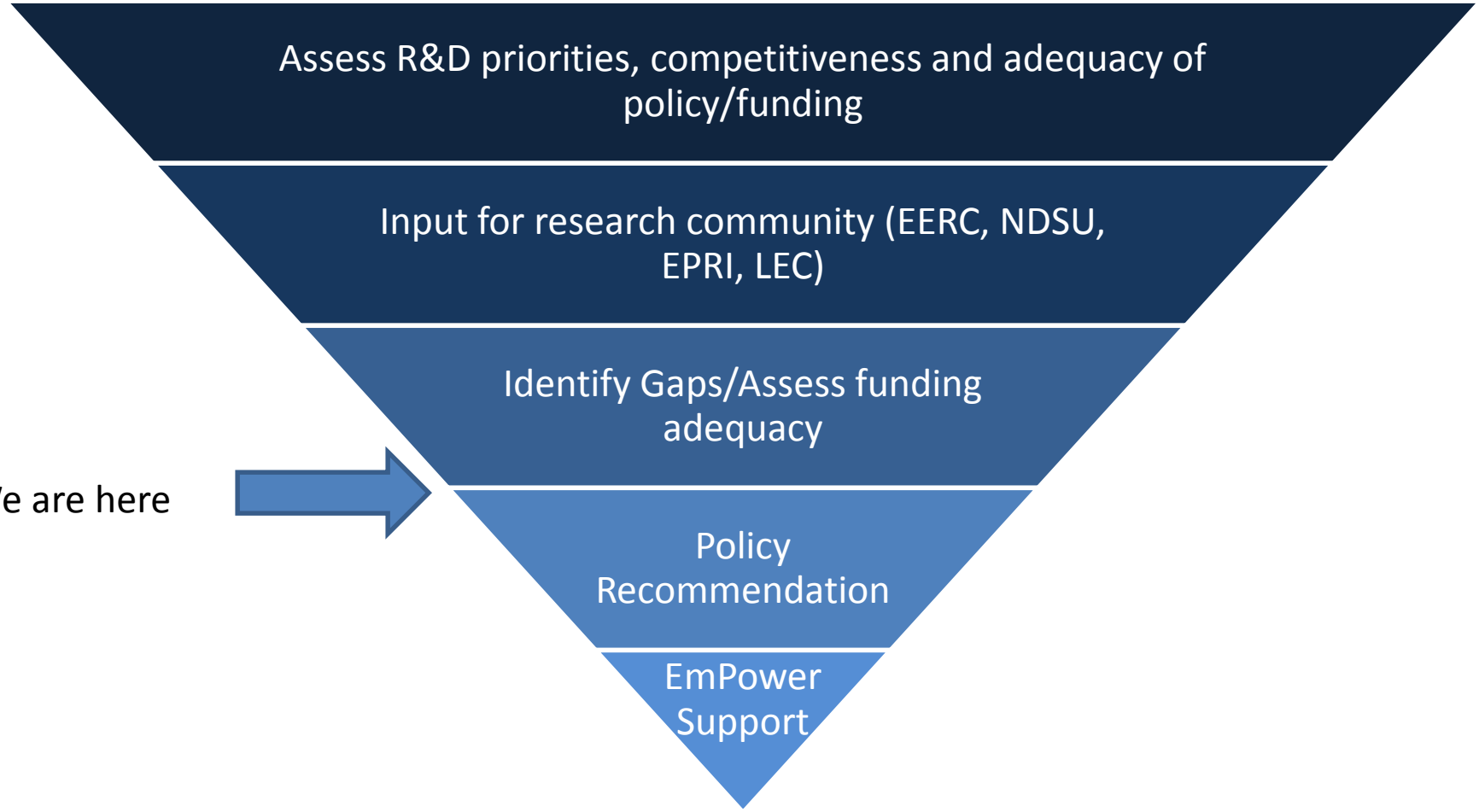
EmPower R&D Subcommittee

North Dakota R&D Pathway and Funding Exhibits

Subcommittee Purpose

The purpose of the committee is to identify R&D priorities for North Dakota's Energy Industry and make policy recommendations that will enable R&D success.

R&D Subcommittee Process



Typical Technology development Pathway & Funding

Current Funding	None	Research Councils	Research Councils	None	None	Incentives & Loan Guarantees

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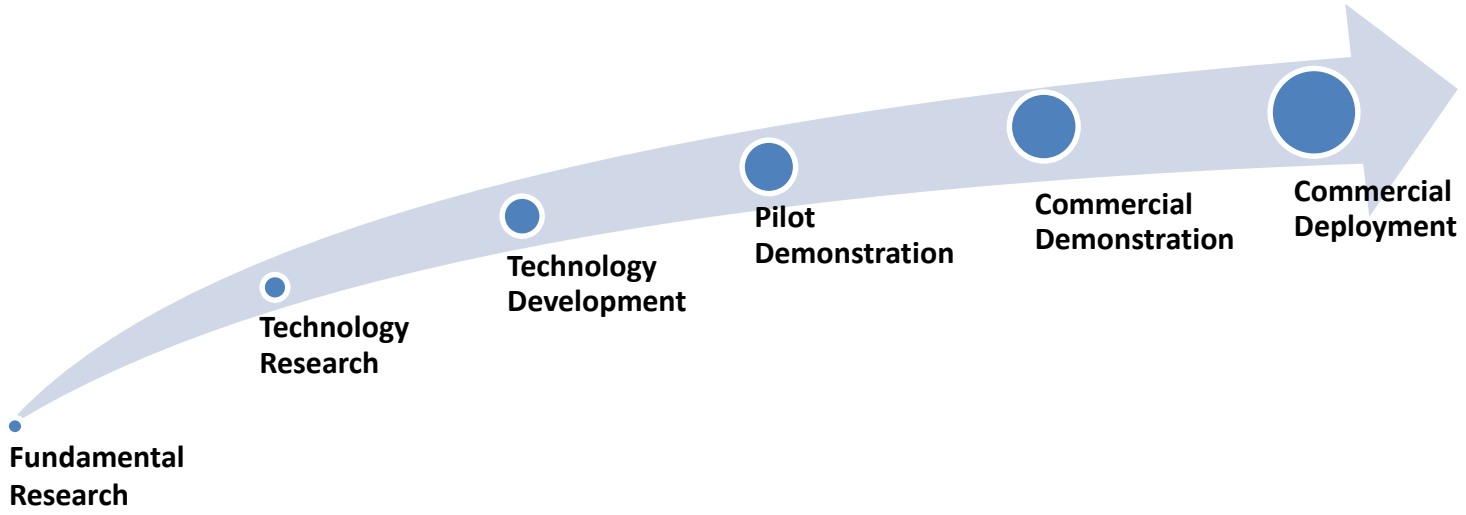


Proposed Funding	Basic Research	Research Councils	Research Councils	Advanced Technology	Advanced Technology	Tax Incentives & Loan Guarantees

ND CO2 Pathways

Key beliefs/conclusions

1) CO2 constraints are here to stay
2) ND is Uniquely positioned for CO2 constraints
   - geology, CO2 liability, supportive state leadership, industrial expertise, research capability, collaborative industry partners
3) Economics are challenged
   - Power markets not rewarding reliability
   - Retrofit CCS $60-$70/ton
4) Time Compression
   - 2022 CPP Compliance
   - 2030 4GW load growth
   - 2040 CCS technology ready
5) Preserving CO2 is strategic to ND
   - ND needs 2-3 billion tons CO2 for EOR
   - ND gets 5-7 billion barrels of additional oil
6) Need to make a technology Leap

Keys to Success

1) Maintaining state primacy

➔ Make sure ND Health Department has the resources they need

2) Communications

➔ Vision vs. Policy.

- Reframe the current message to be more positive
- The science is not proven/commercial
- Time is of the essence

ND CO2 Pathways

Vision

Next generation energy production and utilization solution for ND

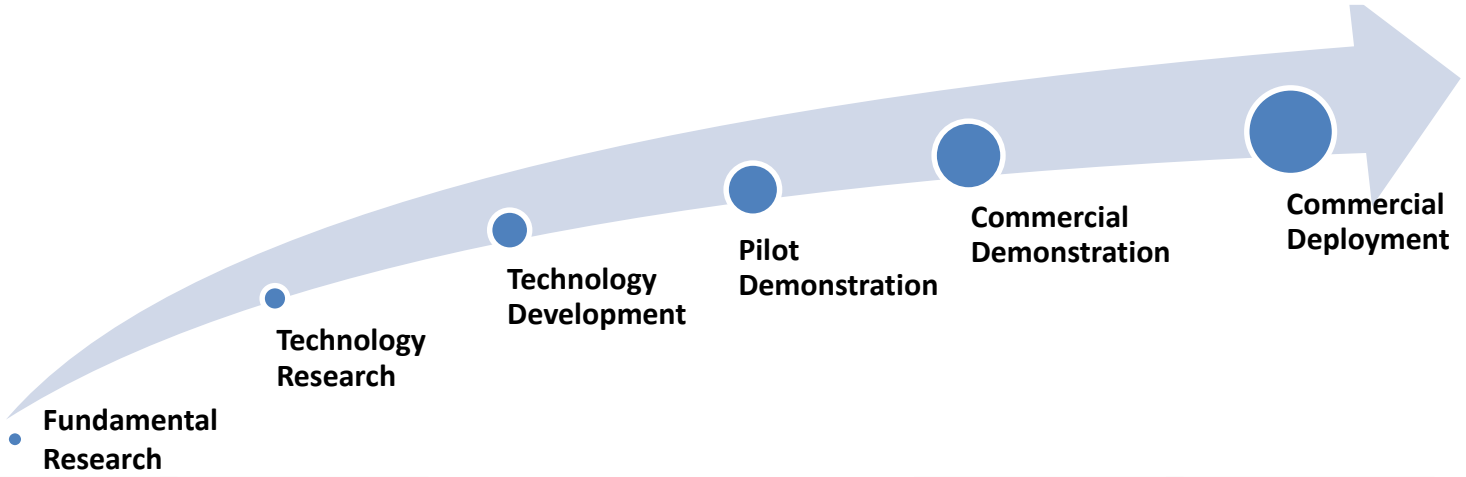
How

1) Technology Leap → develop pilot/commercial plans
   - Retrofit existing coal → Conventional EOR
   - Develop transformational technologies → Allam/Bakken EOR
2) Develop demo/pilot pathway
   - schedule and dollars
3) Define economic case
   - State and Fed support/incentives
4) Collaborate with ND Dept of Health on ND SIP goals/targets that satisfy CPP
5) Develop Communications plan

Example: Allam Cycle- Development Pathway & Funding

Timeline	Pre 2013	2014 - 2015	2015-2017	2018-2020	2020-2024	> 2025
Current Funding Mechanism	None	Lignite R&D	Lignite R&D	None	None	Lignite Vision 21
Current $ Available	$0	$8.4 million	$5.0 (one-time 2015)	None	None	$?

Draft



Estimated Allam cost	NA	$1.0 Million	$10.0 to $15 Million	$50 to $250 Million	$500 M - $1 B	$TBD
Proposed Funding	Basic Research	Lignite R&D	Lignite R&D	Advanced Technology	Advanced Technology	Lignite Vision 21
Proposed $/biennium	$ 10 million	$8.4 million		$40 million	$40 million	$?

Empower Infrastructure Subcommittee

Prioritize/Justify & Validate the Big Picture and need for strategic investment into infrastructure that builds our energy future

Consider funding options that address critical needs that grow the long-term growth of North Dakota's energy resources. Energy development and growth will not occur without the critical infrastructure in place from a private and public standpoint

Five Key Infrastructure Needs for Energy Production and Value Added Energy

1. Water Availability –
   - If North Dakota doesn't utilize it – others will!
2. Reliable Feedstock – natural gas, ethane, etc…
   - Multiple supply options
3. Electric Power – reliable and low-cost
4. Roads & Transportation Options
   - County to county connectivity @ 105.5 lbs.' along with uniform permitting and fees
5. Workforce
   - 80% of ND's Population Increase is located in nine communities
   - Skill trades education & training
   - Affordable Permanent and Temporary Housing

No Surge - what to do? Good Time for Smart & Strategic Investments

Recognizing revenues for Surge funding or energy impact funds are not likely to be available, we recommend focus on three key areas:

Funding mechanisms that allow communities leverage and financial support for Critical Community Infrastructure

1. Support Upper Great Plains plan to prioritize on economic value/2 yr. plan
2. Consider low-interest loans or tax credits buy-down costs to communities
3. Funds should be to complete existing critical need or strategic value projects
    - Upgrade and Maintenance
4. Oil Impact funds should focus on EMS

2nd of Three Key Infrastructure Issues:

Easements/Right of Ways – Landowner Concerns

- Huge Issue – no silver bullet
- Continue funding for Ombudsman Program
  - This Program Works
  - Ag Department has done a good job

3rd of Three Key Infrastructure Issues:

Clarify Jurisdictional Authority - Infrastructure Projects will not get built if applicants successfully follow a prescribed statewide process and then are subject to the project being derailed by a vocal special interests at another level of government.

Citing/Permitting/Zoning:

- *Local input and discussion are valued, but should not duplicate a state permitting process, create jurisdictional uncertainty, or delay the project once a statewide permit has been issued.*
- *The input must follow the prescribed process and preserve the due process designed for state oversight and authorization.*
- *53 sets of rules, or 300+ city rules, or 1430 township rules is a recipe for no growth, no jobs, and high taxes.*

Why Fund Infrastructure in Down Times?

- Adequate infrastructure including roads, water resources, pipelines, railroad, transmission lines and housing – is the key to future energy development of North Dakota's energy resources.

- Critical infrastructure not only promotes development it minimizes development impacts and enhances public safety.

- More bang for a buck!

Power market update
Current, forecast & modeling

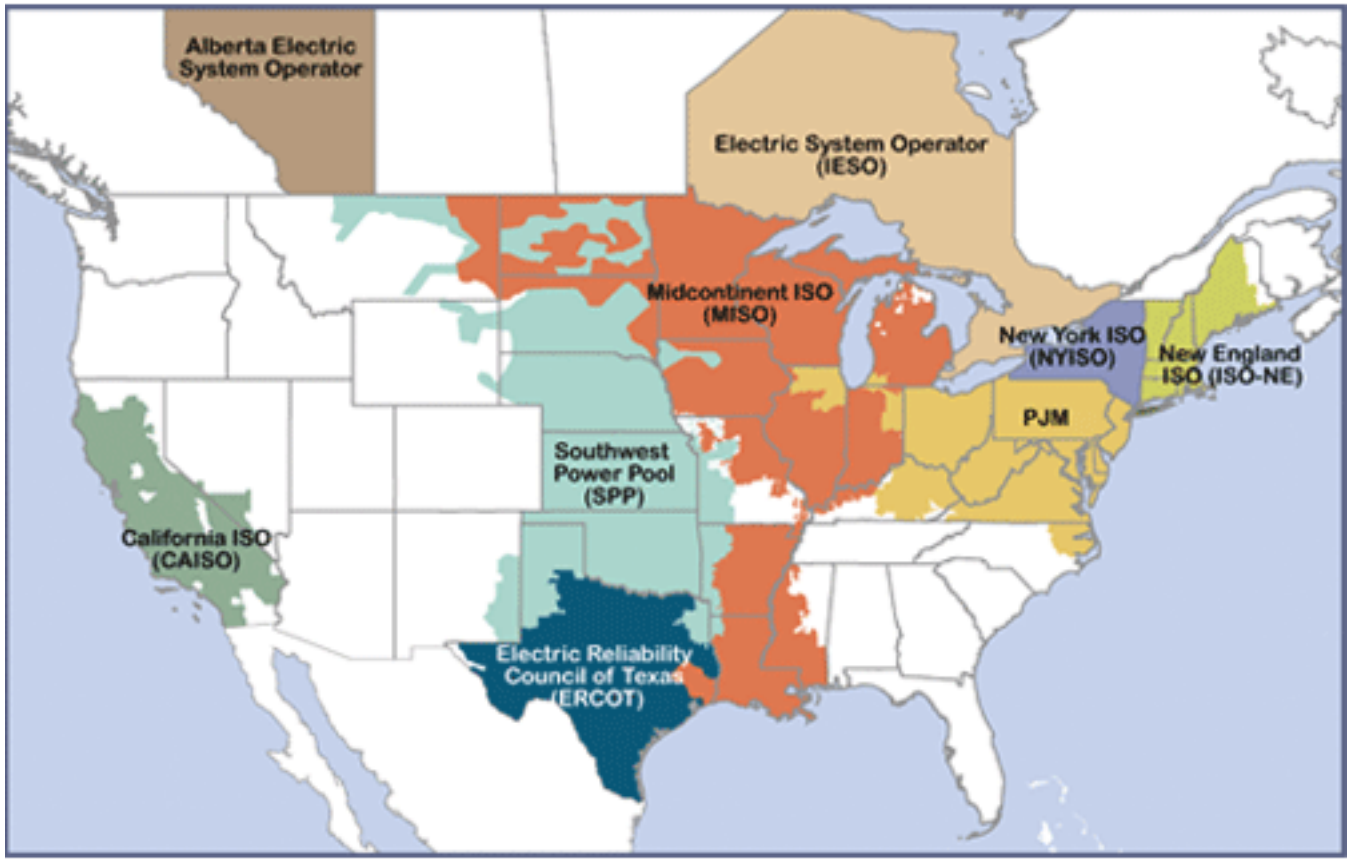
April 2016

John Weeda

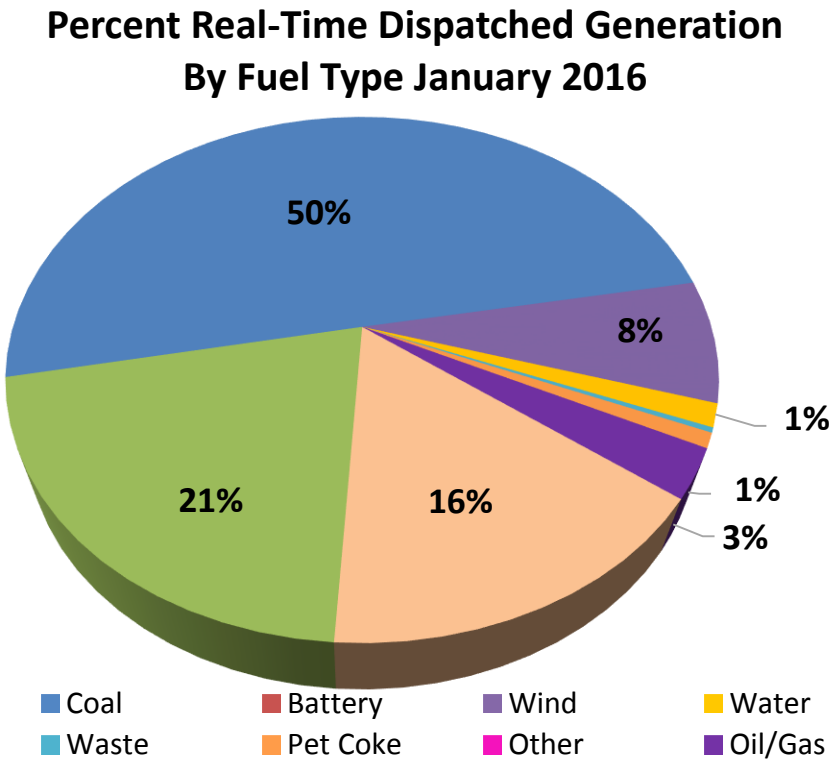
Presentation content acknowledgement

- This information is compiled from various sources acknowledged on the slides

Independent system operators



January 2016 MISO generation mix



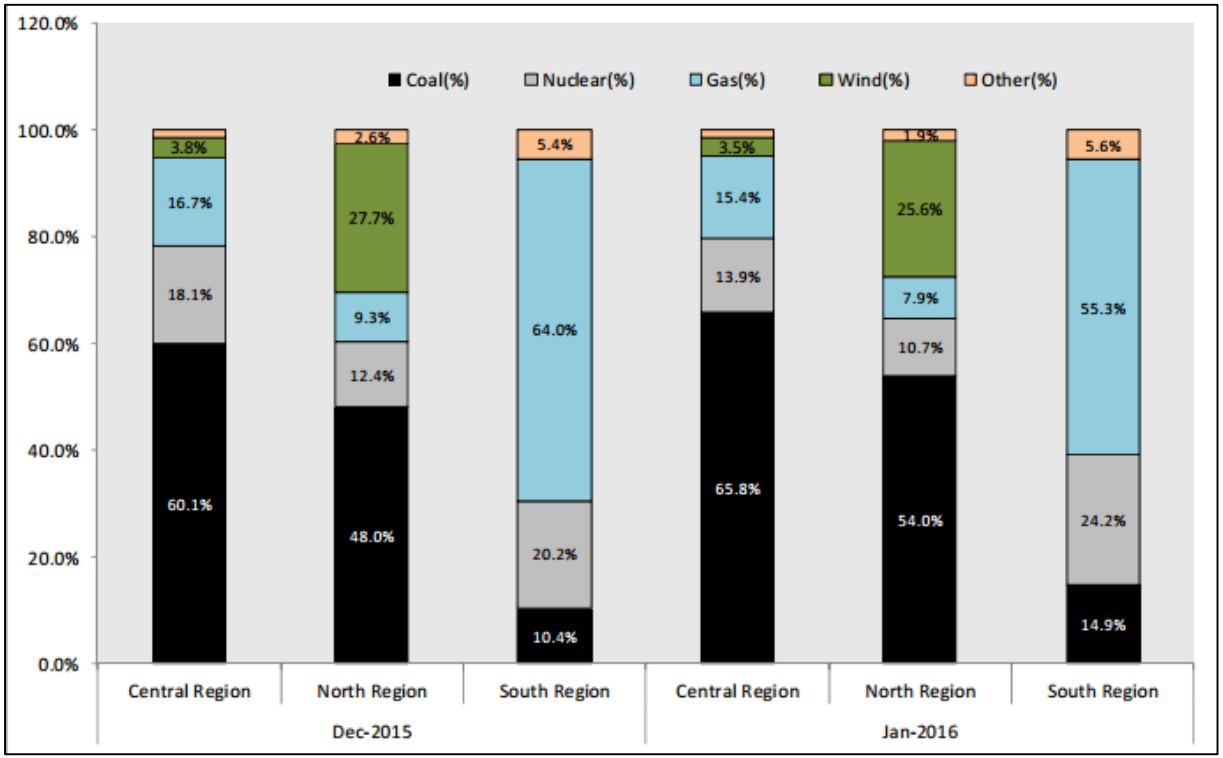
	Total		
Fuel	**16-Jan**	**15-Dec**	**Change**
Coal	50.1%	45.7%	4.4%
Gas	20.9%	22.5%	(1.6%)
Hydro	1.4%	1.5%	(0.1%)
Nuclear	15.8%	17.3%	(1.4%)
Oil/Gas	3.0%	3.6%	(0.5%)
Wind	7.5%	8.3%	(0.8%)
Other…	1.2%	1.1%	(0.1%)
Total	100.0%	100.0%	

Milder January in 2016

Source: MISO Market Analysis

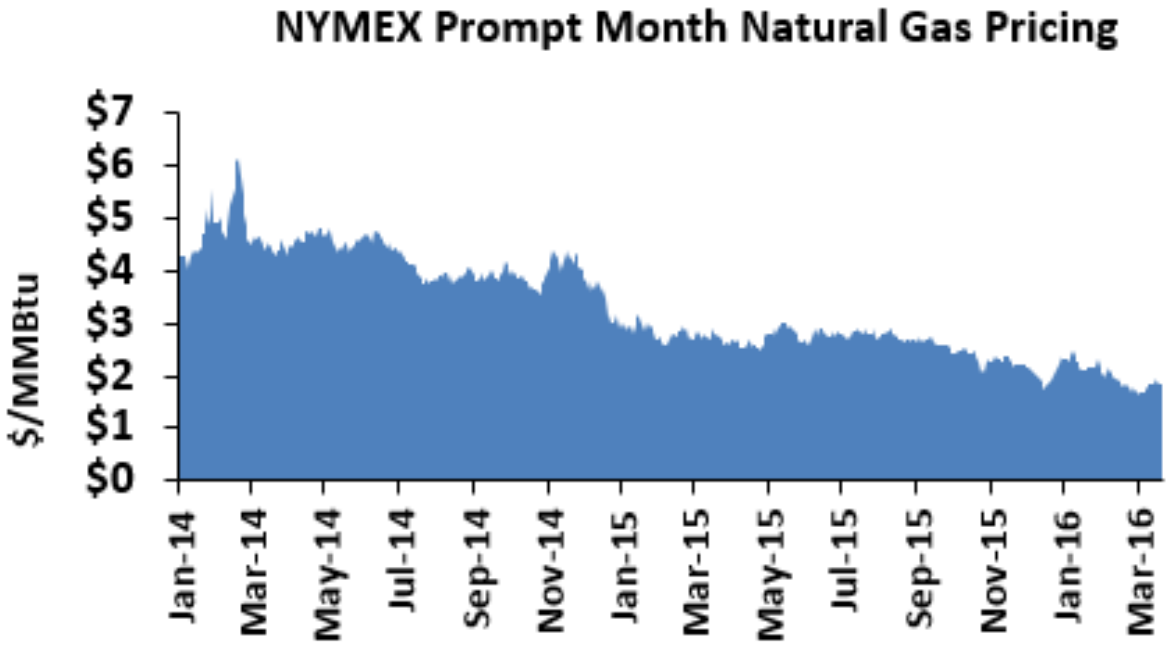
Generation mix by region

- Wind and coal still dominate the generation mix in the North Region



Source: MISO Market Analysis

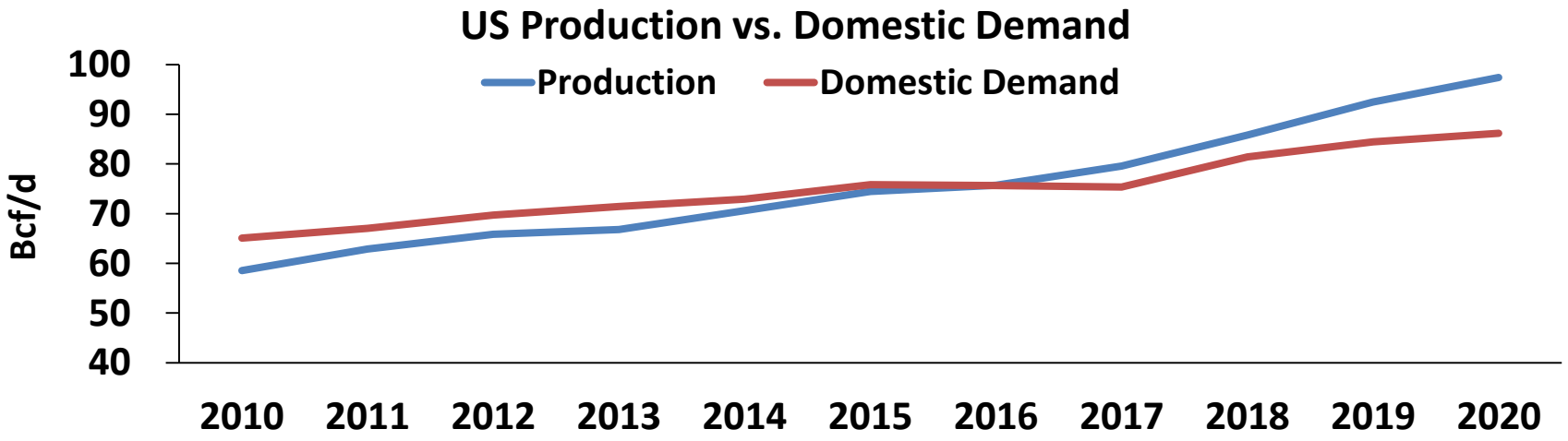
Natural gas pricing



- U.S. gas glut has provided downward pressure
- Pricing has declined ~70% since polar vortex
- 17-year low hit in early March

Source: U.S. Energy Information Administration

U.S. “long” gas in 2016

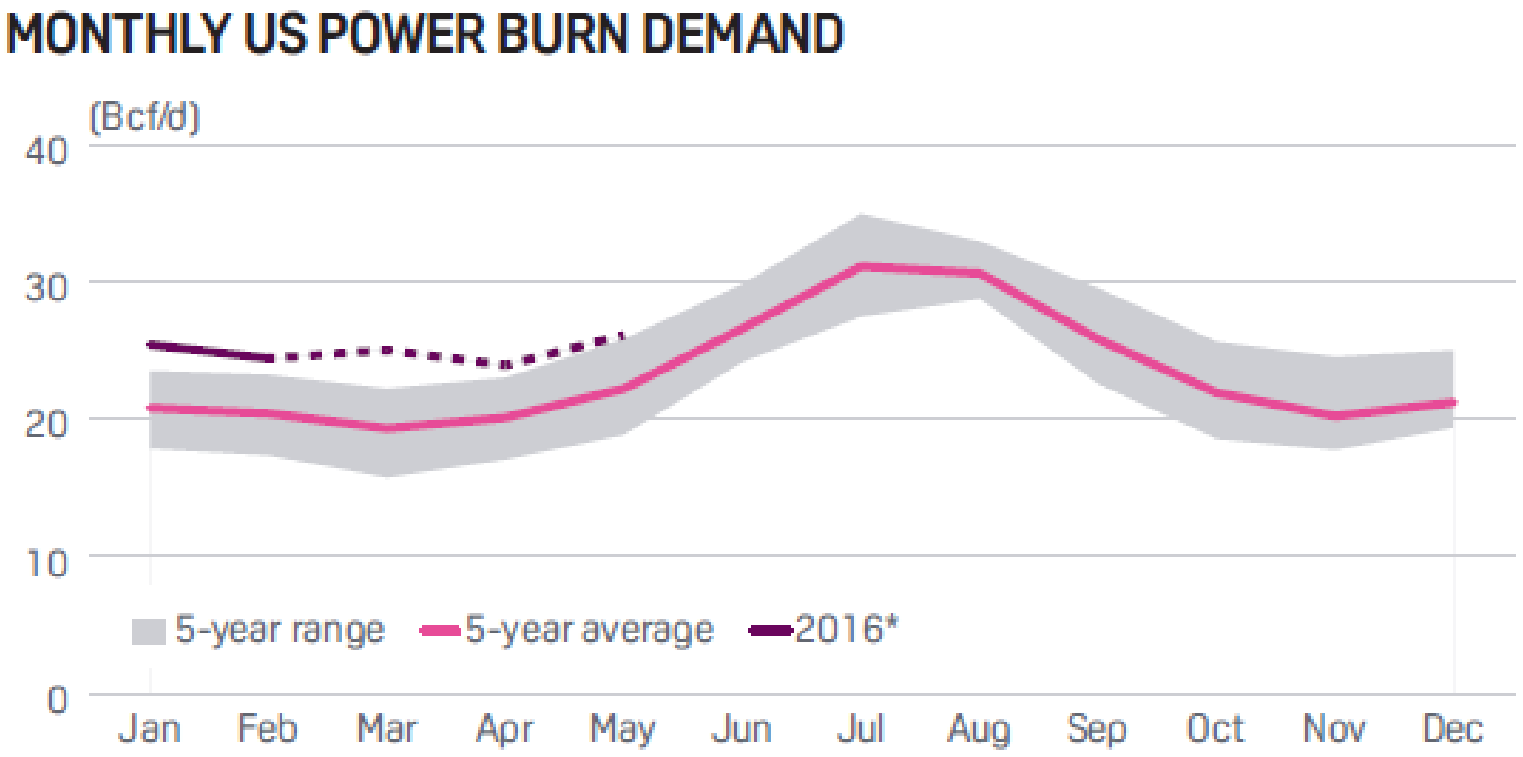


- U.S. “long” domestically after 2016
- Production remains strong despite low prices
- Lack of 2016 winter demand and efficiency increases help temper overall demand over next two years

Source: Wood Mackenzie

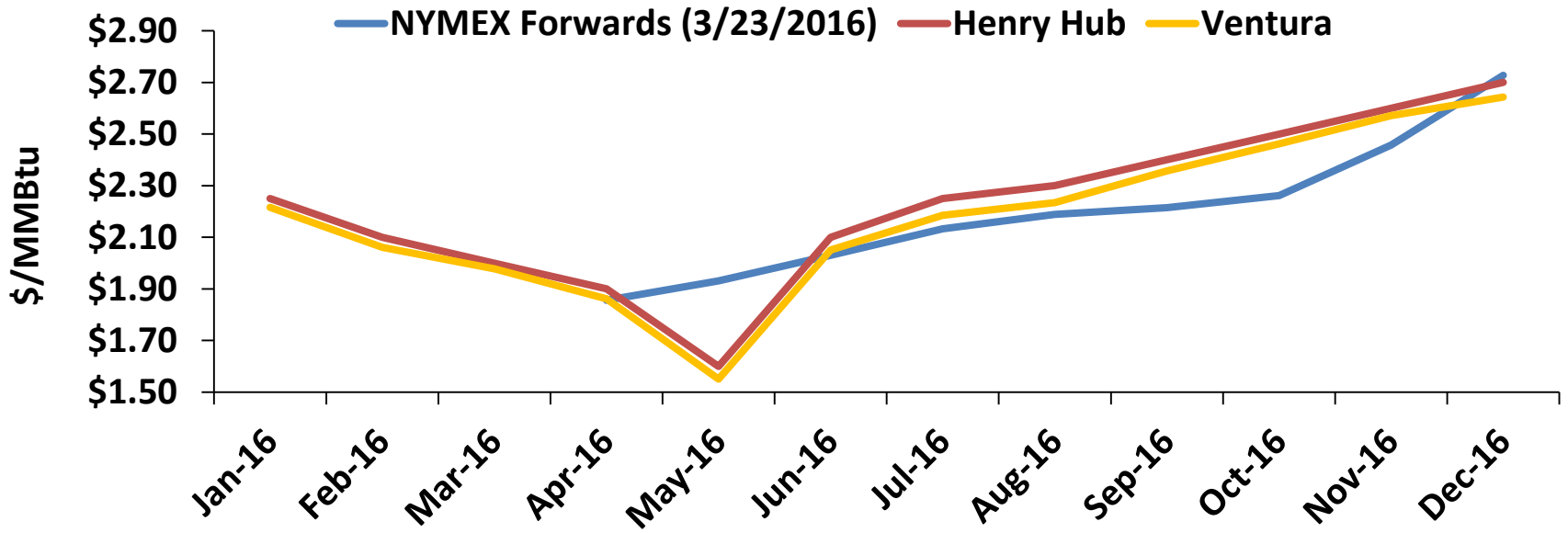
Power burn

- Natural gas power burn continues to outpace prior years



Source: ***Megawatt Daily***

Price outlook

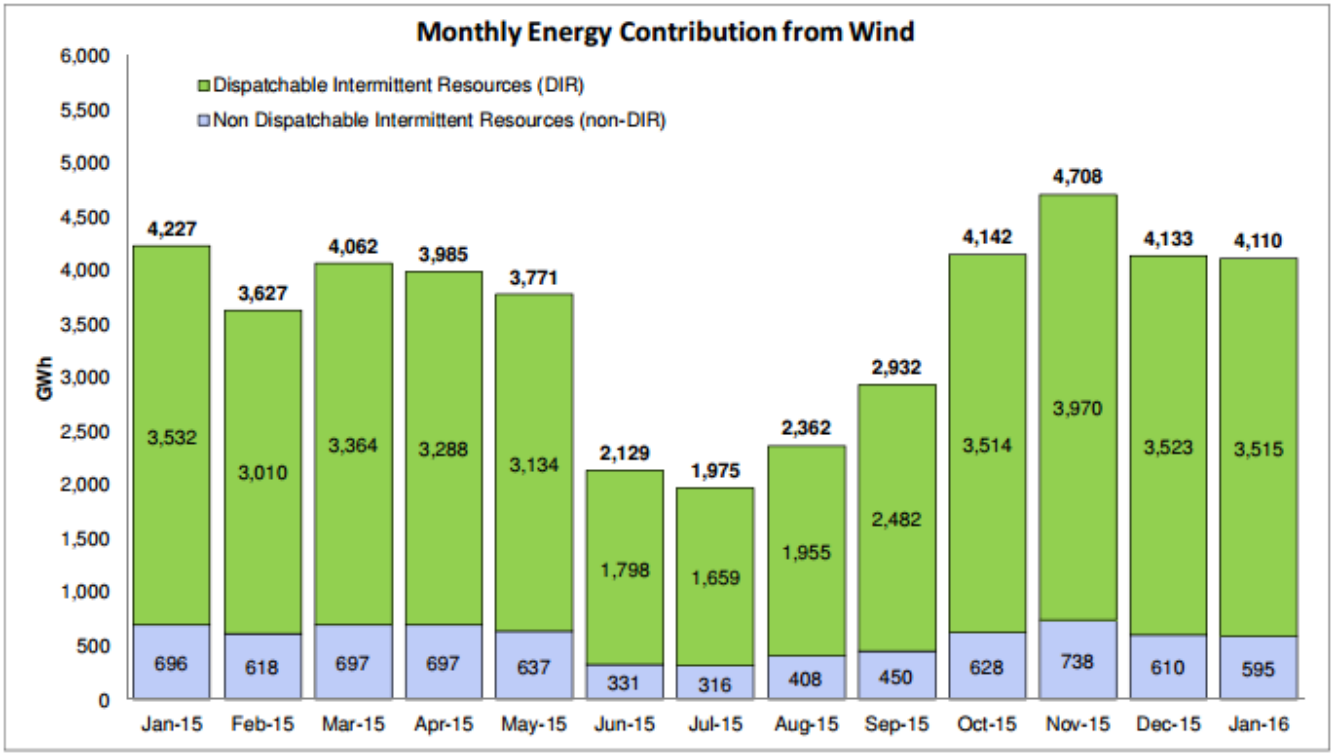


- Spring presents large downside opportunity
- Summer La Niña?
- Demand growth in summer/potential production slump creates possible rally late in 2016

Source: ACES/NYMEX

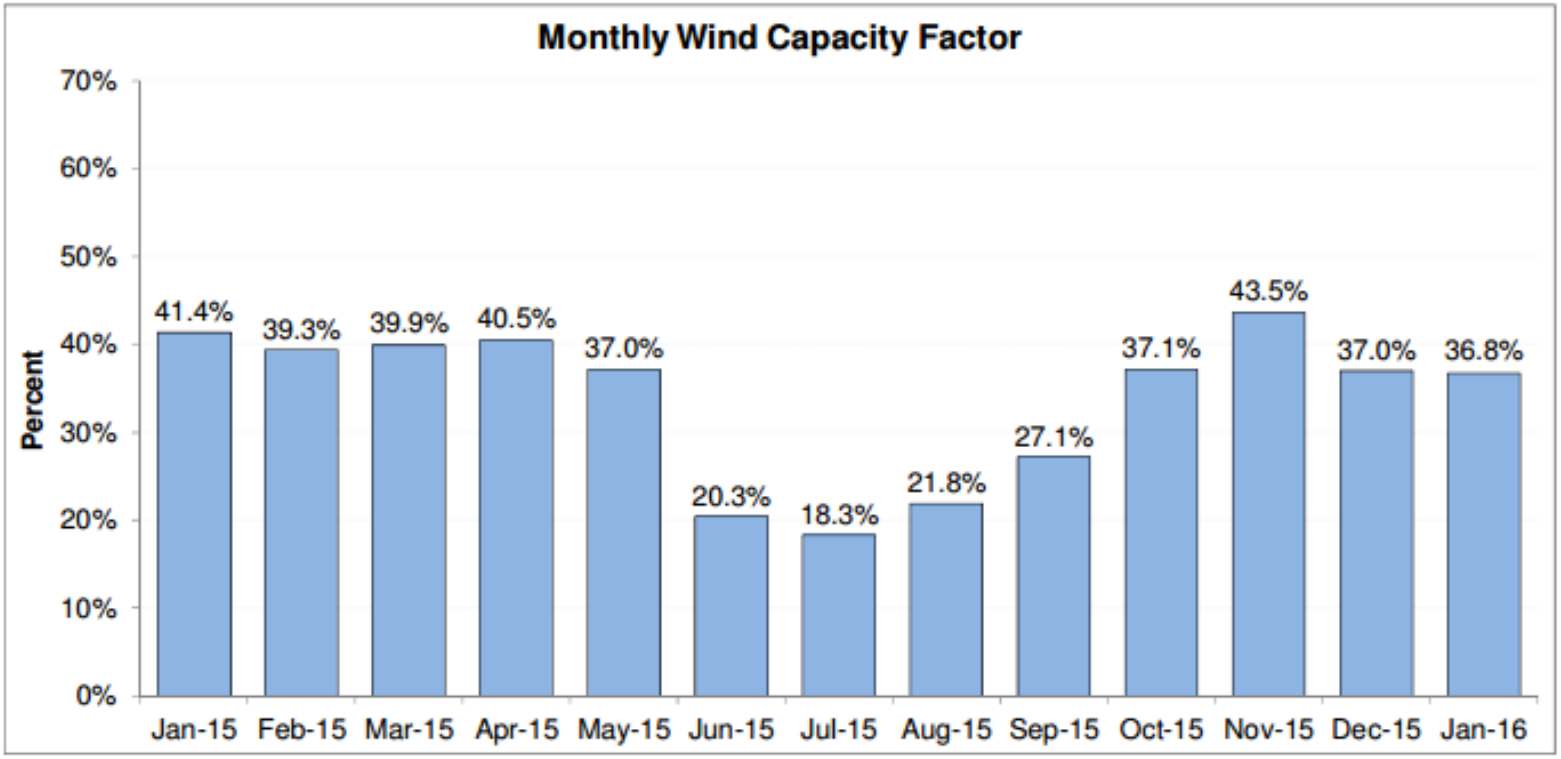
MISO monthly wind production

- Wind continues to be a dominant factor in late 2015 and early 2016



Source: MISO Market Analysis

MISO monthly wind capacity factor

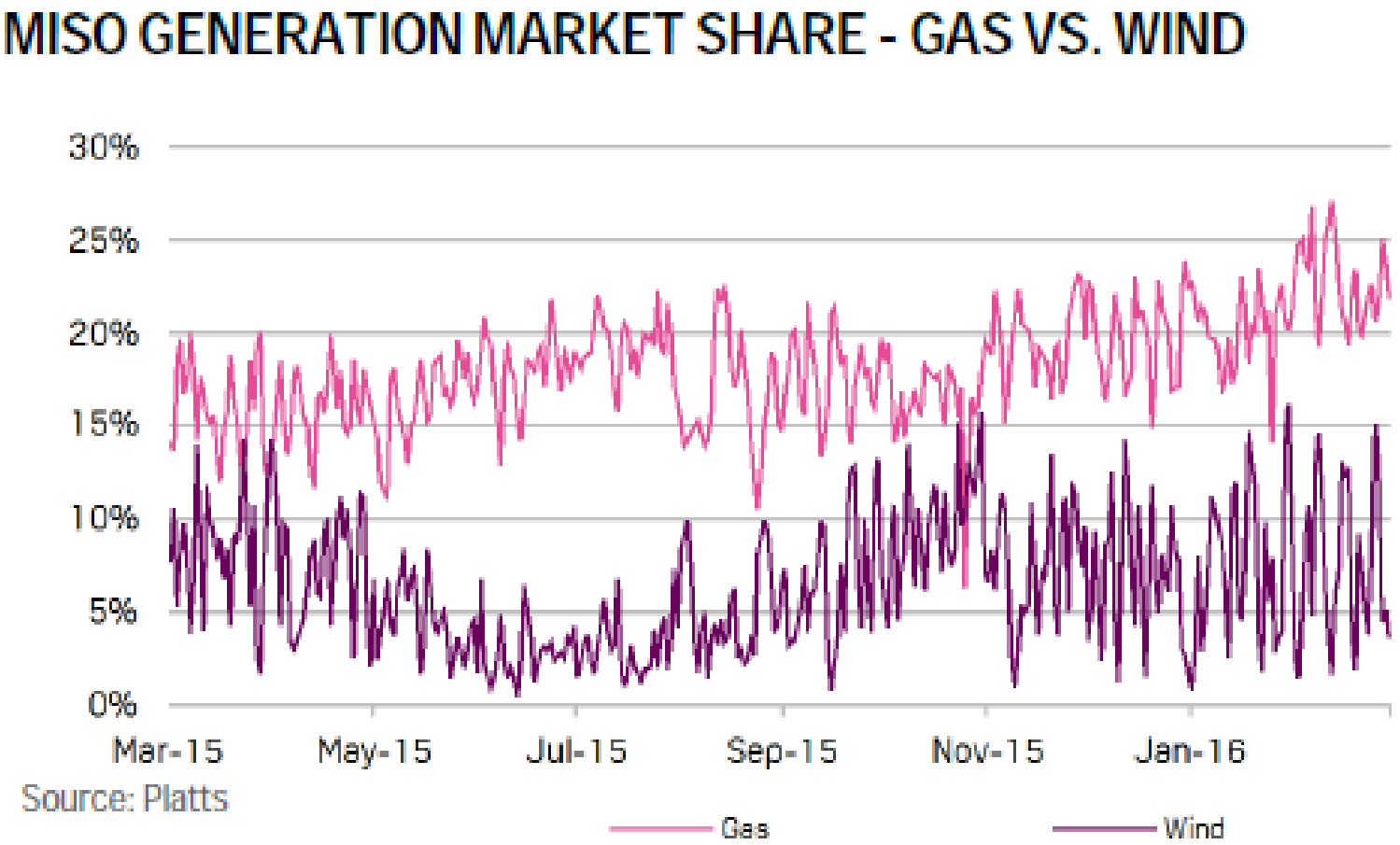


** Wind Capacity factor is calculated by taking the average of hourly actual wind generation divided by registered capacity.*

- Total registered wind capacity was 15,029 MW in January 2016. The wind capacity factor decreased to 36.8% this month.

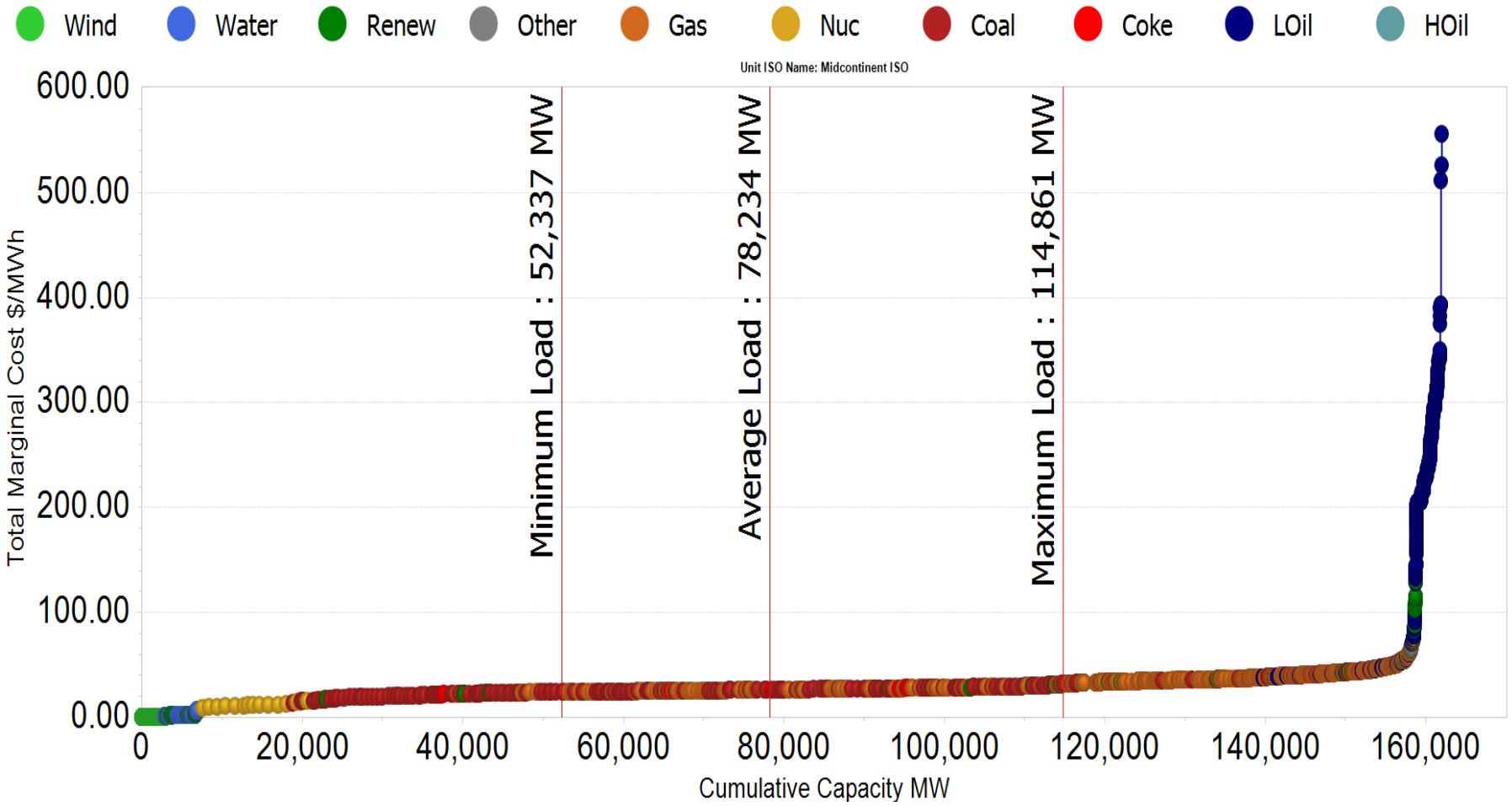
Source: MISO Market Analysis

Gas vs. wind generation



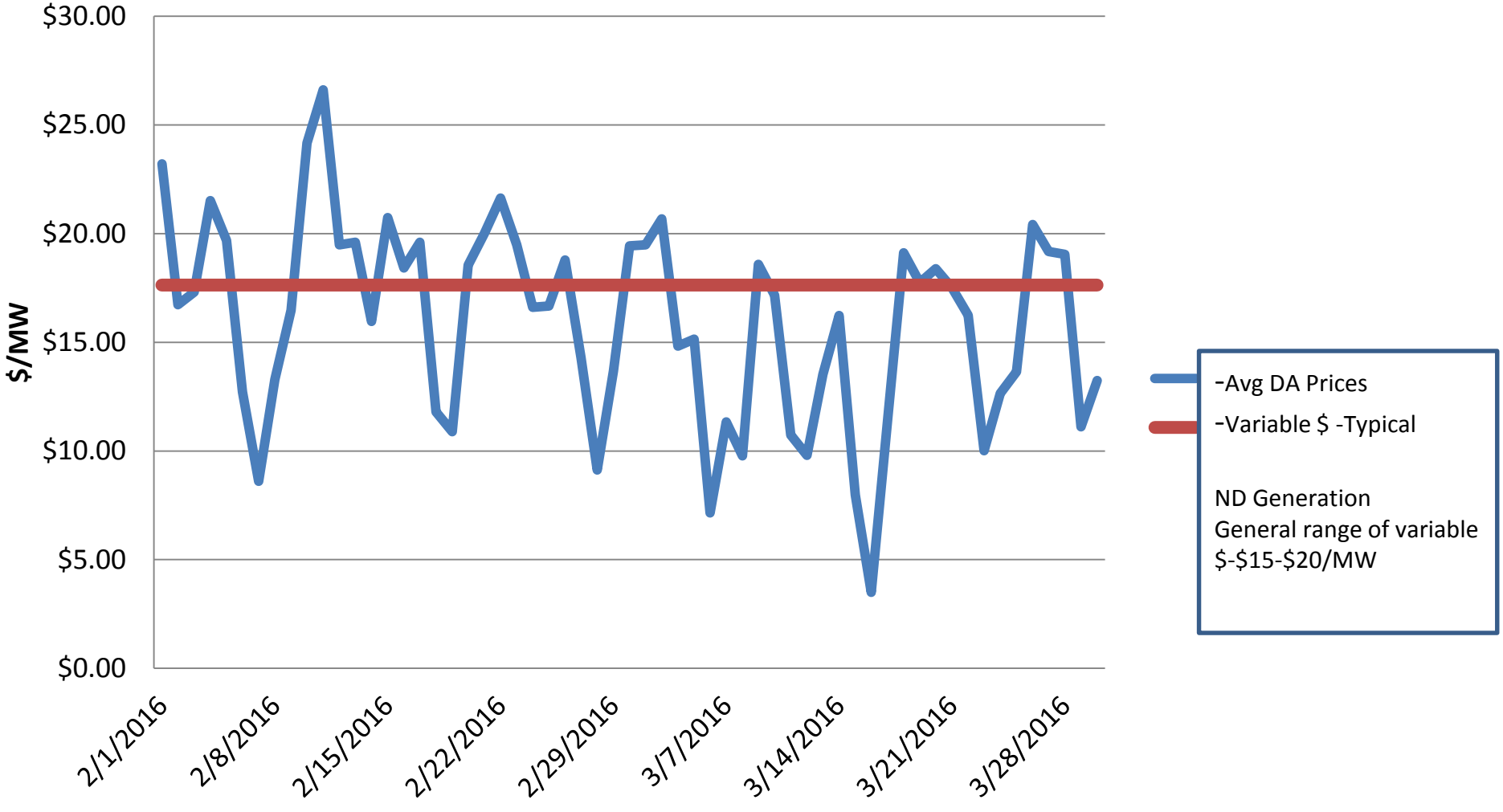
Source: ***Megawatt Daily***

MISO supply curve



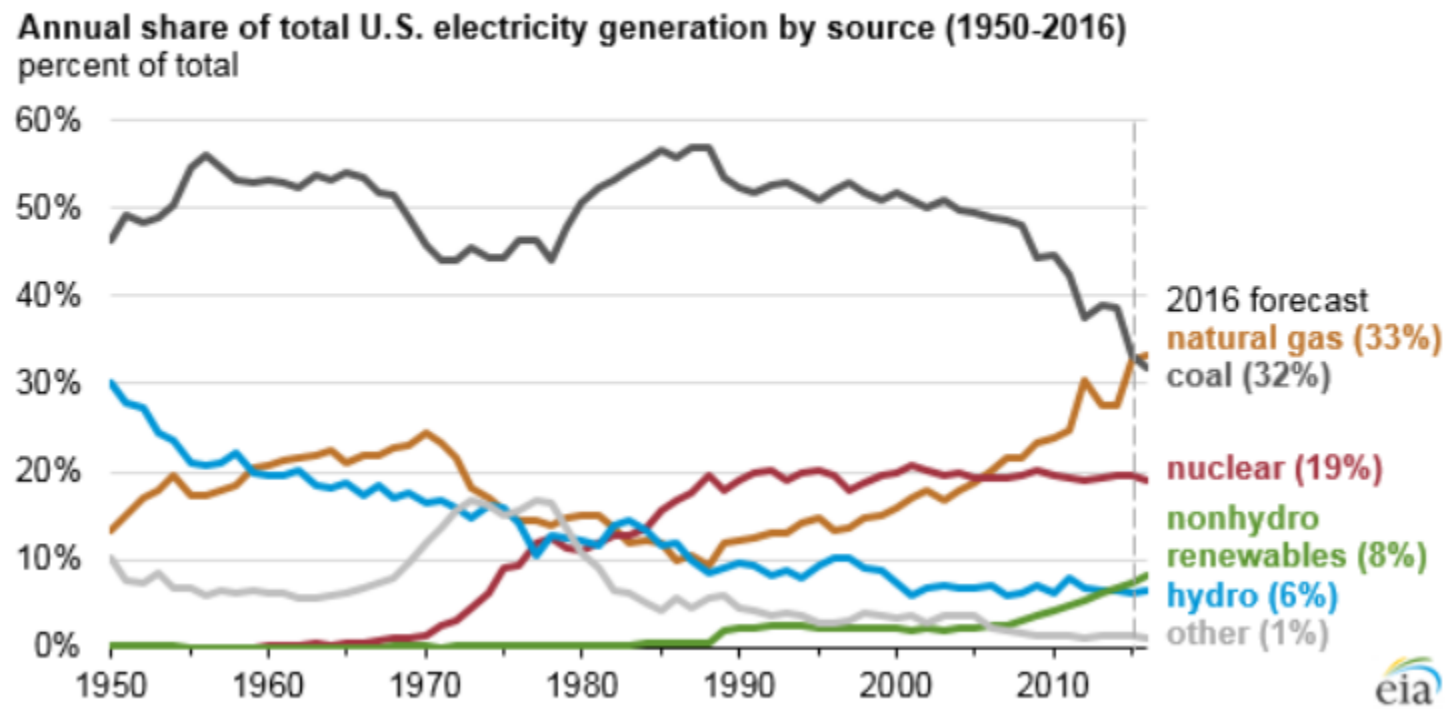
Source: Ventyx Velocity Suite

ND Coal Generation cost vs. prices



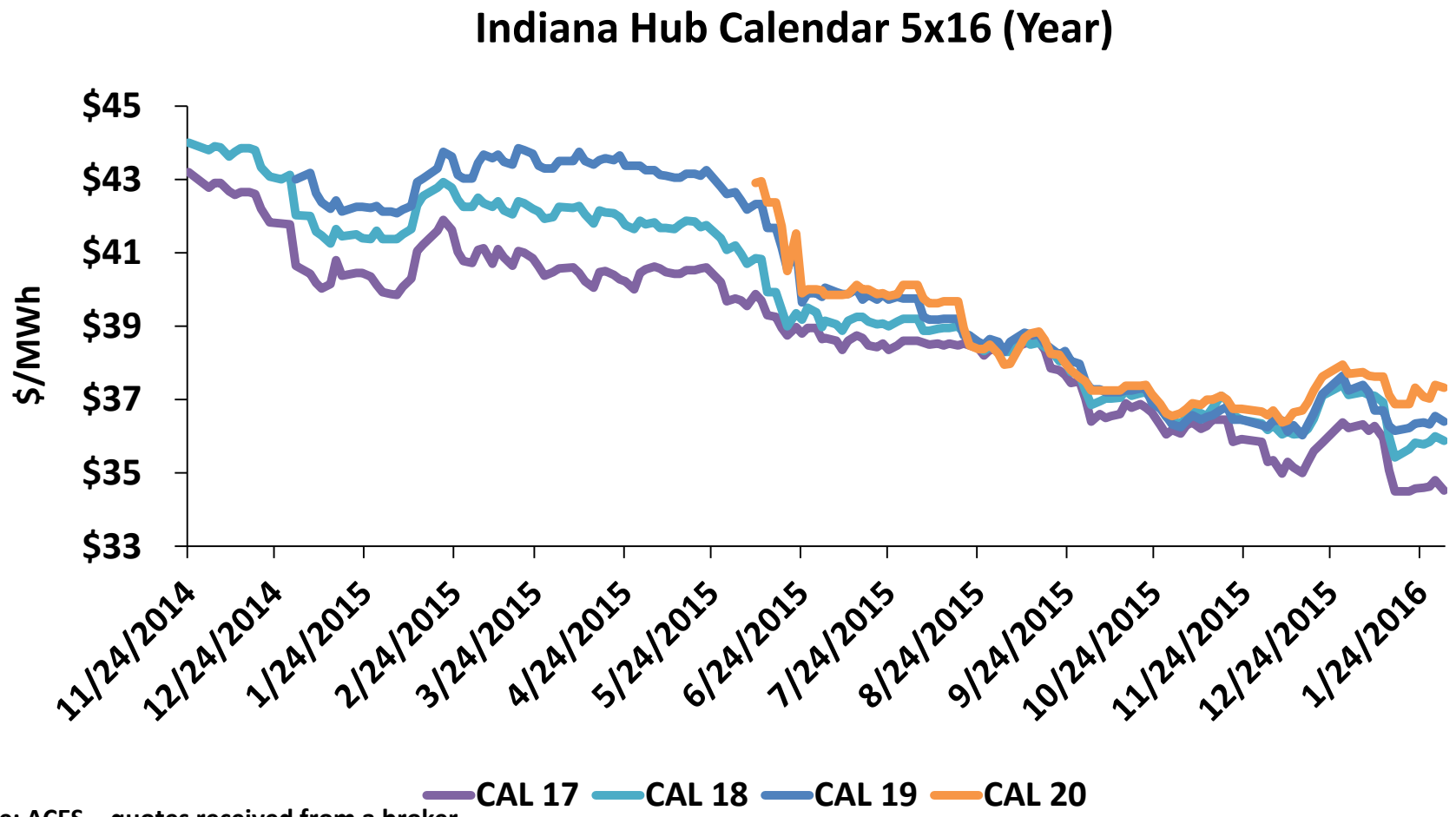
Generation share by type

Natural gas expected to surpass coal in mix of fuel used for U.S. power generation in 2016



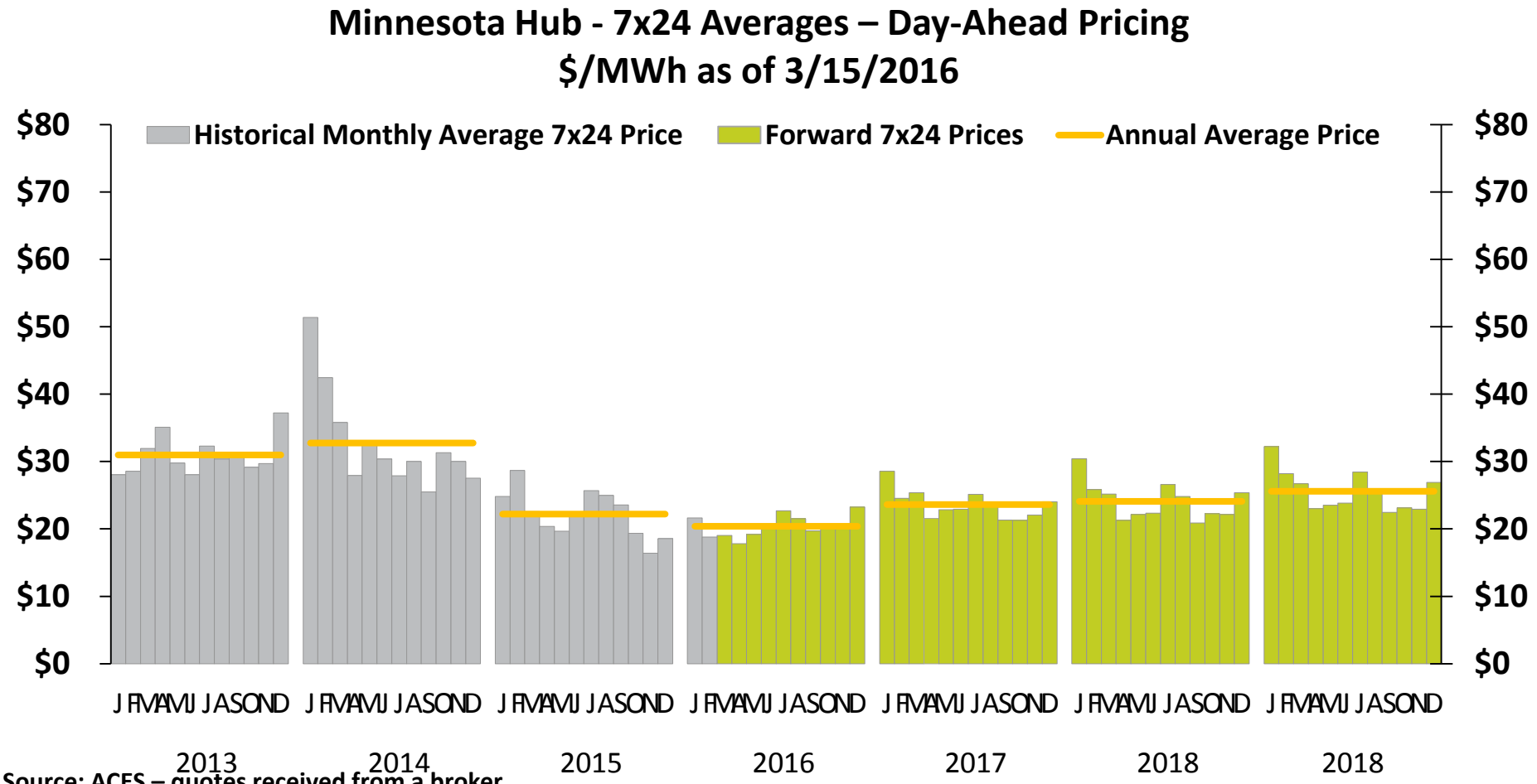
Source: U.S. Energy Information Administration, *Monthly Energy Review*, and *Short-Term Energy Outlook* (March 2016)

Indiana Hub calendar year prices



Source: ACES – quotes received from a broker

Forward price outlook



Source: ACES – quotes received from a broker

Changing mission of baseload (coal) power plants

- Previous mission – Maximize output and reliability
  - Coal plants were low-cost, reliable sources of round-the-clock electricity
- New mission – Respond appropriately to market price signals
  - Wind power and low-cost natural gas exclude baseload from round-the-clock economic viability
  - Baseload plants are still needed, but only during higher-priced periods, especially winter and summer
  - Baseload plants must respond to the new economic reality

Example impact on running plant capacity factors (%)