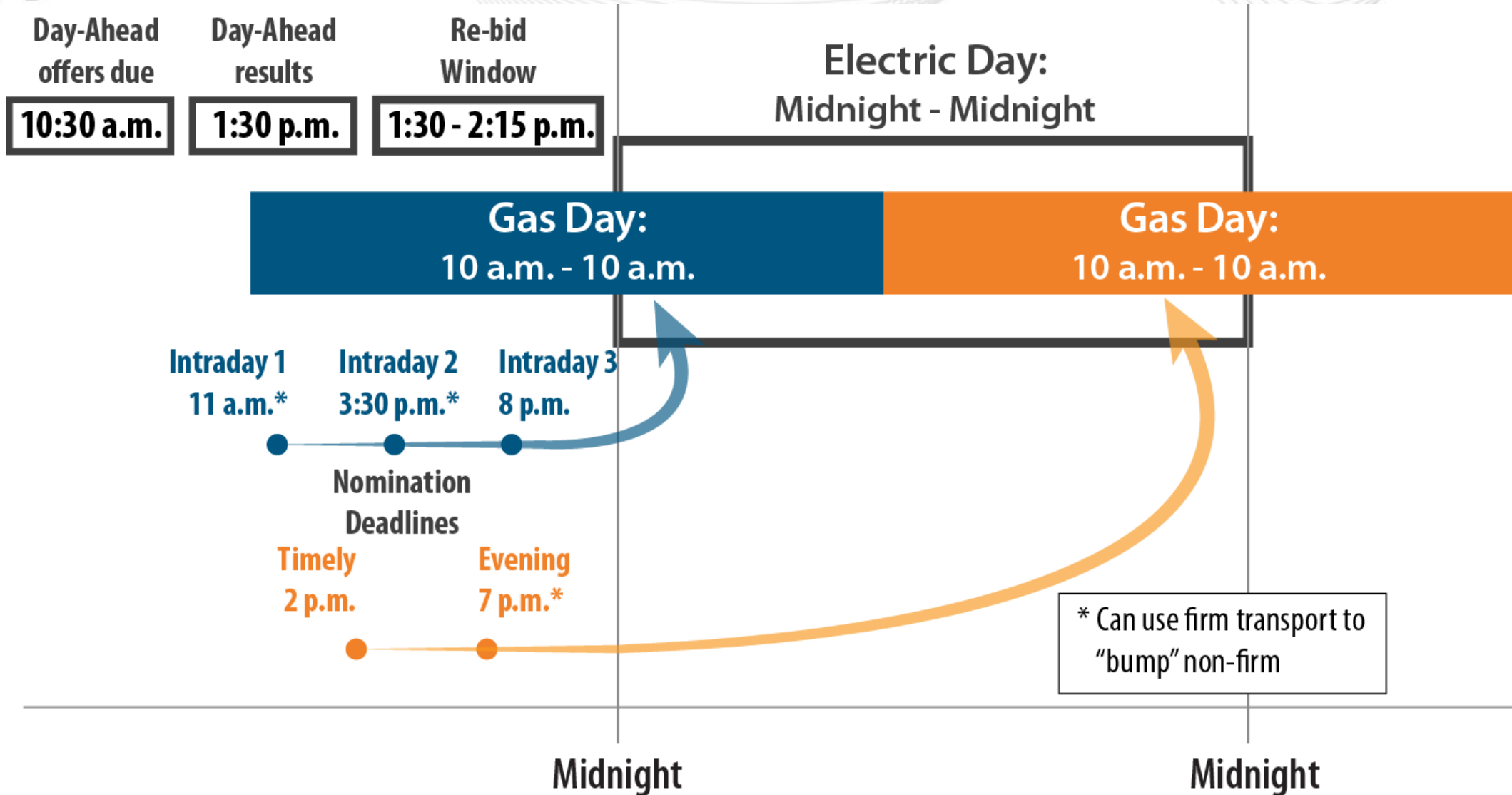


Peak gas usage in winter is ~ 6 Bcf/day

Current Day-ahead Market and Gas Nomination Timelines



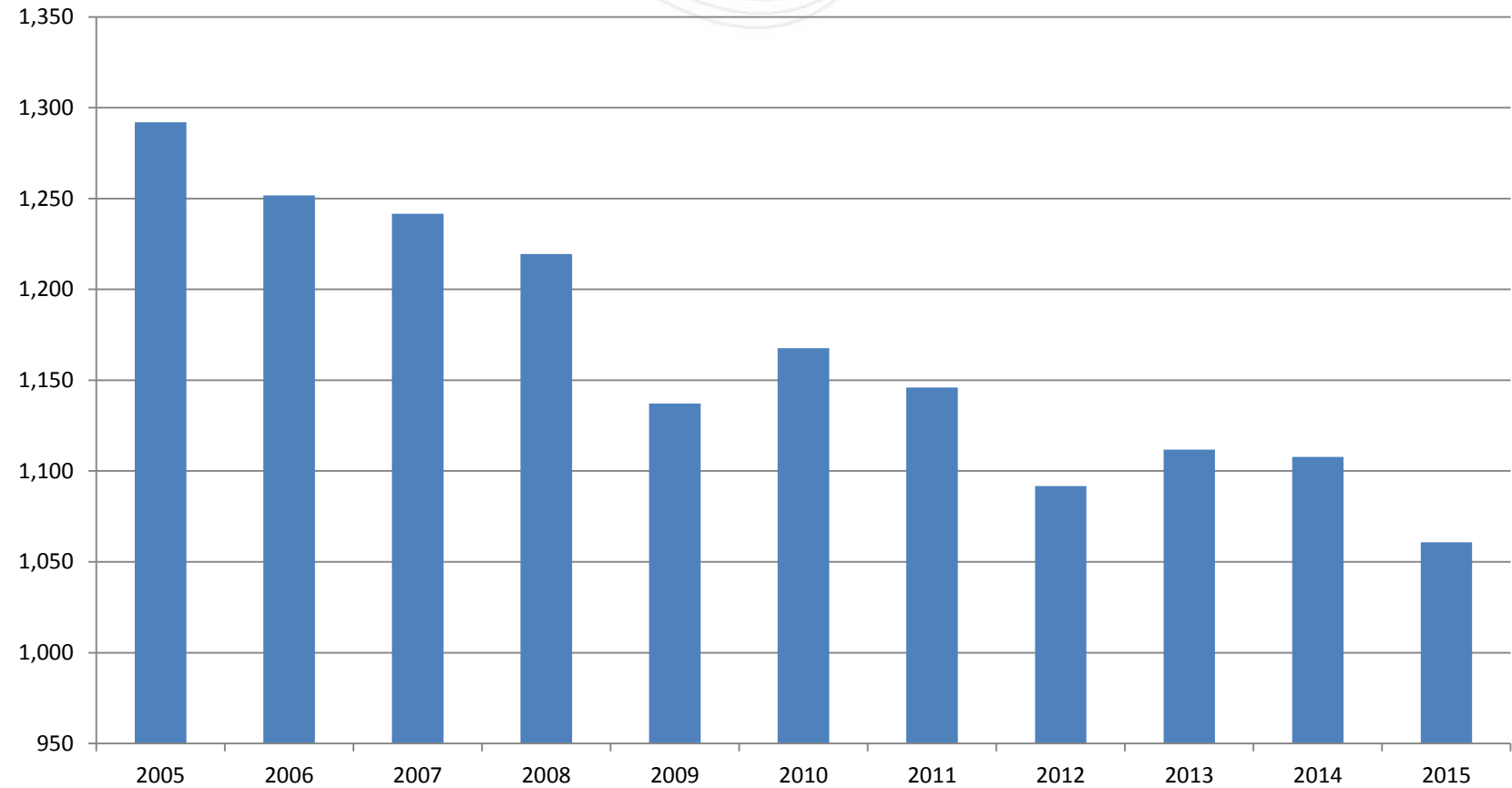
Proposed Day-ahead Market and Approved Gas Nomination Timelines

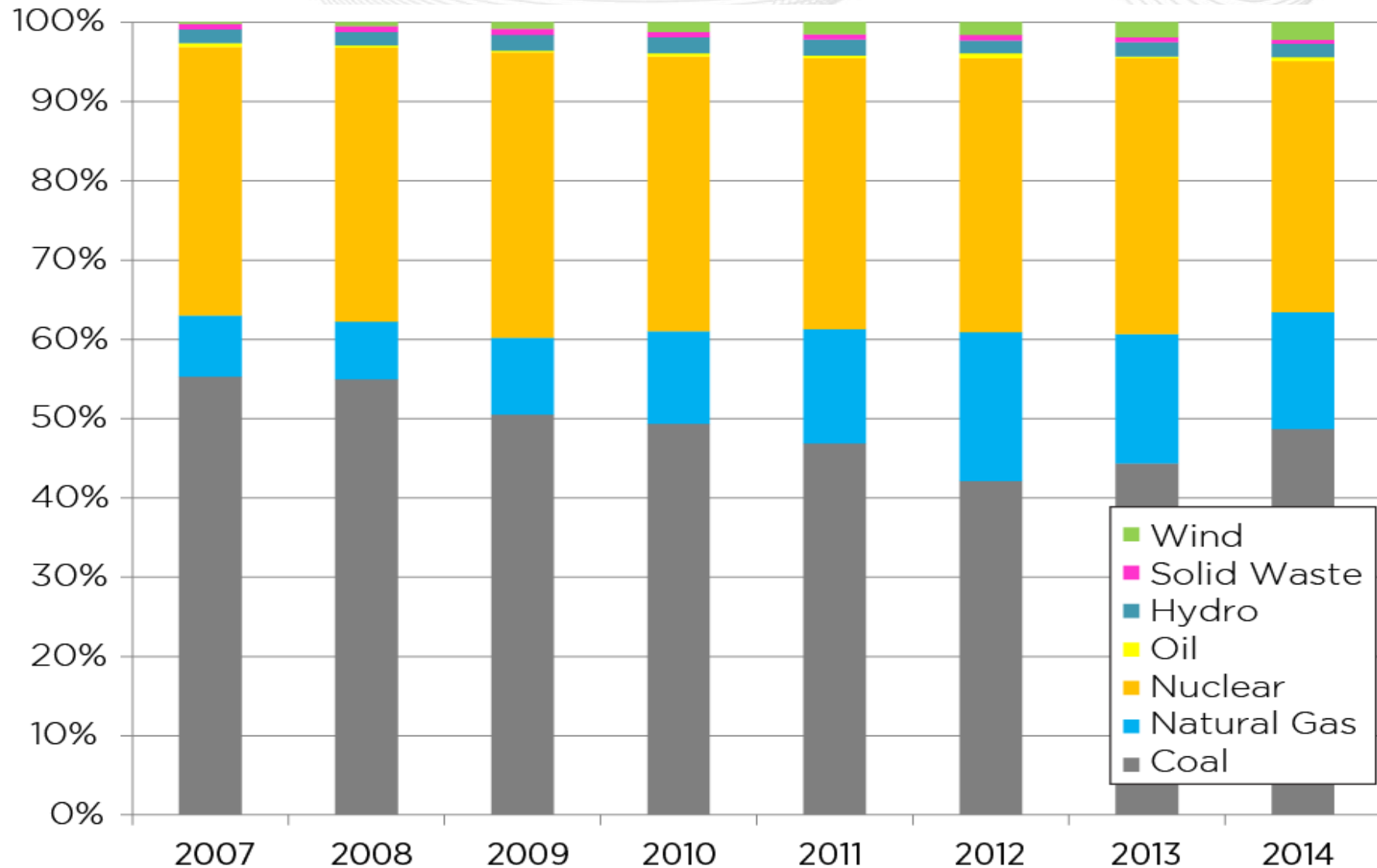


- What is it?
 - US EPA released its Final Clean Power Plan rule to regulate CO₂ emissions on August 3, 2015
 - For the PJM region, the regulation calls for a 36 percent reduction in CO₂ emissions versus 2005 levels and 23 percent reduction relative to 2012 CO₂ levels through enforcement of rate and/or mass based emissions standards
- What is PJM Doing?
 - Provide an assessment of the potential economic and reliability impacts of the EPA's Clean Power Plan compliance pathways
 - Primary study years: 2023, 2026
 - PJM will also study 2028, 2030 but with less detailed transmission modeling

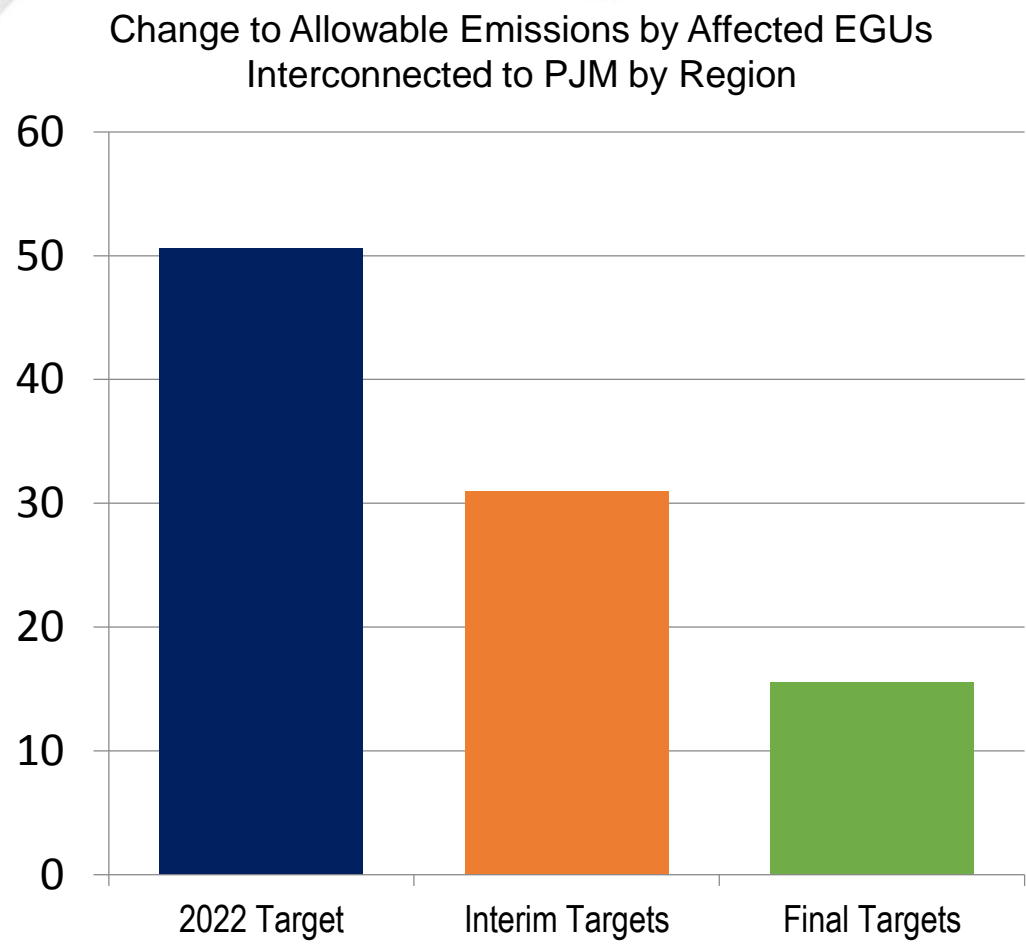
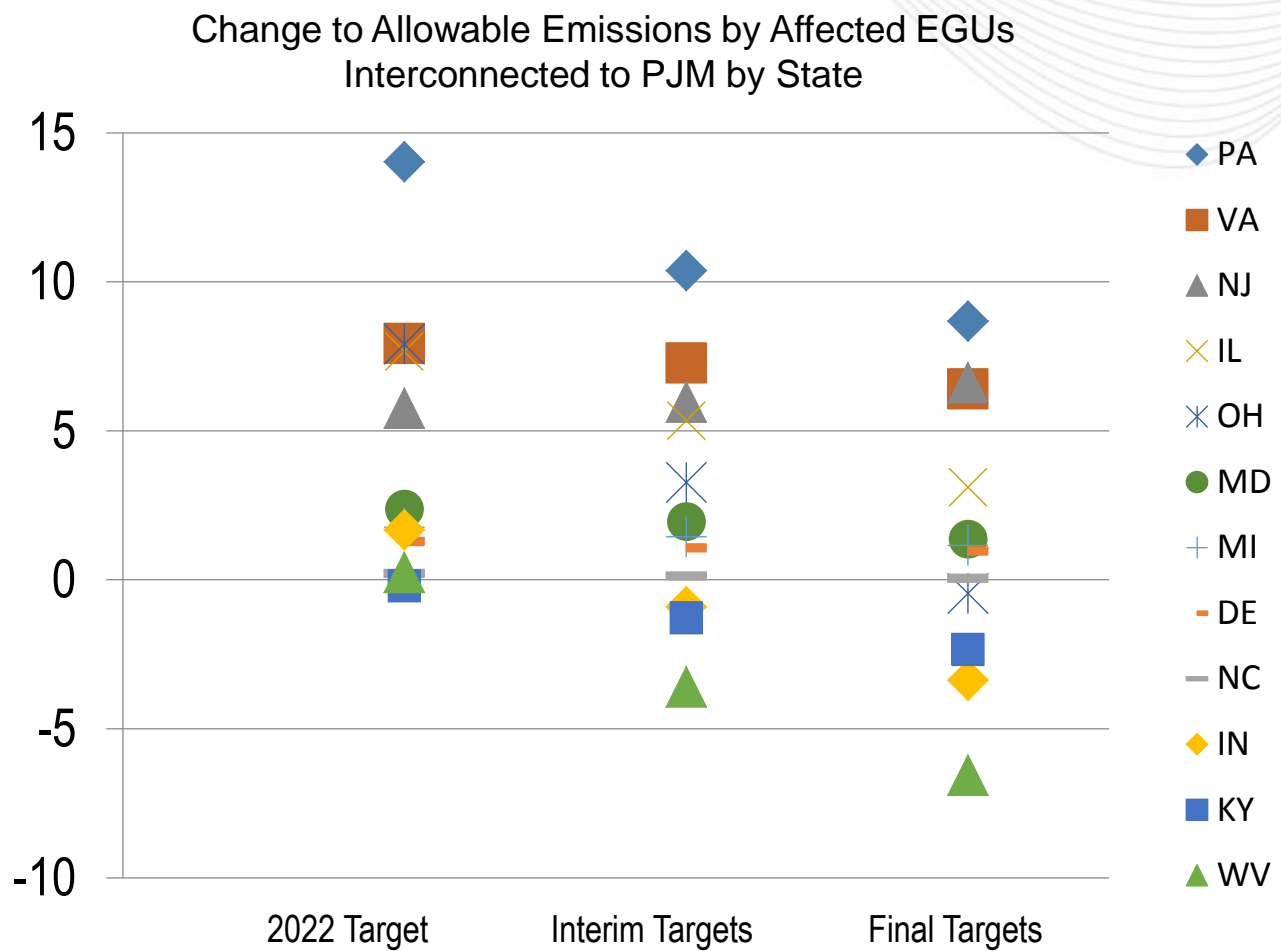
Clean Power Plan Targets 36% Reduction from PJM Region by 2030

PJM Actual Average CO₂ Emissions (lbs/MWh)



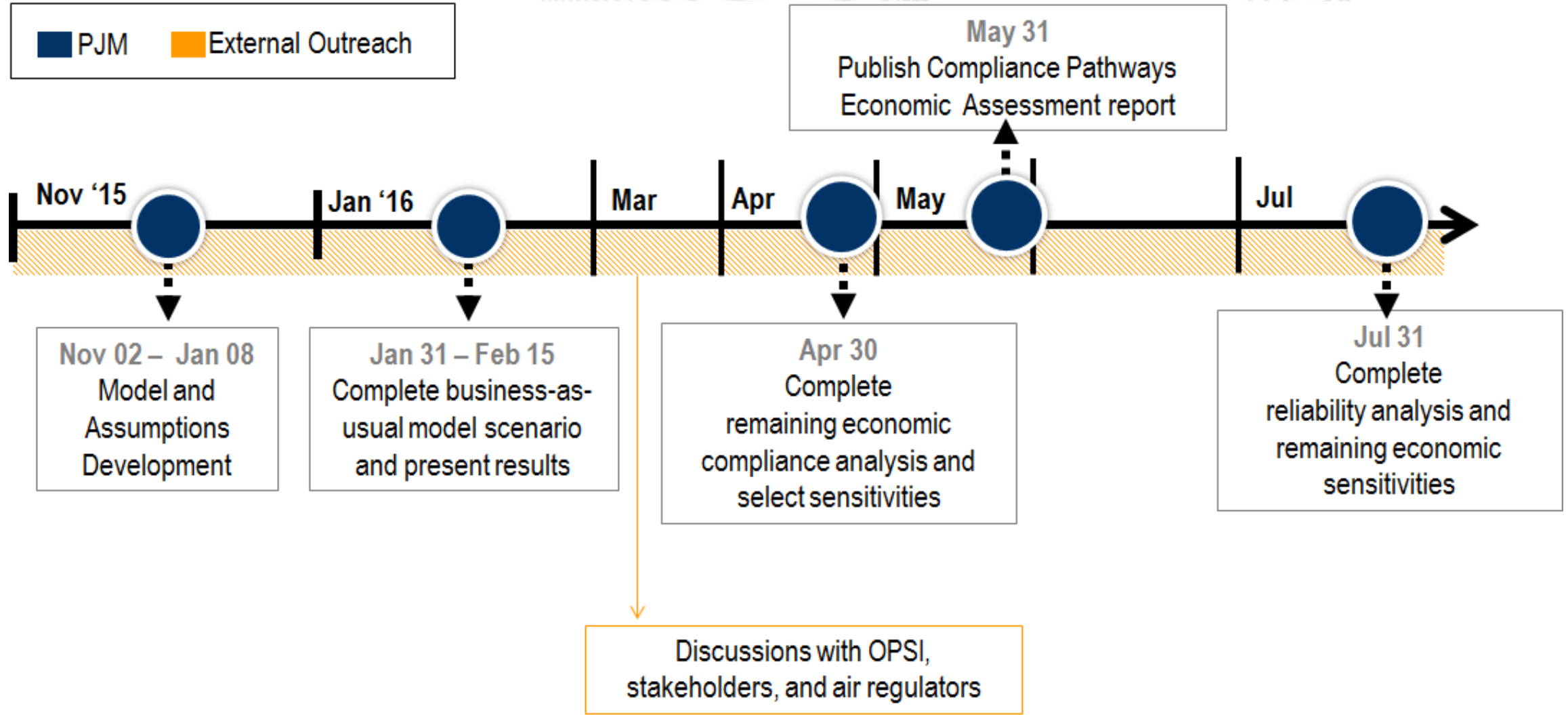


Final Rule Mass Target **Less:** Proposed Rule Mass Target(Millions of Tons)



*DC does not have a CPP compliance target and Tennessee doesn't have any affected EGUs in the PJM footprint

Clean Power Plan Analysis Timeline



- What is it?

Economic base case that will be compared to CPP compliance scenarios to determine compliance impacts

- What will be included?
 - New capacity resources based on PJM capacity market results for the 2018/2019 delivery year
 - Under-construction energy only (e.g. wind and solar) resources
 - Demand side management resources based on PJM capacity market results for the 2018/2019 delivery year
 - Announced deactivations will not be simulated
 - Incorporate compliance with other environmental regulations to the extent possible
 - Beyond 2018, new resources will enter/exit the market based upon market signals

PLEXOS® enables PJM to perform the economic analysis required to evaluate the CPP Compliance Pathways and provide the necessary inputs for detailed reliability analysis:

- Long-term resource entry/exit optimization with enforcement of multiple emissions limits
- Security constrained economic dispatch analysis with enforcement of multiple emissions limits
- Detailed renewable generation modeling
- Representation of energy efficiency and demand response

- **Economic analysis by individual state and/or PJM region:**
 - Carbon dioxide price, total emissions and emissions rate
 - Locational Marginal Prices and energy market load payments
 - Aggregate facility level transmission congestion by voltage level
 - Monthly peak hour natural gas flows
 - Percentage of generation by prime mover and fuel type
 - Capacity retired and added by Locational Deliverability Area
 - Fuel, and variable operations and maintenance production cost
 - Resource expansion capital costs
- **Reliability analysis:**
 - Generation and Load Deliverability tests based on resulting compliance pathway generation portfolio

