The Future of Unconventional Natural Gas Resources
A New Path Forward

Center For Energy Economics
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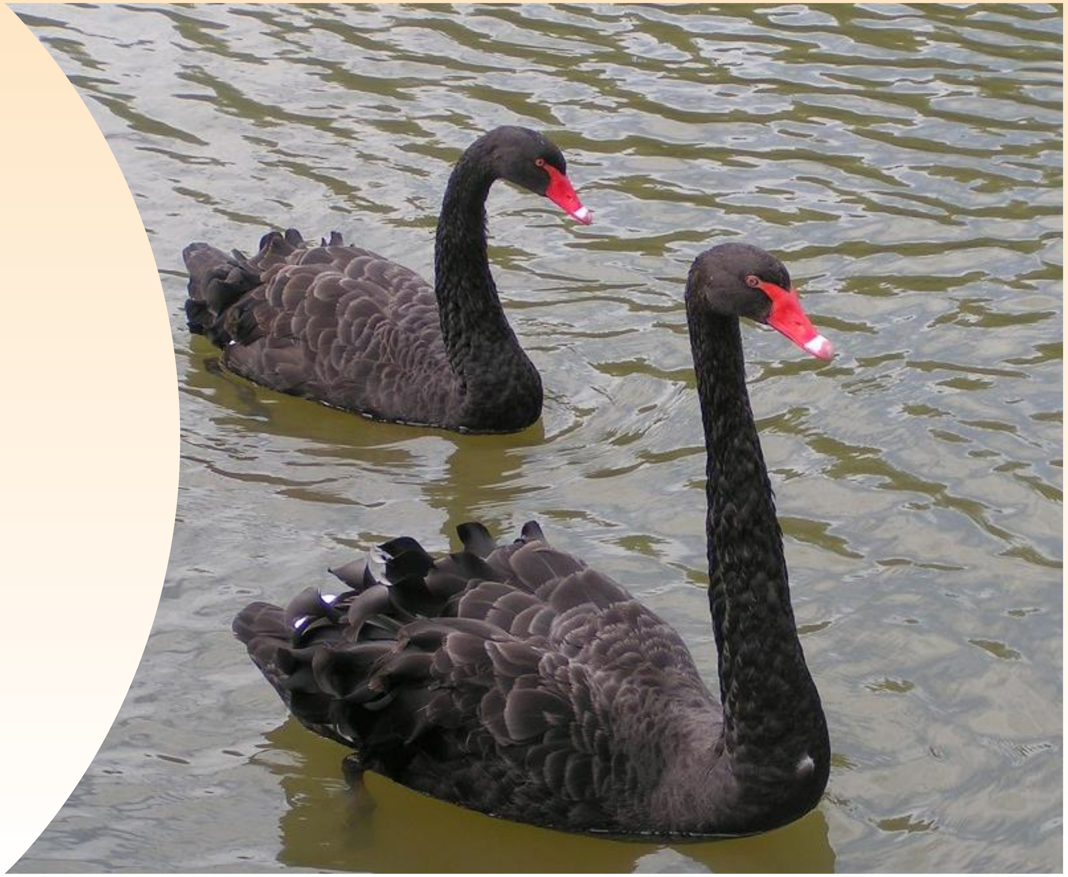
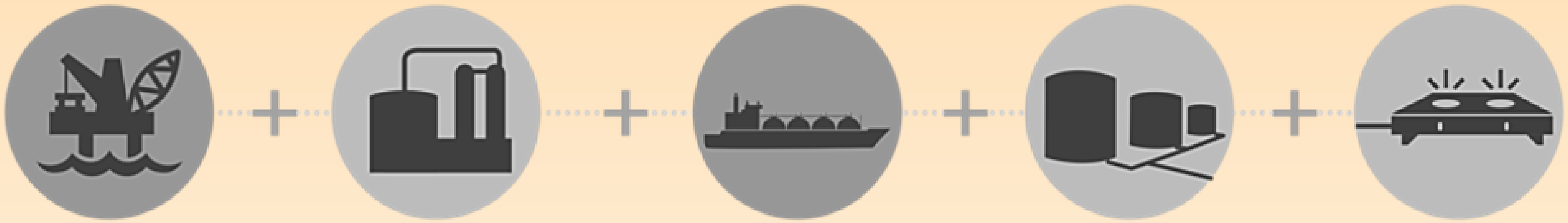
What just happened?



- Global economic lockdown sparked by the COVID-19 pandemic
- Oil price drop, from battle for market share between the world’s largest oil producers

What Impacts on the gas value chain?



Upstream

- Oil Price and Upstream production

Midstream

- Infrastructure connectivity
- Prices and basis

Downstream

- Market growth
- Demand seasonality

Workflow of Natural Gas Market Simulators

Model Inputs

(TORA) Bottom-up resource evaluation

Customized assumptions to focus on specific projects or markets

Supply Builder

Infrastructure Builder

Demand Builder

North America – GPCM

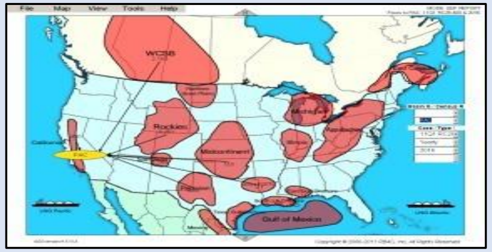
- 245 Pipelines
- +440 Storage areas
- LNG Exports / Imports
- 100 Market Points)
- Import and Exports
- NGL production included and infrastructure extensions
- Gas to power generation demand interface (fuel-switching capacity additions)

Global Gas Market – G2M2

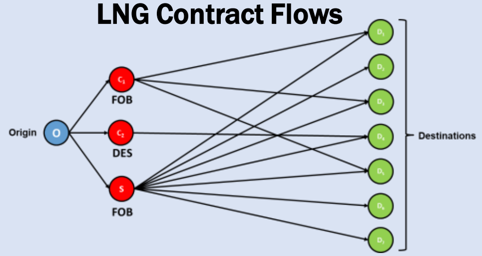
- Sectoral(5) Demand of 100+ countries
- LNG Contracts and Infrastructure
- Pipeline (400+) and Storage (600+)

Demand and Supply Balance

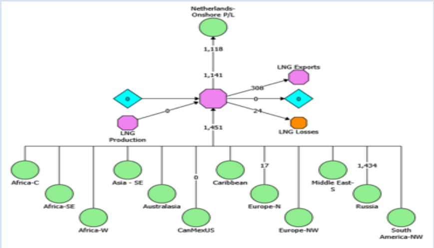
Supply Flows



LNG Contract Flows



Graphic Display of Flows



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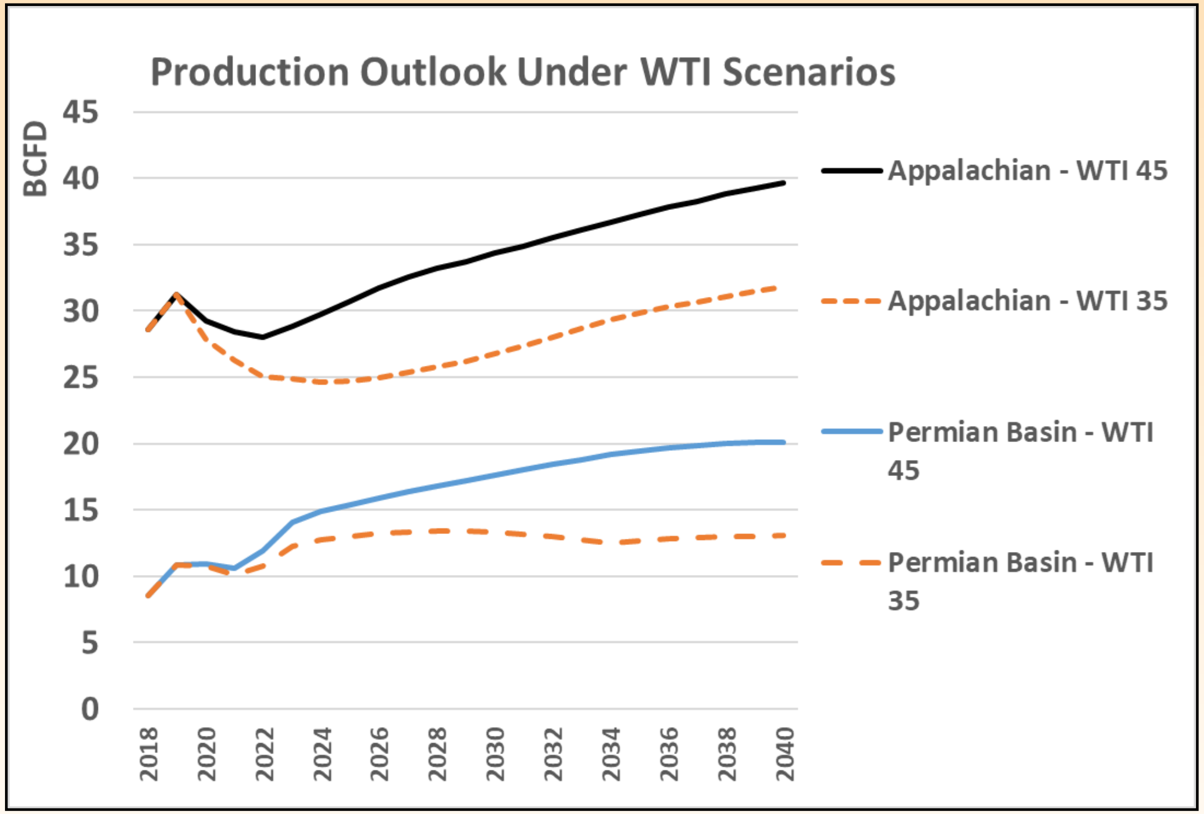
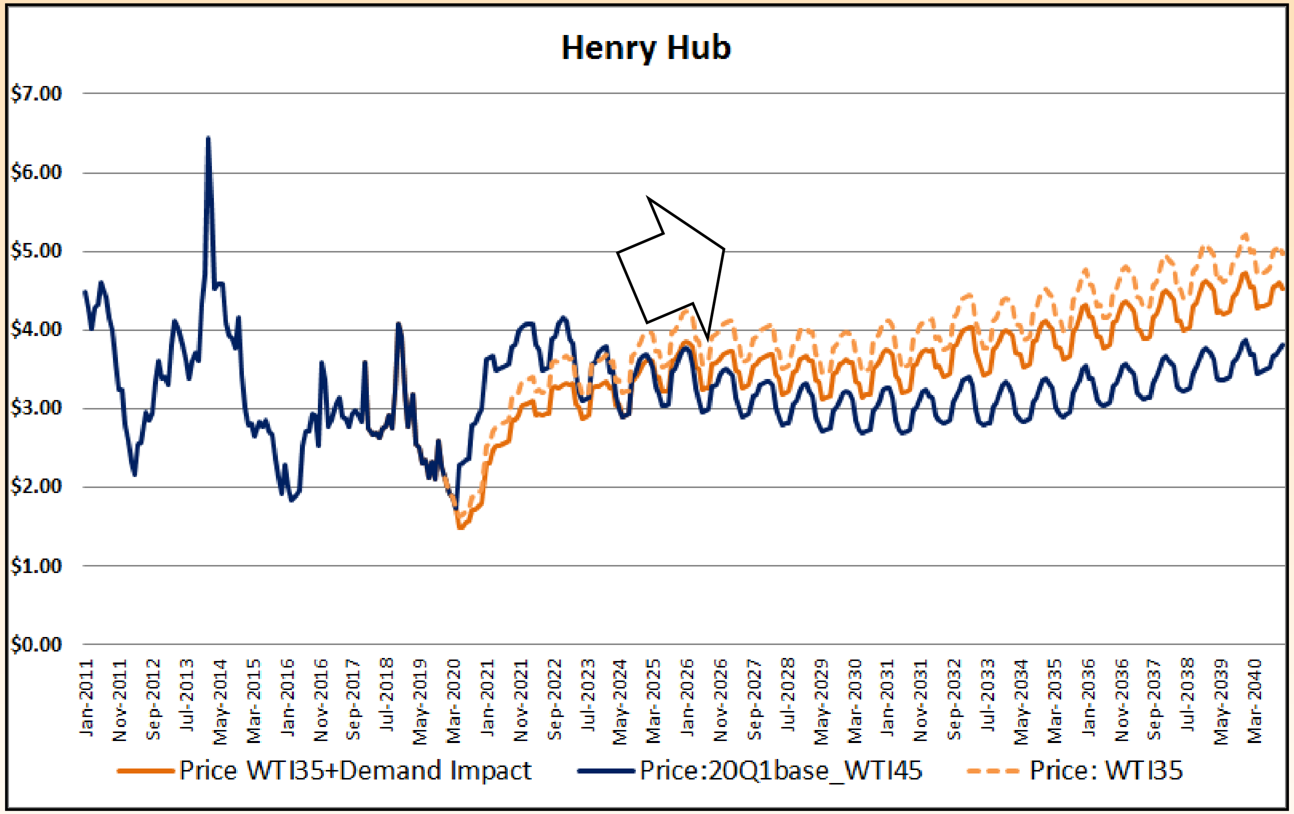
Courtesy of RBAC, Inc.

Oil Price Still Matters: Moving The Needle





- With lower oil price, like $35/bbl, in the long term, it would reduce about 25% of production in both Appalachian and Permian, about 16 BCF/d less gas by 2040.
- With low and sustained oil price, demand sectors will contract at varying degree.
- Net impact of low price of oil would raise HH to balance the market in 3 years.

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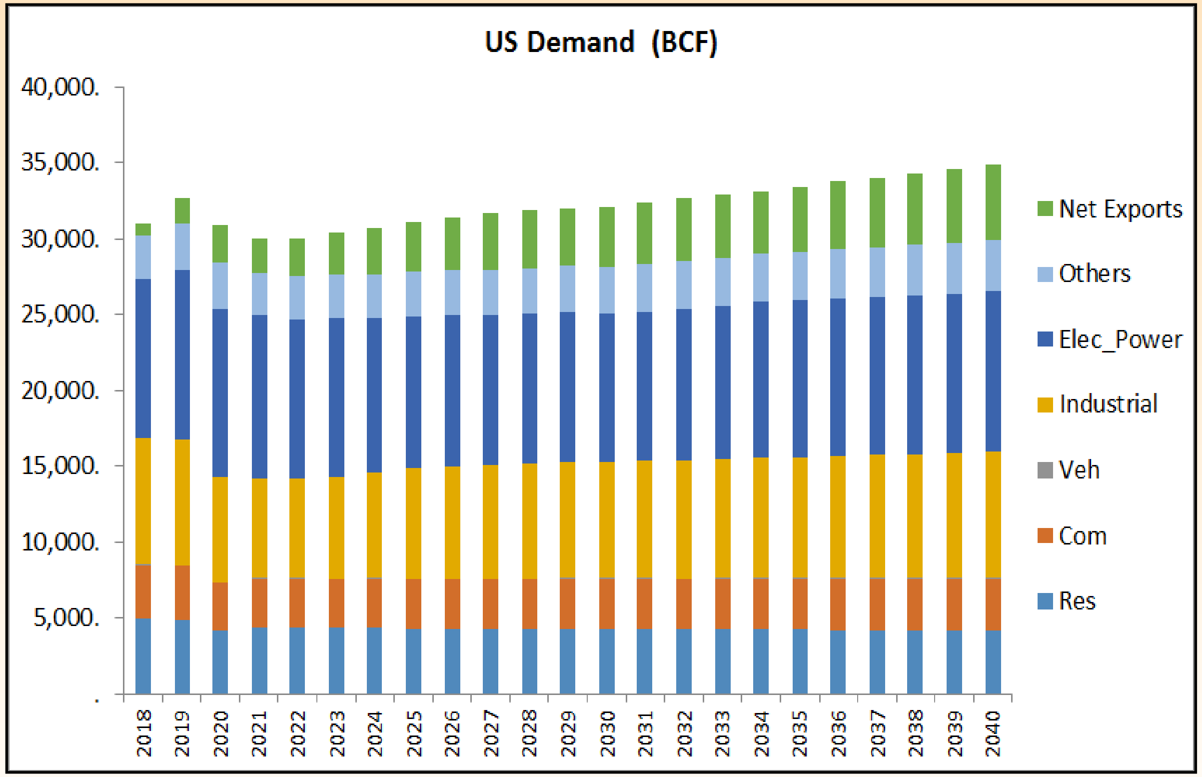
US Demand Overview 2018-2040

- Short Term: decline in electric and industrial sectors, as well as LNG exports for year 2020.

- Long Term:
  - US Natural Gas Demand is stable going forward, with largest demand segments being electric generation and industrial use.
  - LNG exports has the highest growth rate, growing from around 2 BCFD in 2020 at 4% annual growth rate for next decade.



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Appalachian Basin

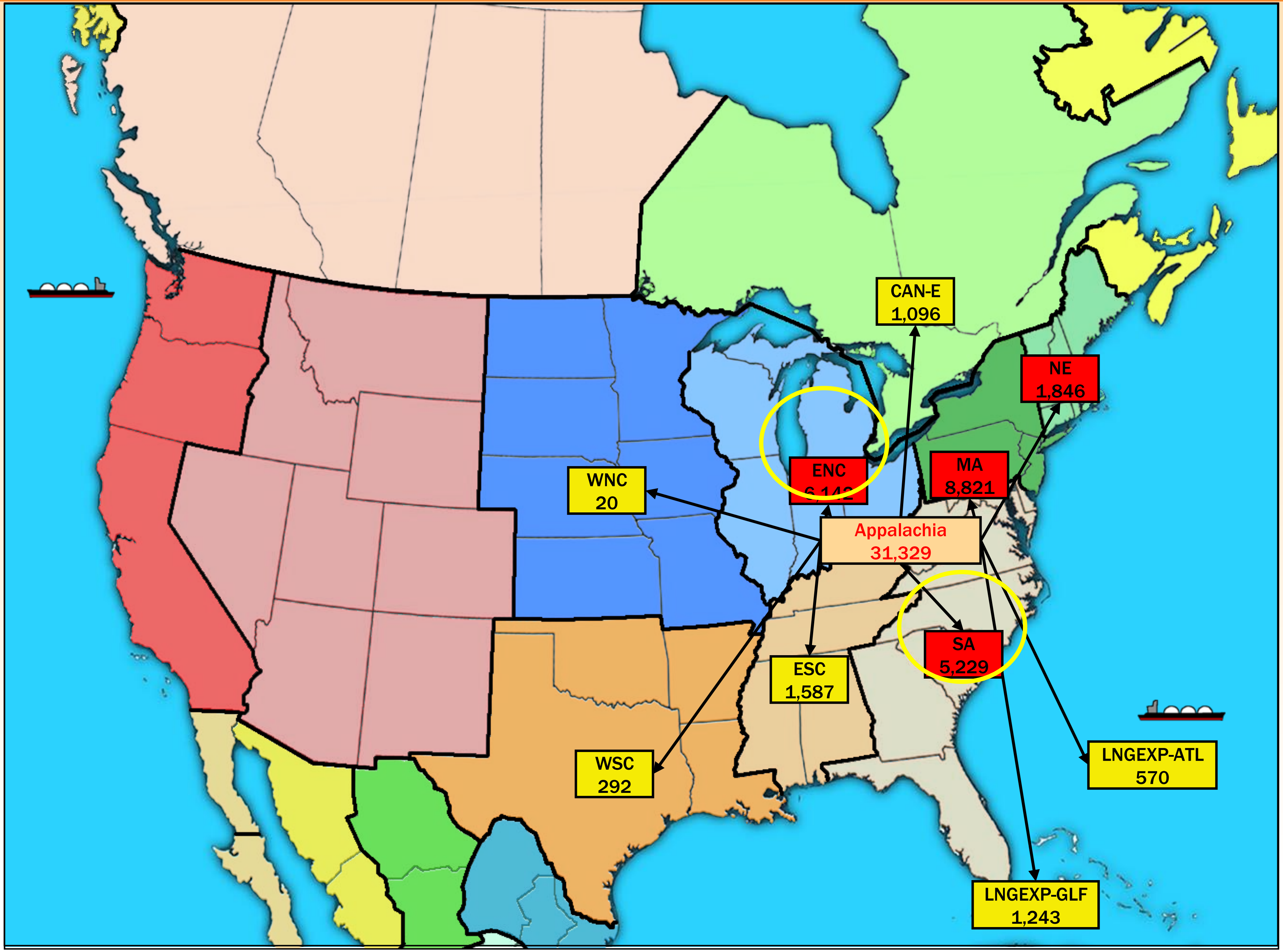
Extreme Seasonal Swing of Demand

Opportunity for Demand for gas fired generation

Will Challenges in infrastructure return?

Demand for Appalachia

- 2/3 of gas from Appalachia serves Middle Atlantic, New England, East North Central and South Atlantic.



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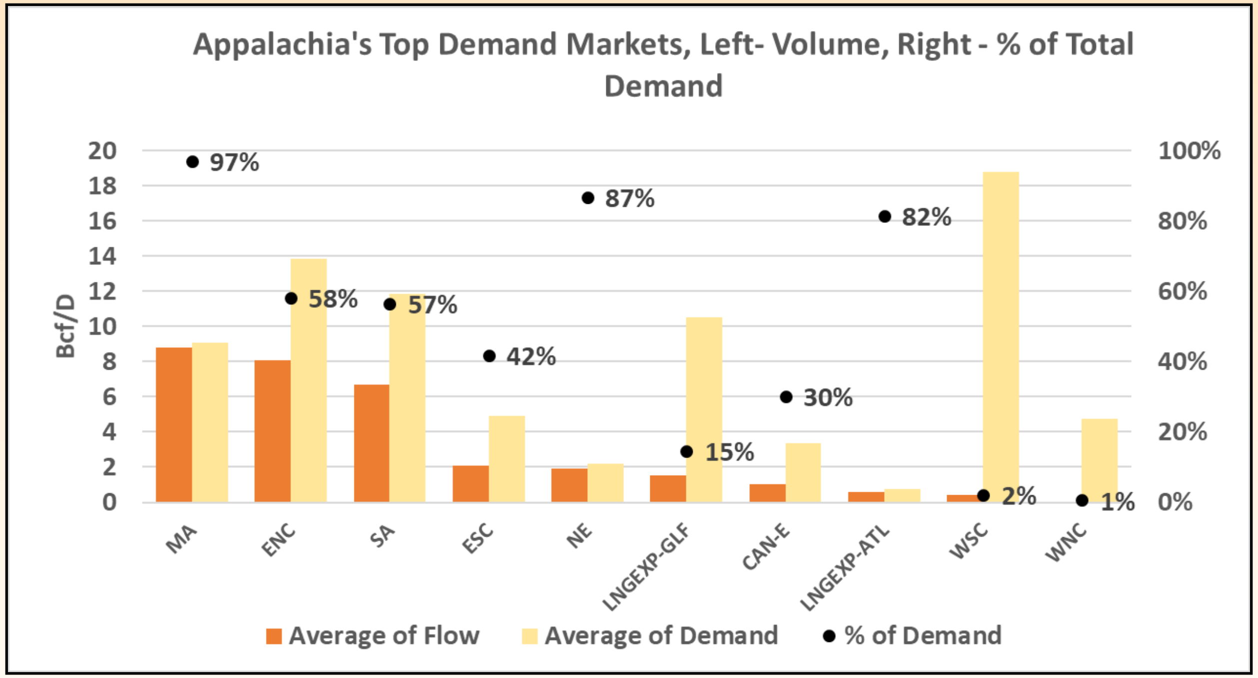
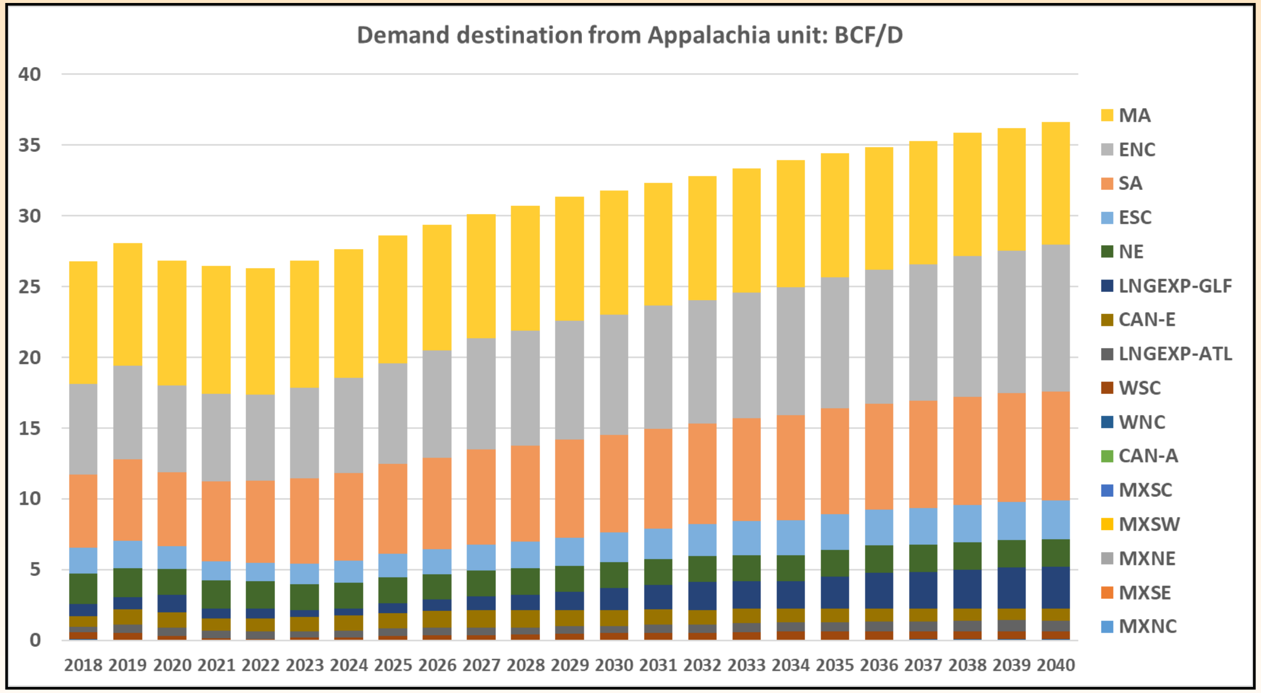
Appalachian Downstream Destinations: Saturated Northeast and Fast Growing Midcontinent markets





- for most NE markets, new England and Middle Atlantic, 97% and 87% of the market would be served by Appalachian for next 20 years, however, there is almost no growth in demand forward.
- The fast growth market for Appalachian would be South Atlantic and East North central, that would take all incremental production (11 Bcfd).

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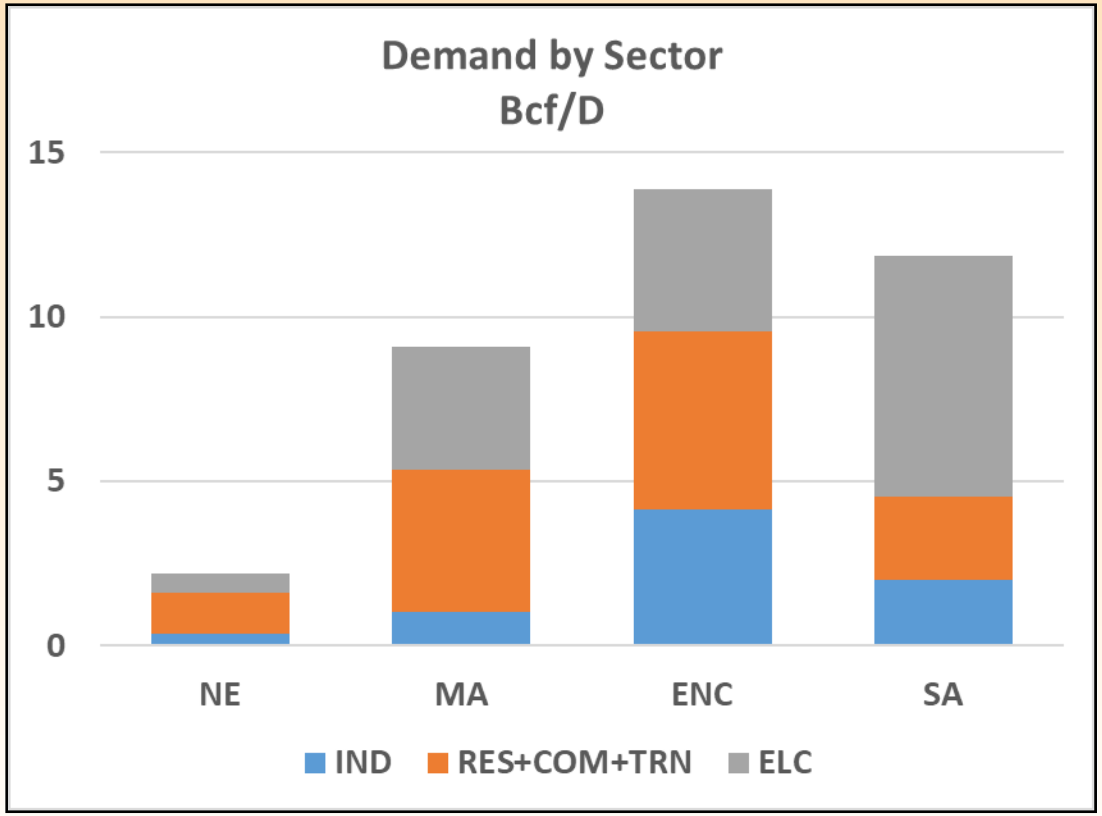
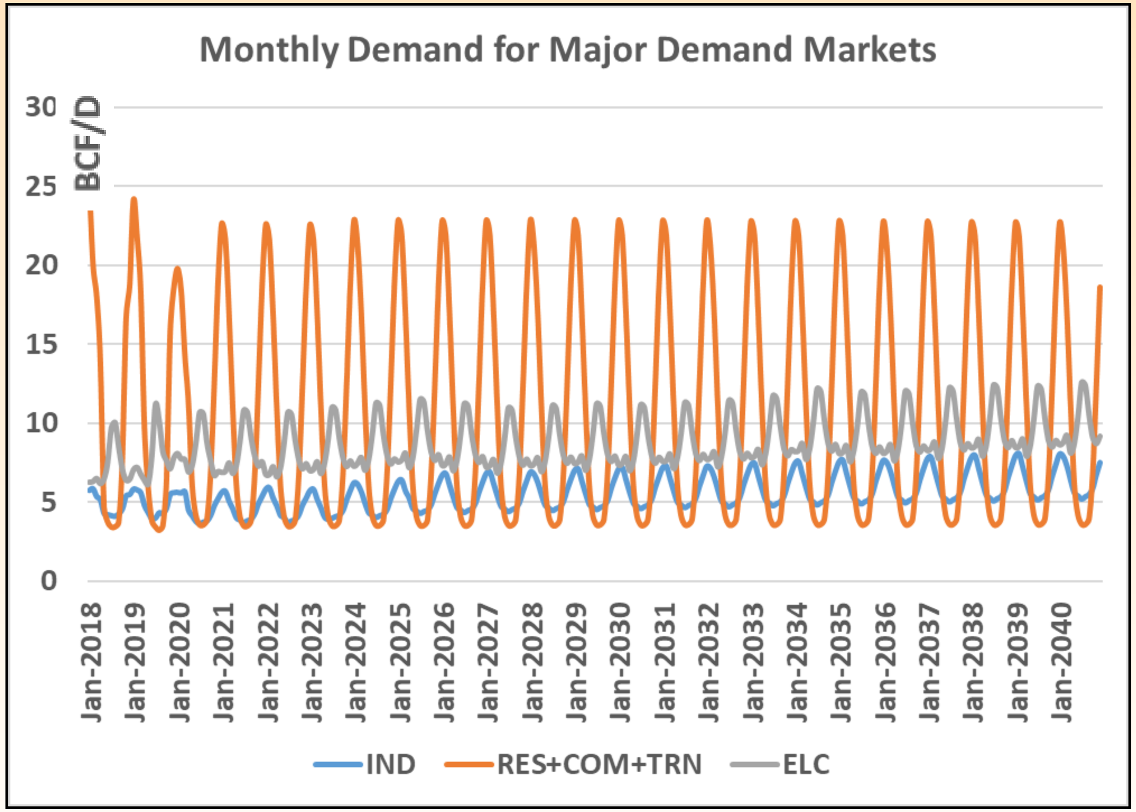
Appalachian Demand Destination: Extreme Winter Peaks and Fuel Switching





- For major markets for Appalachia gas, space heating demand and power generation takes about 75% of the total demand.

- Seasonality swings for space heating could be about 4-5 times from peak to tough.
- It provides extremely volatile price responses when there are transportation constraints.

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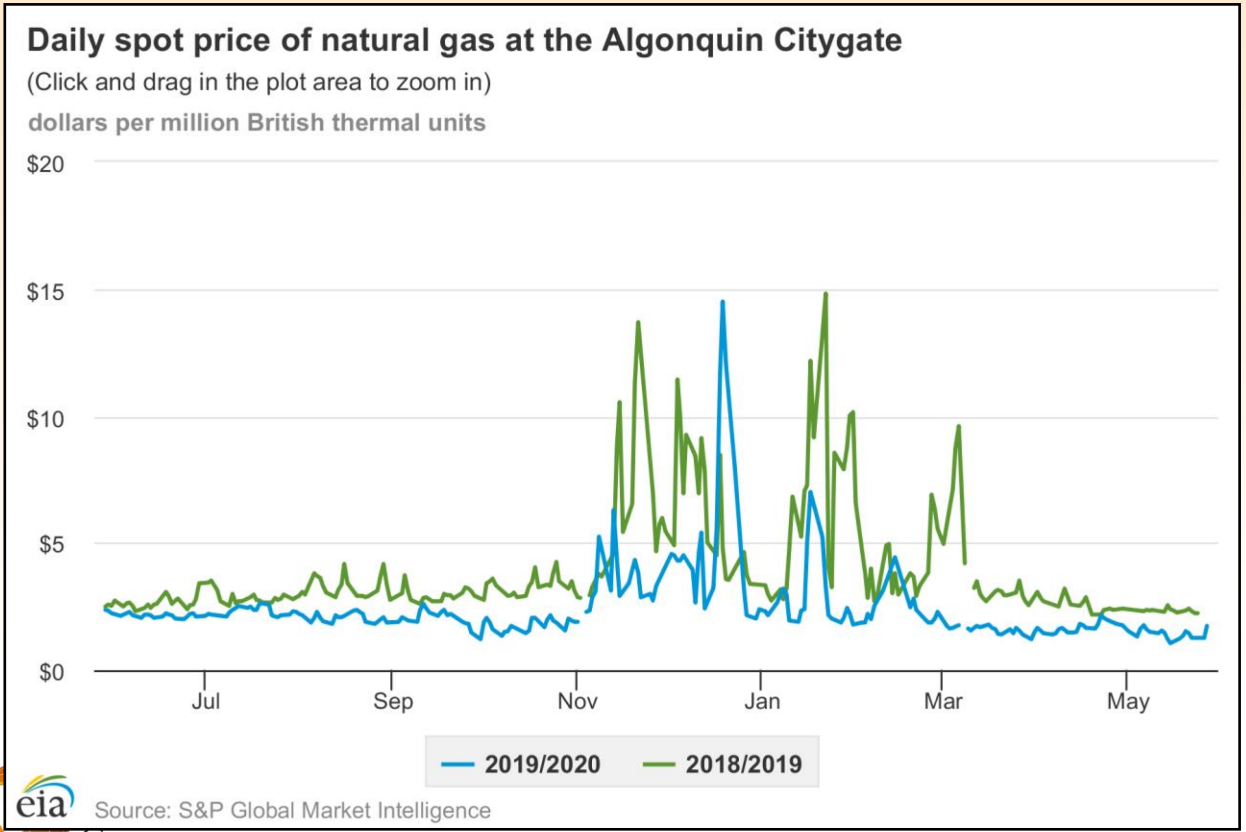
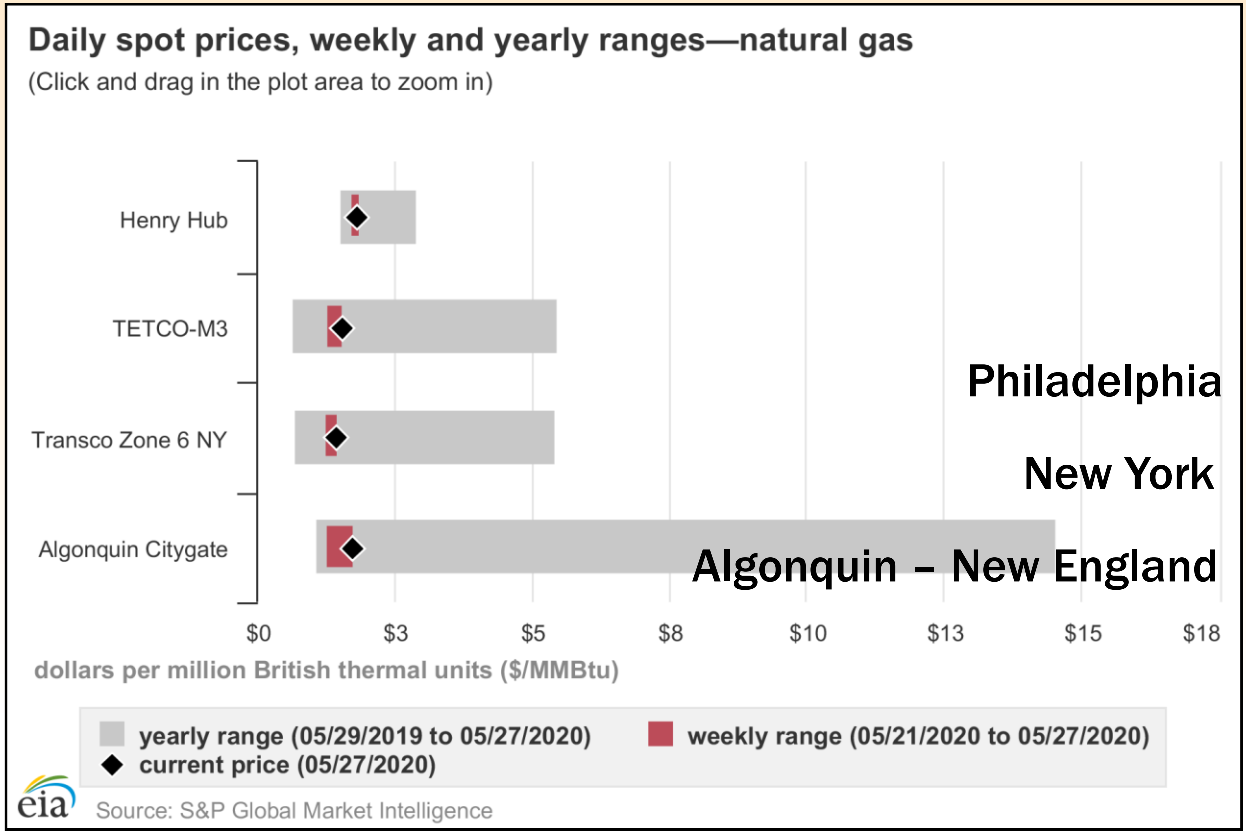
New England: Access to Fuel Has Become Uncertain during Winter for Local Utilities

- Examples of past winter price spikes in North East markets. During the last few years, inadequate infrastructure to transport natural gas has at times affected local utilities in New England and New York. This energy-security risk has become a pressing concern





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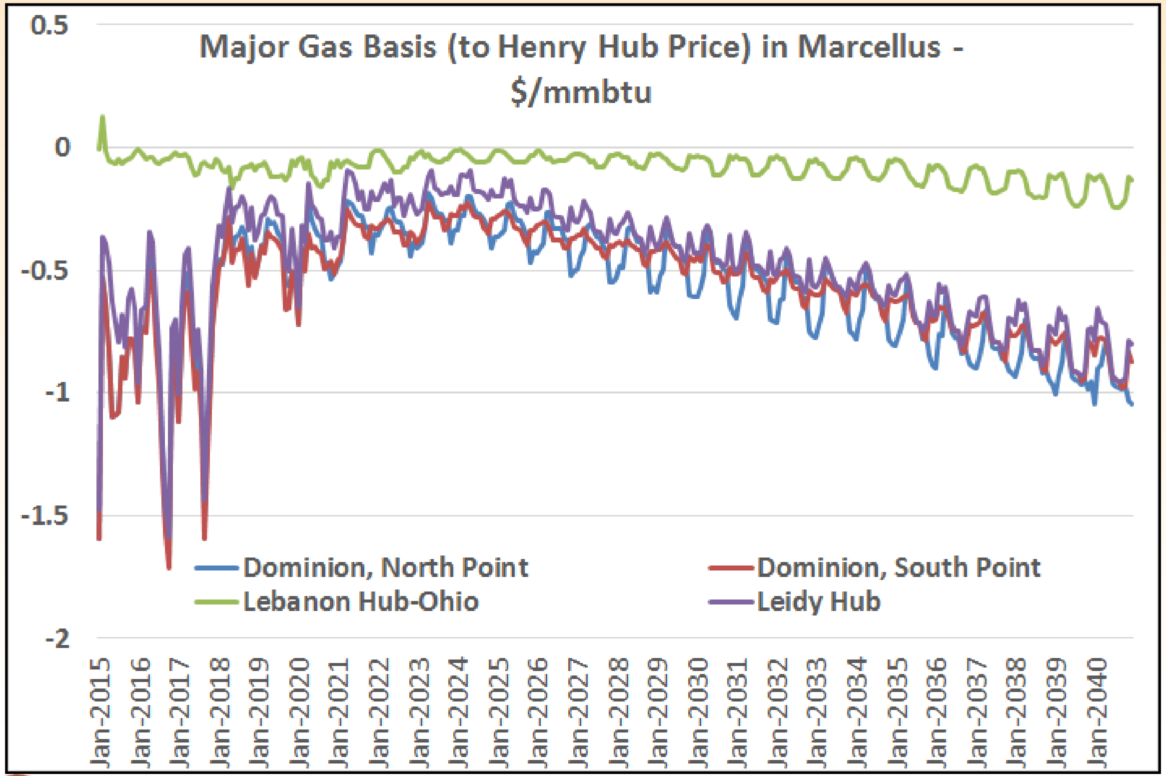
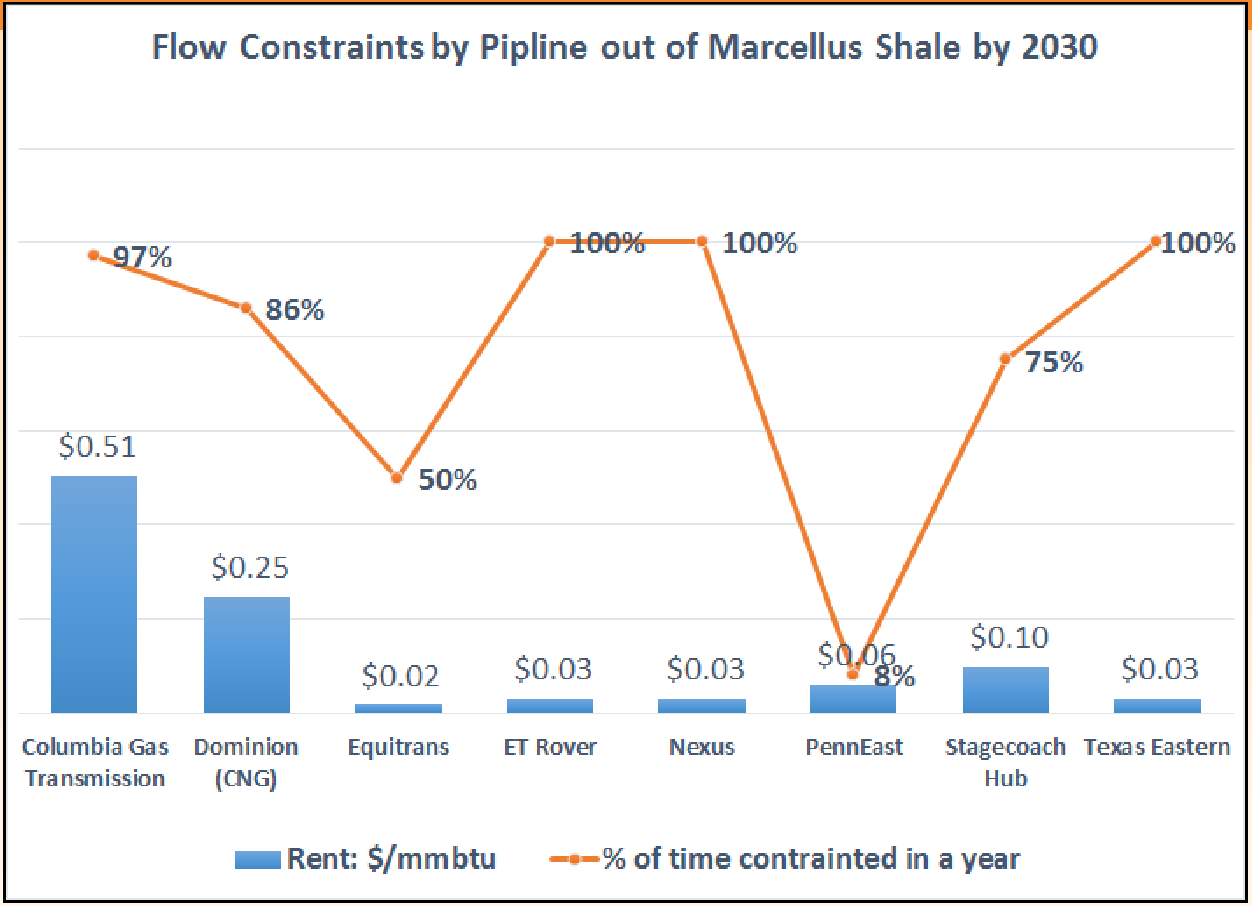
Northeast Pipeline Takeaway Constraints and Basis Blowouts





- Over 13 Bcfd pipeline capacity entered service during 2018. Northeast gas takeaway capacity improved for the first time in 2019, leaving room to spare, around 4 Bcf/d in last summer.
- However, with additional growth, the flow constraints will return by 2030.
- Rent indicates the opportunity cost of value from the market if there were spare capacity.

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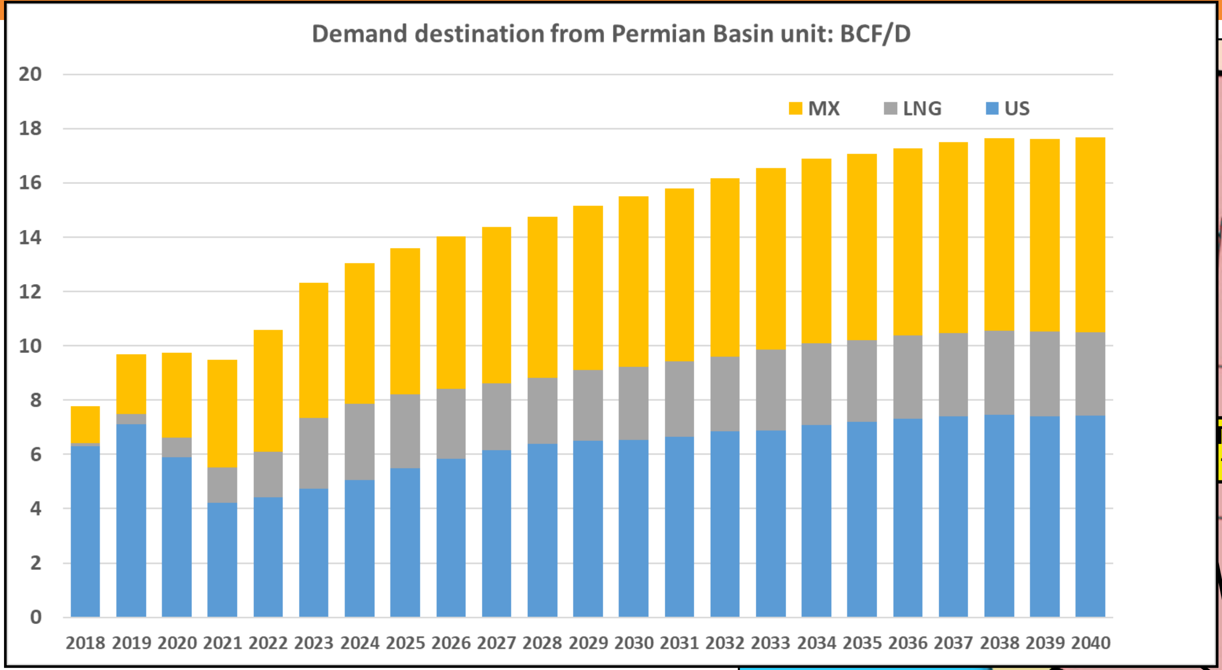
Permian

Stronger link to oil industry

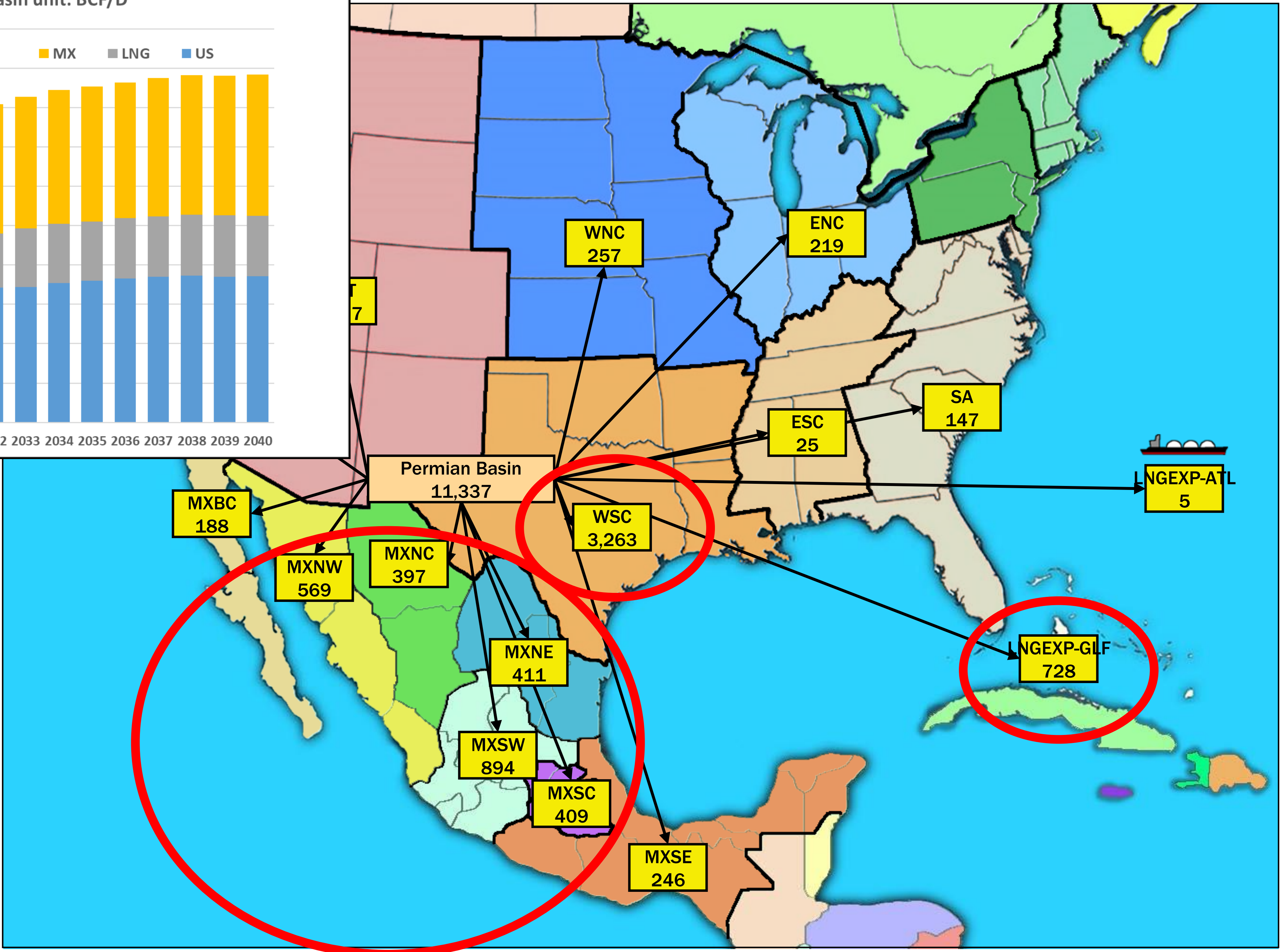
Export influenced

Vertical integration opportunities



- Besides serving south west central market, Permian basin is one single largest basin to serve export markets - LNG and Mexico.

- By 2040, 2/3 of Permian gas, around 12 bcfd will be serving exports.



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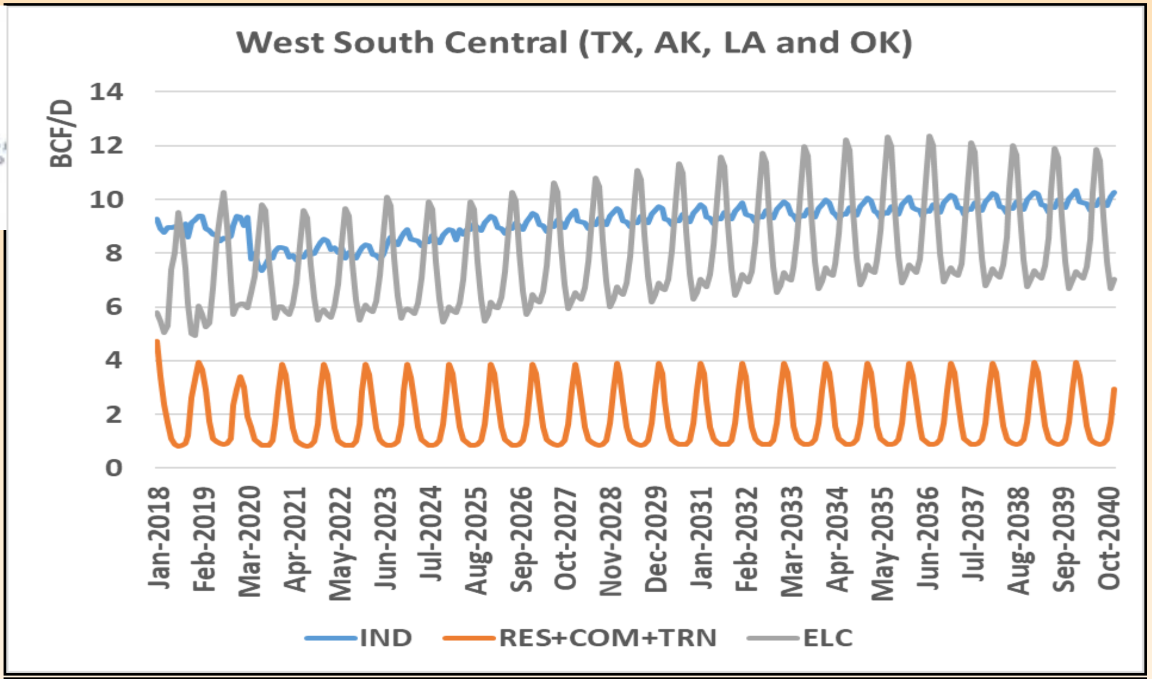
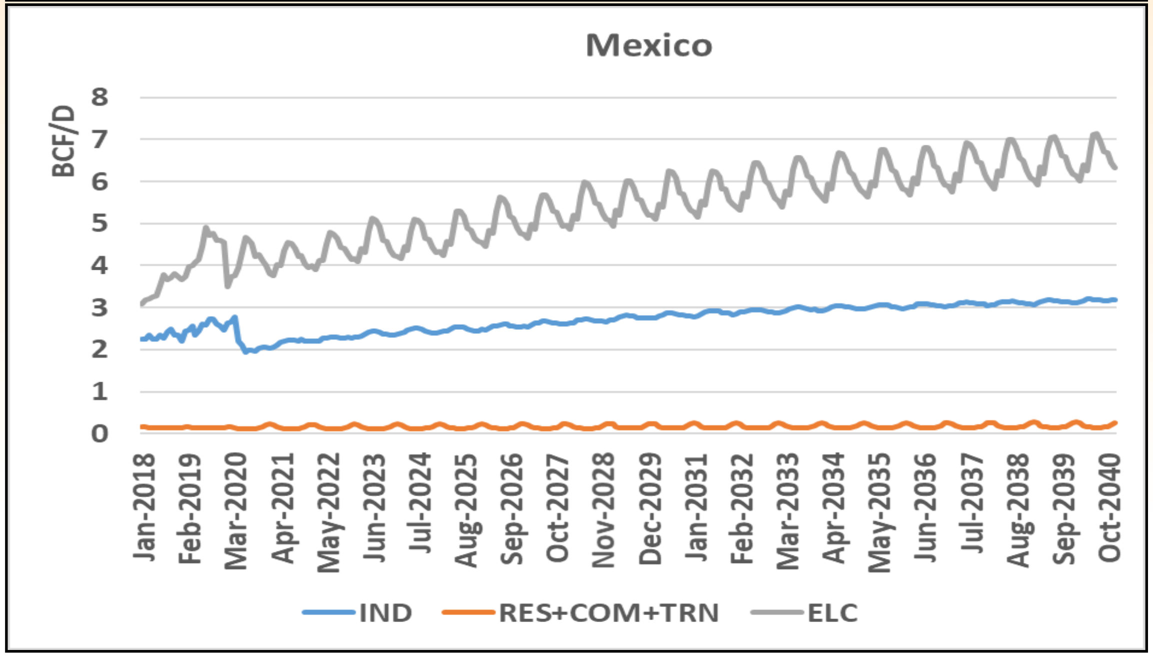
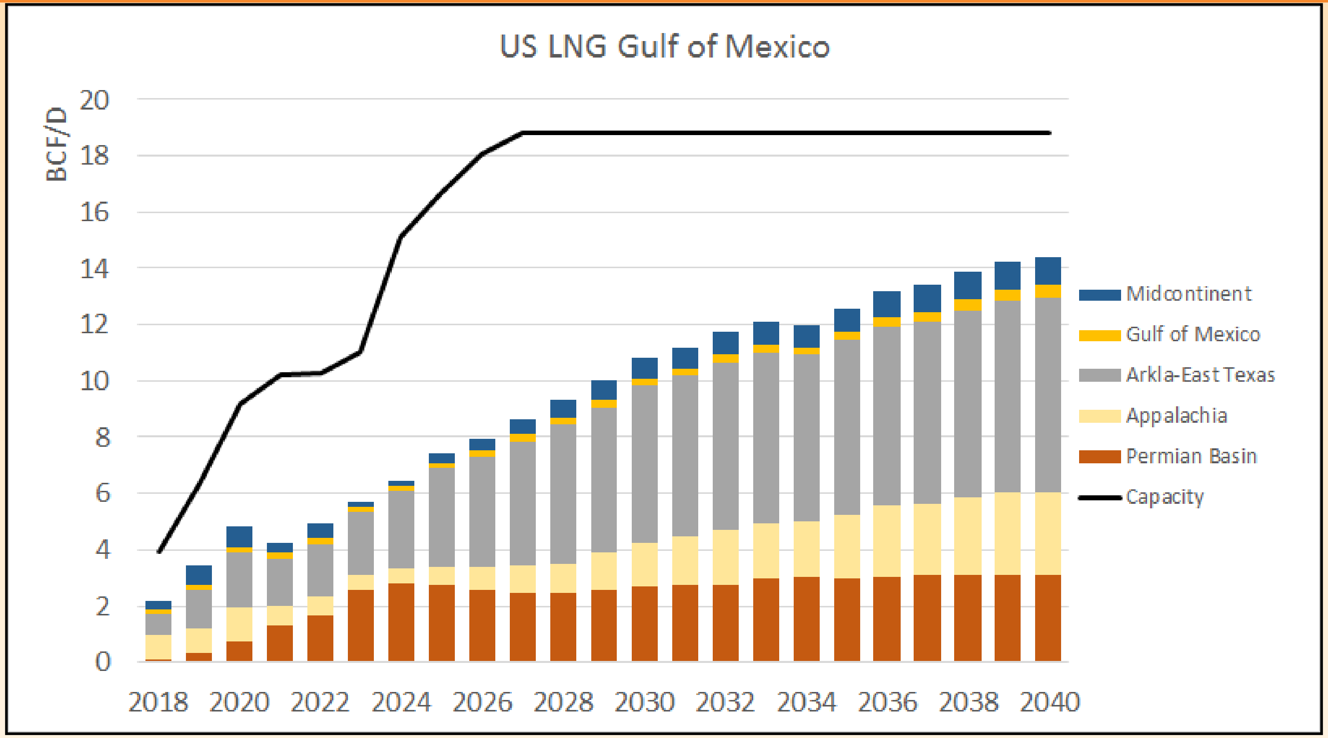
Serving Electric Generation Needs for WSC and Mexico Markets

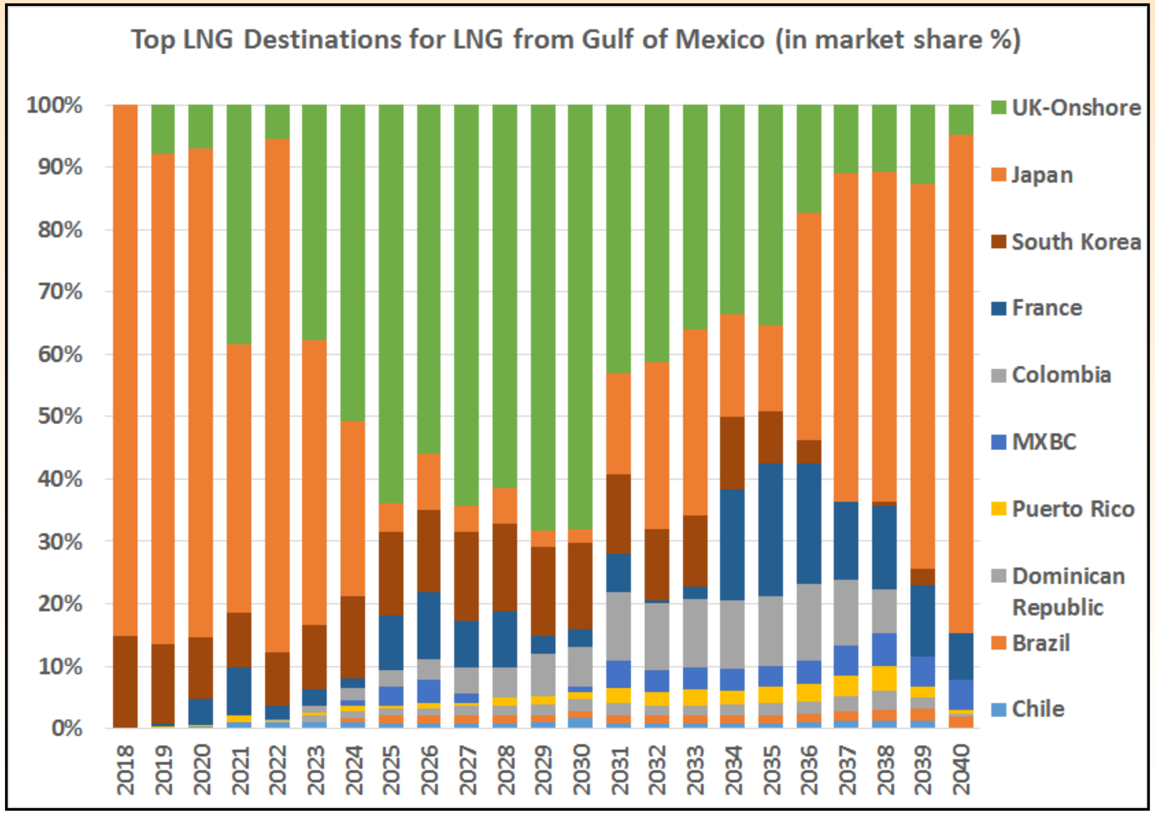




- Industrial demand takes the largest share of demand in the WSC market, while electric sector dominates some summer peak demand.
- Mexico demand mainly serves for power generation, which will take 75% of its total volume.
- Demand impacts on industrial sector demand, mainly petroleum related sectors, in low oil price, could last through next 3 years.

LNG Exports is an important market outlet for Permian





- Exporting capacity addition ramped up quickly for GOM , tripling in 6 years since 2018.
- US LNG lose 1 bcfd due to Covid 19 for 2020 and remains out of money till this fall. This leads more project delays.
- US LNG remains an average 65-70% of utilization rate in long term although with reduce competitive position due to low oil price.
- The top destinations for US LNG cargos out of Gulf of Mexico are UK, Japan and South Korea. Foreign LNG buyers seeks vertical integration opportunities.

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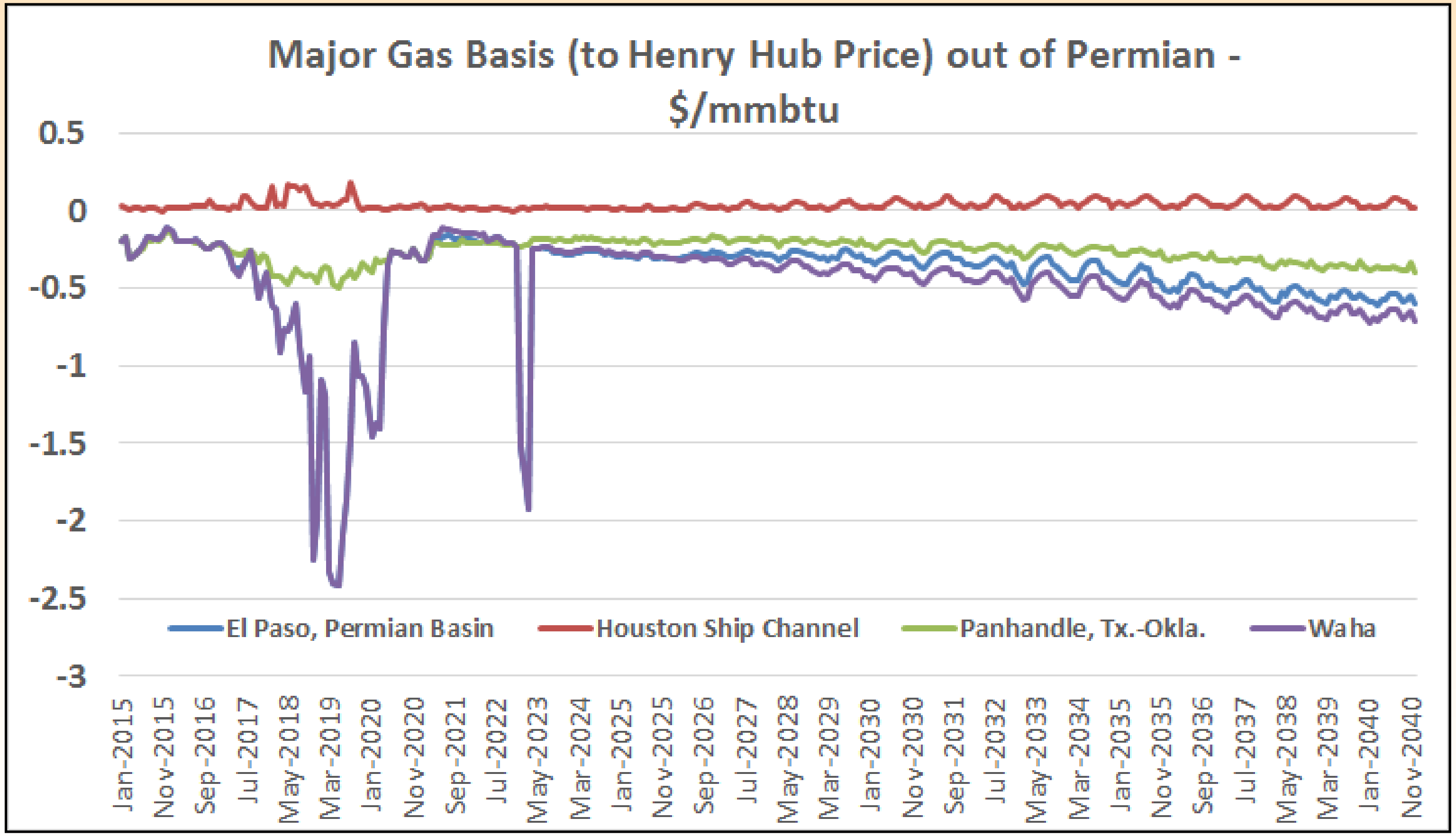
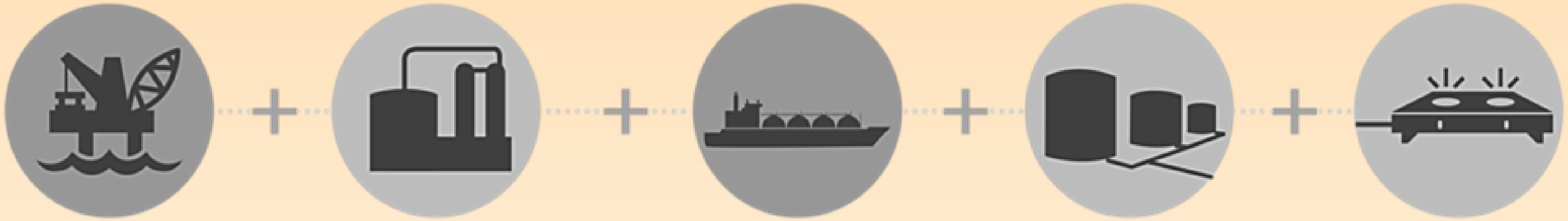
New Pipeline Eases Permian Bottleneck



- Permian Capacity additions eases supply bottleneck.
- Potential delays of projects due to reduced associated gas available may cause negative blowouts in next 2-4 years.

So what to watch for?



Upstream

- Steady gas demand support recovery of price to maintain necessary production
- Operation discipline and cross product monetization

Midstream

- Infrastructure constraints remains ahead with some temporary relief
- Alternative Technology and modular projects

Downstream

- Coal replacement in Midwest.
- Procurement negotiation
- Long term energy security strategies