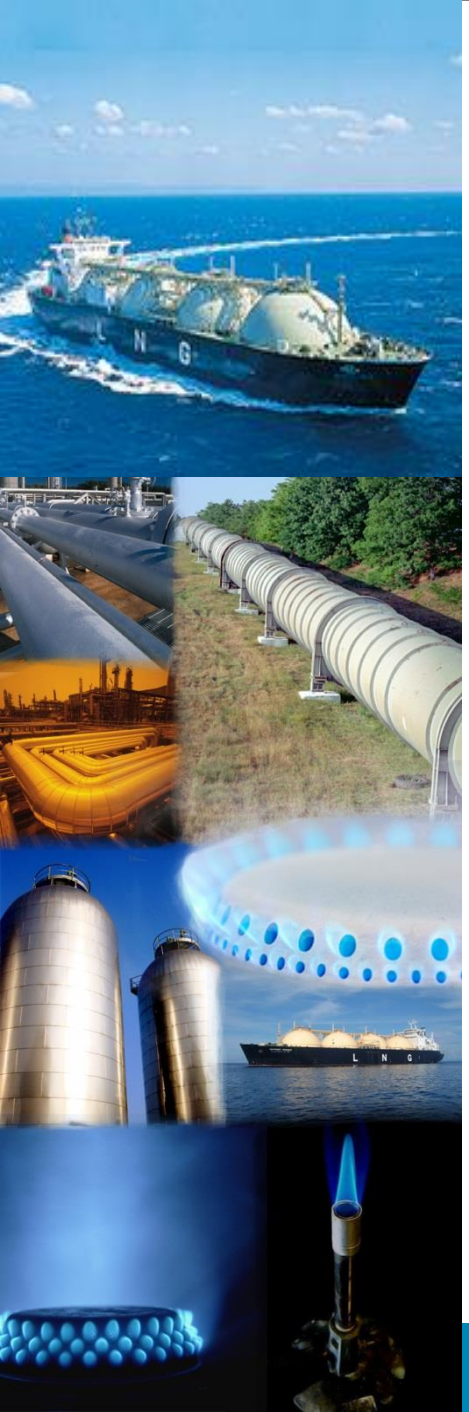


# Global/North American LNG Exports, and Gas and Crude Flows and Consequences

2018 GAS/ELECTRIC PARTNERSHIP
CONFERENCE XXVI SINCE 1994

Houston Texas – January 31, 2018

Mike Juden and Jamie Brick, McKinsey Energy Insights, Houston

# A perspective on key structural trends in LNG, natural gas transportation and crude oil infrastructure

**A** *LNG: The LNG market rebalancing is expected to be pushed towards 2025, driven primarily by lower demand; By 2021, over 9 Bcfd of LNG export capacity will be online; however, a long global LNG market will keep US utilization low until ~2025*

**B** *Renewables: Renewables are contributing, globally, to slower growth of gas demand in power, decreasing expected demand for LNG, and raising questions about underestimation of growth of renewables displacing gas*

**C** *Natural Gas Supply: The Marcellus and Utica areas will continue to dominate shale production in North America; however, associated gas will increase another ~12.5 Bcfd from 2016-2030, primarily from the Permian*

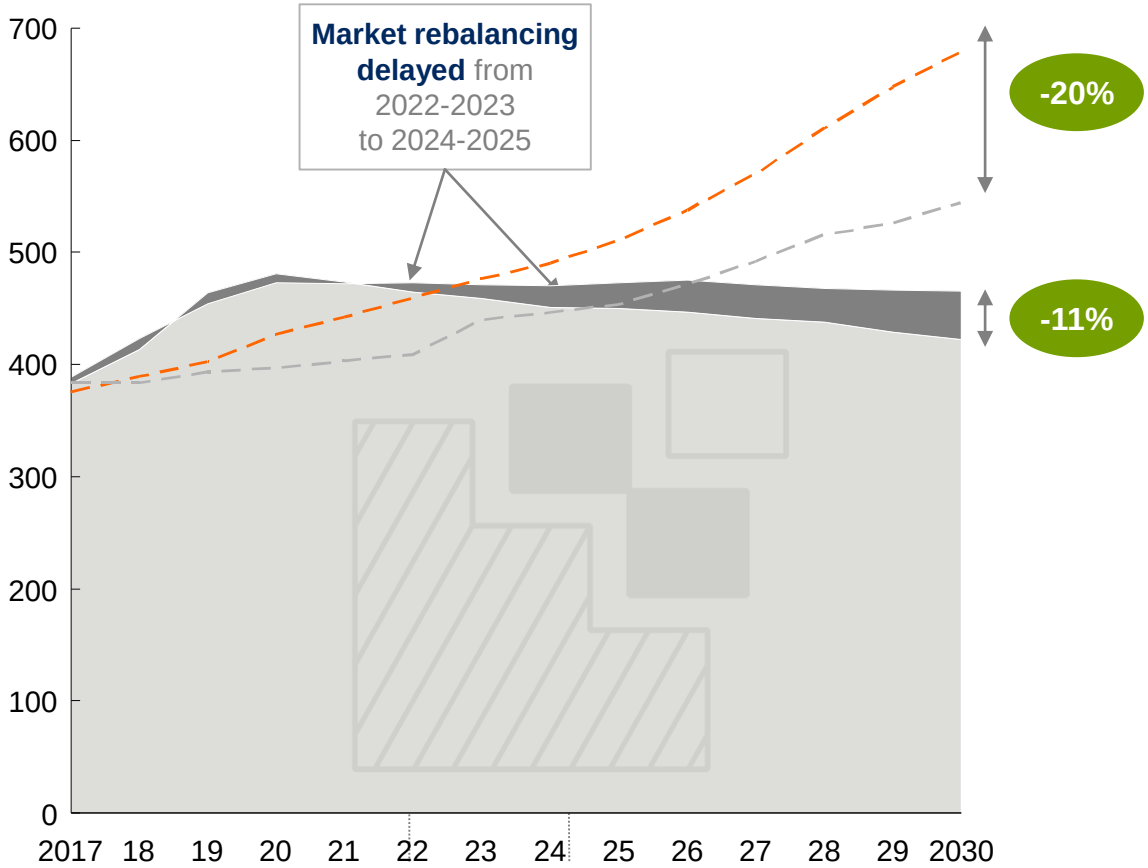
**D** *Natural Gas Transport: Appalachian production continues to be constrained in the near-term and requires more midstream build-out post 2024; Increasingly to 2025, production in the Marcellus and Utica, the Permian, and the SCOOP/STACK will push Canadian and Rockies gas out of the East*

**E** *Crude Oil Transportation: Future US crude production growth is likely to be exported primarily from the US Gulf Coast; New pipeline developments out of the Permian are expected to exceed rising Permian crude supplies*

# A The LNG market rebalancing is expected to be pushed towards 2025, driven primarily by lower demand

UNBALANCED ILLUSTRATION

## Global LNG supply and demand to 2030[1], bcm




**LNG market rebalancing is expected to be pushed later than previously expected and towards 2025 driven by:**

- **Demand**
  - Expected lower penetration of gas in the energy mix and slower GDP growth primarily for South Asia (e.g. India, Pakistan, Bangladesh) and China
- **Supply**
  - Faster than previously expected gas field depletion and increase in domestic gas consumption will reduce supply available for exports

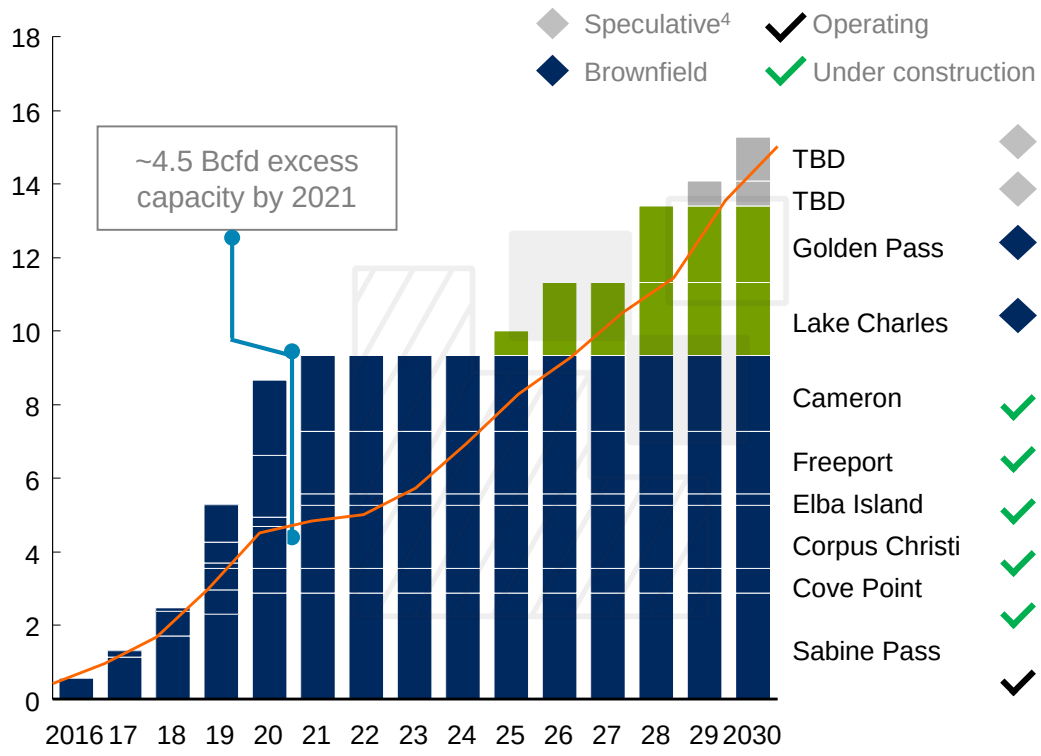
1 Comparison of the previous (June 2017) and current (December 2017) LNG supply and demand forecasts

SOURCE: Energy Insights by McKinsey, Energy Insights Gas Intelligence Model, IHS Vantage

# A By 2021, over 9 Bcfd of LNG export capacity will be online; however, a long global LNG market will keep US utilization low until ~2025

MODELED

## US[1] LNG capacity[2] and demand outlook – base-case




## Short and long-term considerations

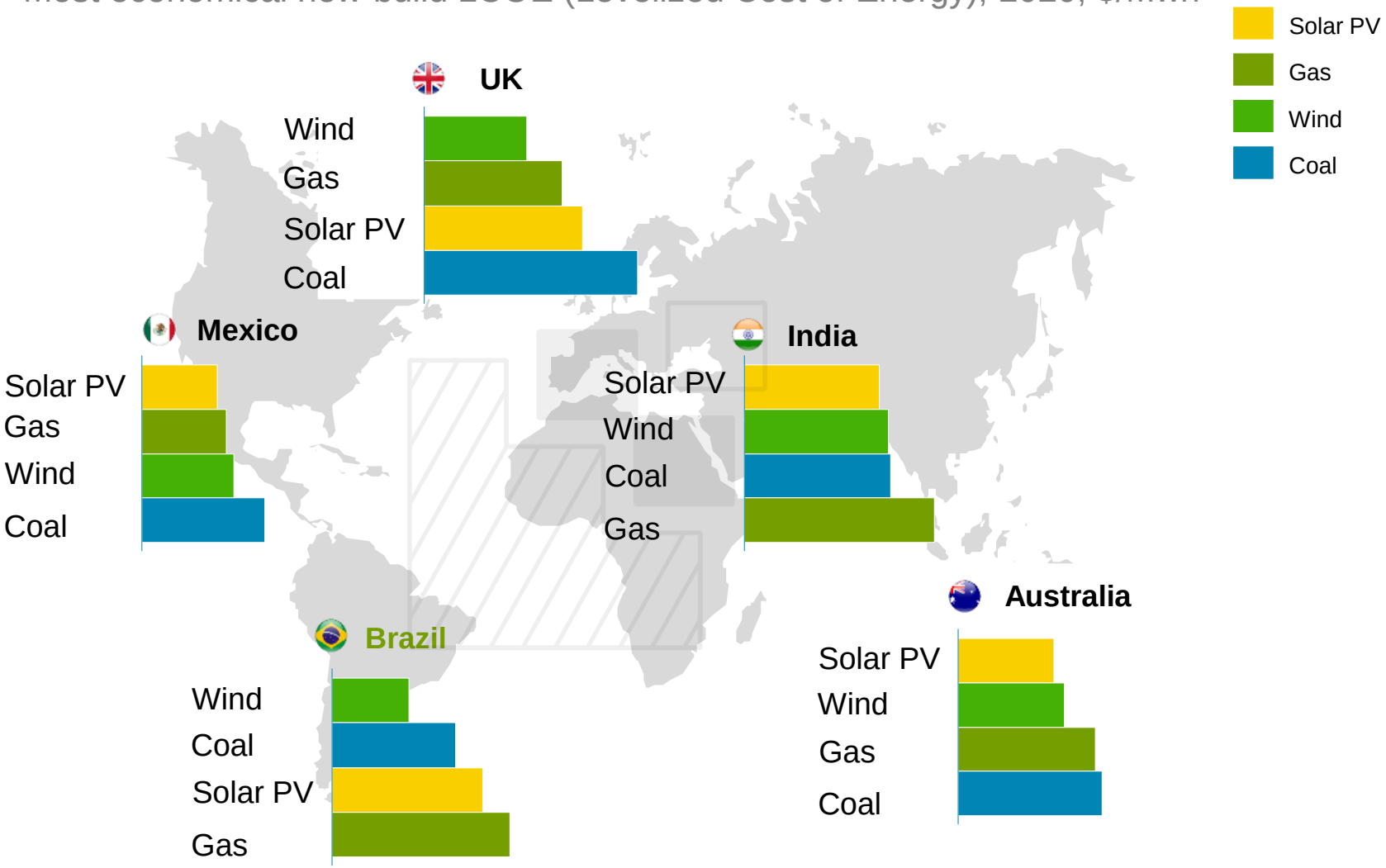
- **Weak global LNG market reduces need for US LNG:** utilization at US liquefaction facilities average less than 60% from 2018-2023
- **As the global market tightens, US exports will increase:** from 2022 to 2026, US LNG exports may increase by ~4 Bcfd and utilization to ~90%
- **Second wave of LNG starts from 2025 after existing terminals approach 90% utilization:** Lake Charles and Golden Pass are the first to be converted from import to export terminals while more speculative Delfin and Venture Global may come online from 2029

1 Base case does not require additional LNG exports from Canada, Alaska or Mexico 2 Capacity assumes 90% utilization
3 US LNG export view aligned with McKinsey Energy Insights Global Gas Model and takes into account cash costs and contracting. Note, due to global LNG oversupply, SPAs do not guarantee exports from the US 4 There are several potential projects that could come online post 2025, projects indicated are speculative and have not taken FID

SOURCE: McKinsey Energy Insights, team analysis, press release

# B By 2020, renewables are already expected to be the most economic new build option

Most economical new-build LCOE (Levelized Cost of Energy), 2020, $/Mwh



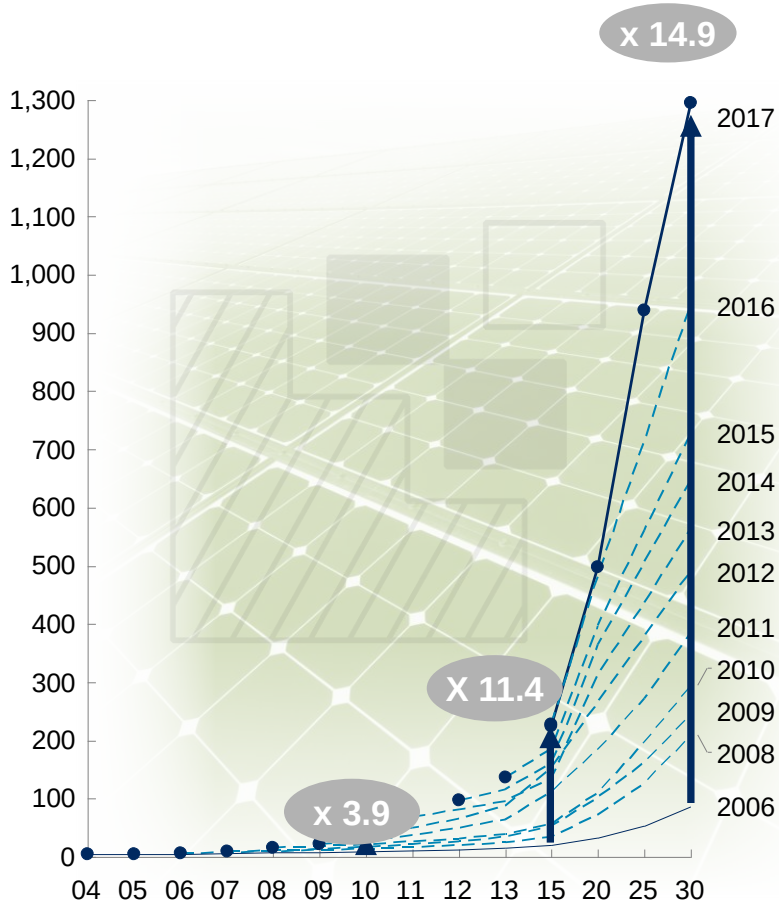

SOURCE: Based on recent McKinsey Energy Insights' Global Power Supply Model: Bottom-up country-level model projects capacity and generation mix, Detailed technology cost analyses are underlying the cost optimization in this model

# B Global growth of solar and wind has been consistently faster than analysts have projected – thanks to faster than expected cost declines

Global forecast of cumulative installed capacity, GW

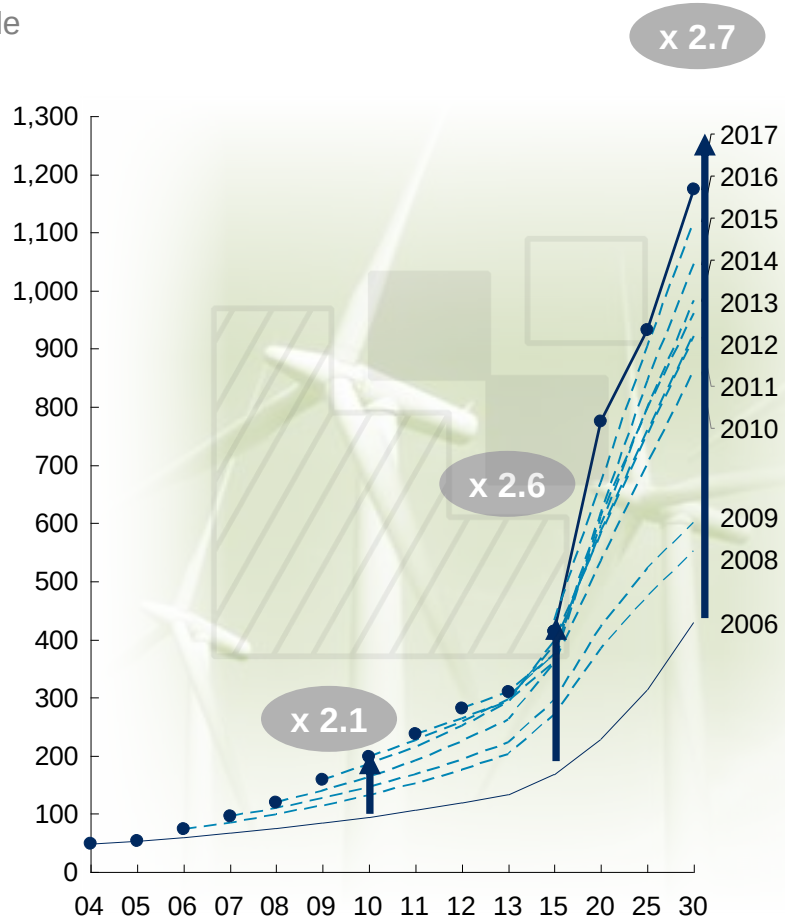
## Solar

IEA forecasts and actual development




## Wind

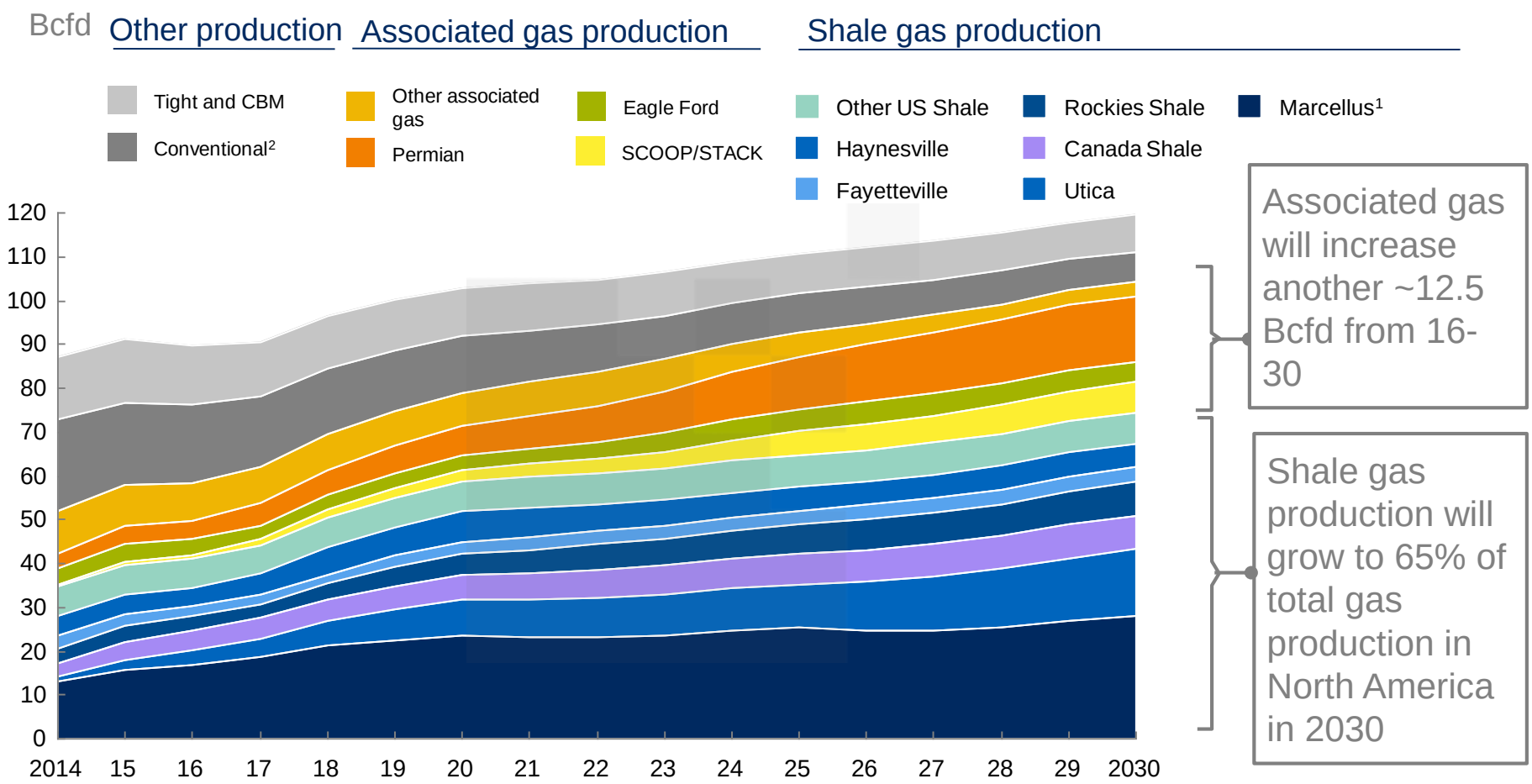
IEA forecasts and actual development




SOURCE: IEA World Energy Outlook – New Policy Scenario

# C The Marcellus and Utica areas will continue to dominate shale production in North America

## North American gas production by basin

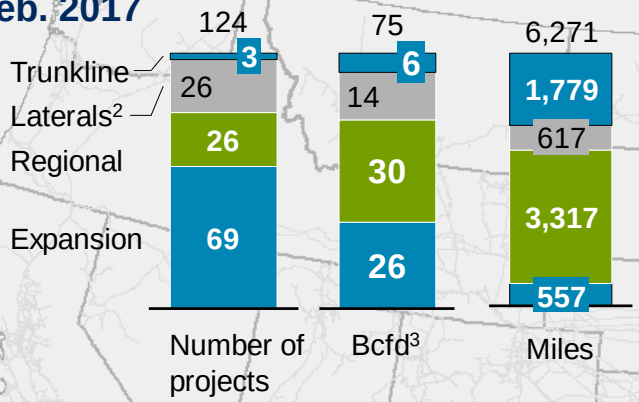



1 Marcellus and Utica total production constrained at 24 and 28 Bcf/d in 2017-2018, assuming 90% pipeline take-away capacity
2 Conventional includes Conventional gas basins, Alaska and Offshore
SOURCE: EIA; Energy Insights North American Supply Model

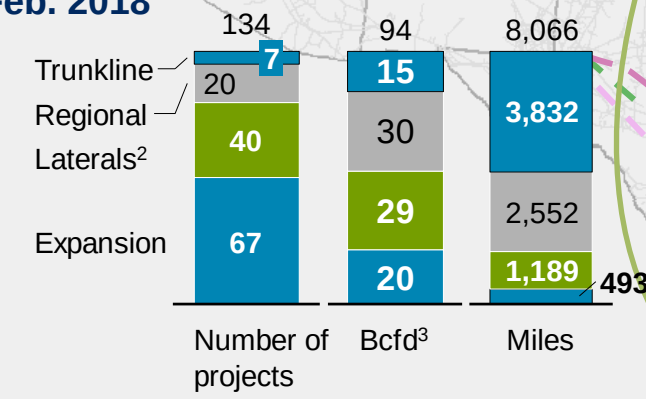
# C Proposed[1] natural gas interstate pipeline projects – continue expanding beyond regional projects to reversals to the GoM

PRELIMINARY

## Proposed[1] natural gas pipelines – Feb. 2017




## Proposed[1] natural gas pipelines – Feb. 2018




- Significant number of large expansions in 2018 vs. 2017
- Appalachian and Permian focus, with significant pipelines from Permian and for Mexican exports

**Proposed Natural Gas Pipeline Projects**

- Atlantic Coast (Dominion)
- Atlantic Sunrise (Transco)
- Cameron Access
- Elba Express
- Gulf Coast Express (Kinder)
- Midship (Cheniere)
- Mountaineer Xpress (Columbia)
- Mountain Valley (EQT/NextEra)
- Nexus Gas (Spectra)
- Pecos Trail
- PennEast (TETCO)
- Permian Global Access (Tellurian)
- Permian to Katy (Sempra/Boardwalk)
- Rio Bravo
- Rover (Energy Transfer)
- Sabine Pass (Cheniere)
- Sur de Texas - Tuxpan
- Valley Crossing

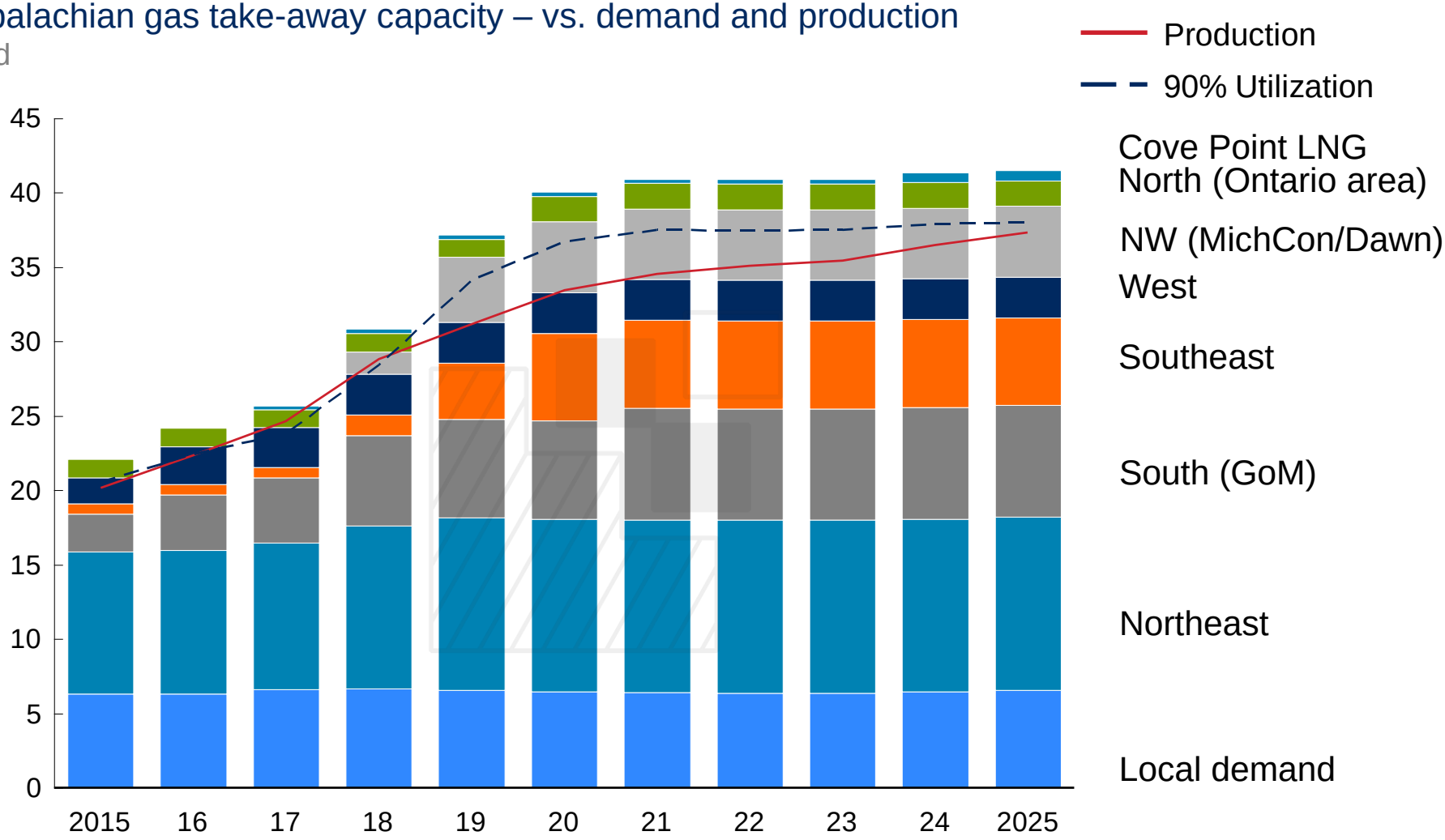
1 Includes projects under construction, approved, filed and proposed in all regions. Reversals included as expansions. Does not include any pipeline conversion projects
2 Laterals to storage, LNG, terminals, power plants, other pipelines, LDCs, etc
3 Where capacity ranges are given used largest

SOURCE: ABB Velocity Suite; EIA; FERC; Platts; SNL; Company websites and presentations; Trade press; team analysis

# D Appalachian production continues to be constrained in the near-term and requires more midstream build-out post 2024

## Appalachian gas take-away capacity – vs. demand and production

Bcfd



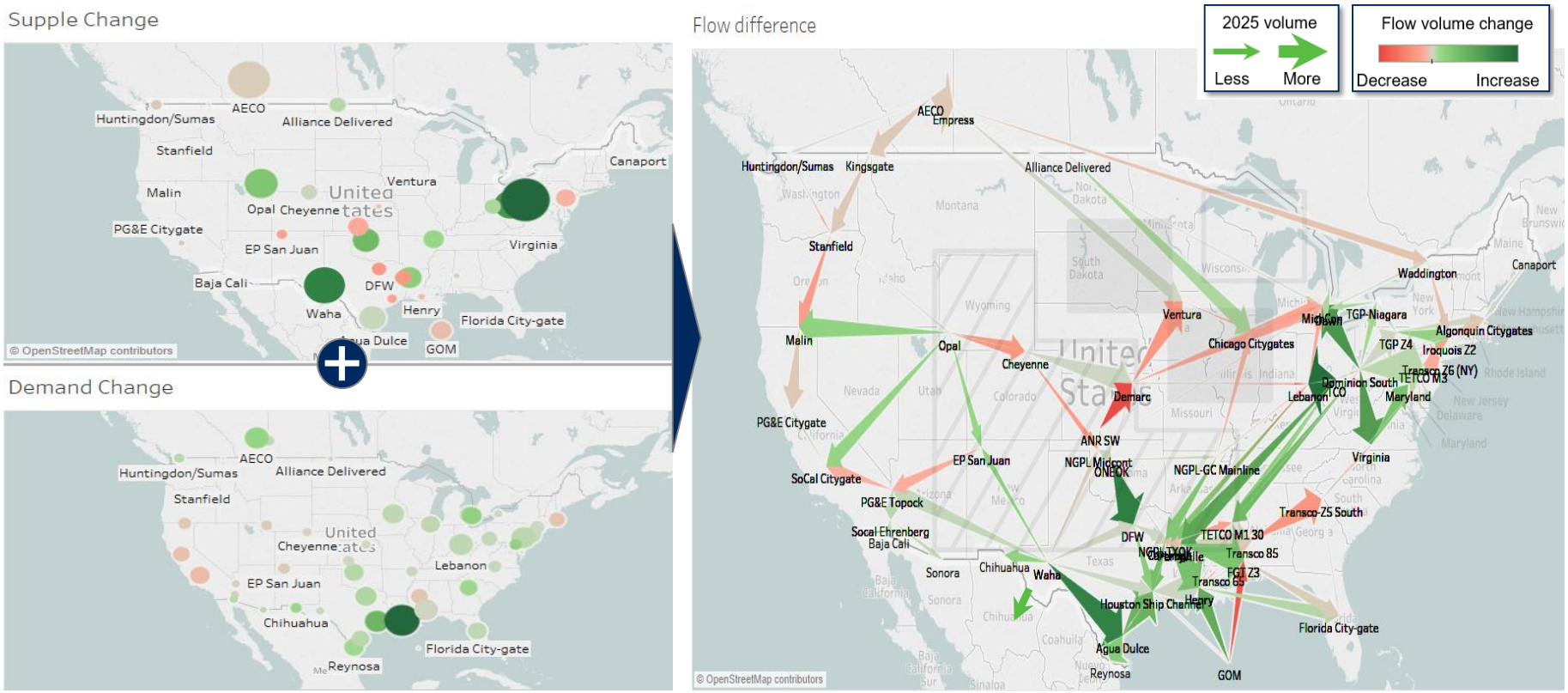

1 Including local residential, commercial, industrial and power demand of PA, MD and NJ 2 Based on End-User contracted demand of Cove Point LNG

SOURCE: Energy Velocity, Press research, McKinsey team analysis

# D McKinsey Energy Insights' North America Flow and Basis Model helps determine how shift in supply and demand will impact flows and basis

## Natural gas S/D and flow changes between 2016 to 2025[1] – Tableau visualization

ILLUSTRATIVE




- **Model scope** – 55 gas pricing nodes (with assigned demand and supply); 149 flow paths; monthly optimization forecast to 2030
- **Flow and path utilization** – Solve for gas flow between nodes and utilization on each path
- **Marginal and constrained path** – Identify marginal path that determine node gas prices and areas with capacity constrains
- **Basis differential** – Forecast basis differential based on flow patterns and regional pricing mechanisms

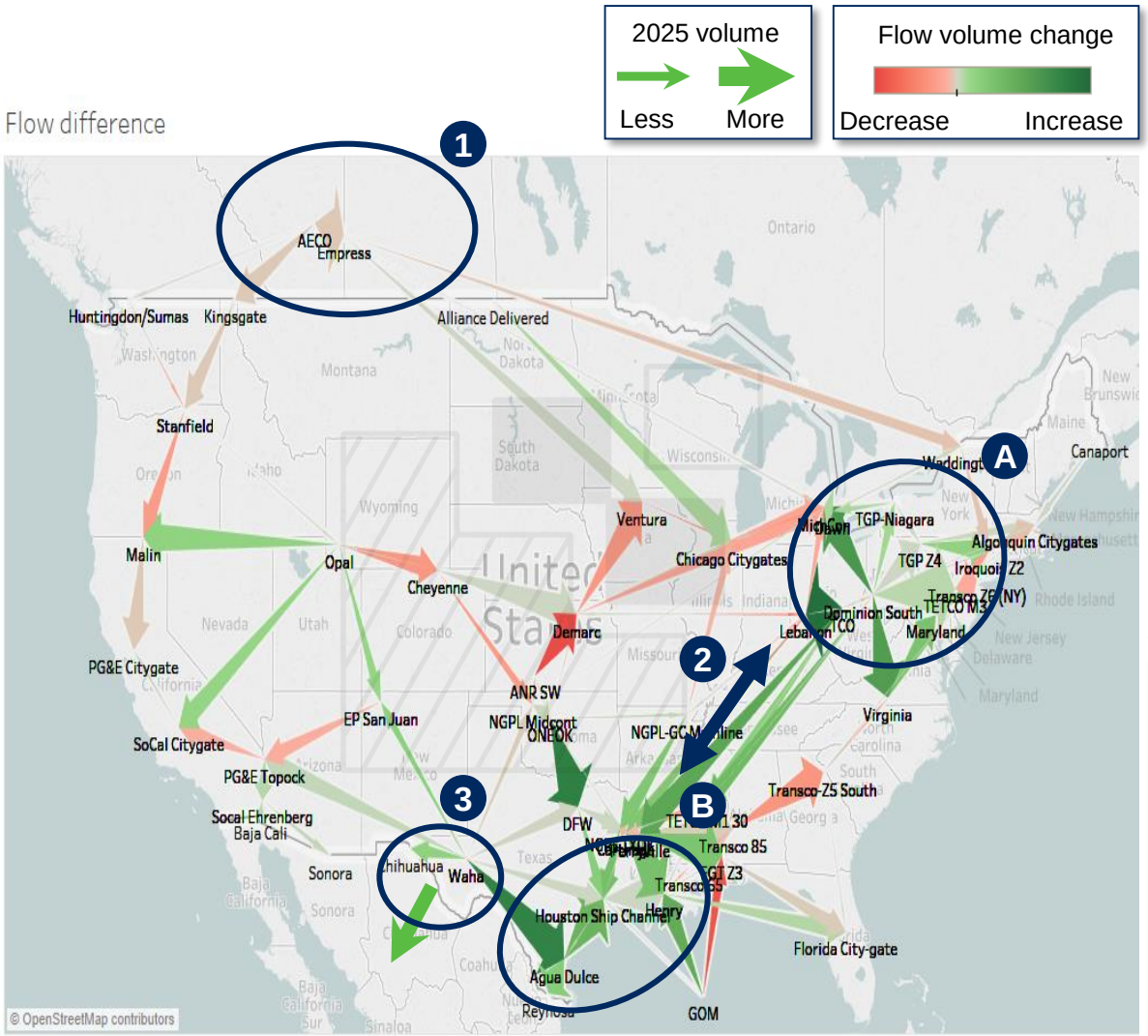
1 Circle and flow arrows size proportional to 2025 volume

SOURCE: EIA, McKinsey Analysis

# D Unlocked Appalachian supply coupled with growing USGC demand has ramifications across the continent

MODELED

## Gas flow changes between 2016 to 2025




## Cause

- **A** Unlocked Appalachian supply
- **B** Growing USGC demand

## Effect

1. Demand is lower for WCSB
2. Pipeline reversals
3. New Permian pipe to USGC

## Key take-away

- Debottlenecking Appalachian supply will reduce demand for Western Canadian gas
- Growing USGC demand is enabling Appalachian reversals and new pipelines will deliver additional associated Permian production

SOURCE: EIA, McKinsey Energy Insight's North America Flow and Basis Model

# D Record demand and storage withdrawals coupled with LNG imports and freeze-offs helped a unique set of market conditions

MODELED

## Gas flow changes "Bomb Cyclone[1]" vs expected


## Cause

- **A** Demand spikes due to cold weather
- **B** Freeze-offs reduce supply

## Effect

1. Record storage withdrawals
2. Pipeline flow change
3. LNG imports

## Key take-away

- Once additional northeastern pipeline comes online the market would be better suited deal with "Bomb Cyclone" but prices would still increase
- Uncertain how LNG exports would react during the next "Bomb Cyclone"

1 'Bomb Cyclone' date assumed to be around January 5, 2018, input data estimated from various sources
SOURCE: EIA, McKinsey Energy Insight's North America Flow and Basis Model, press releases

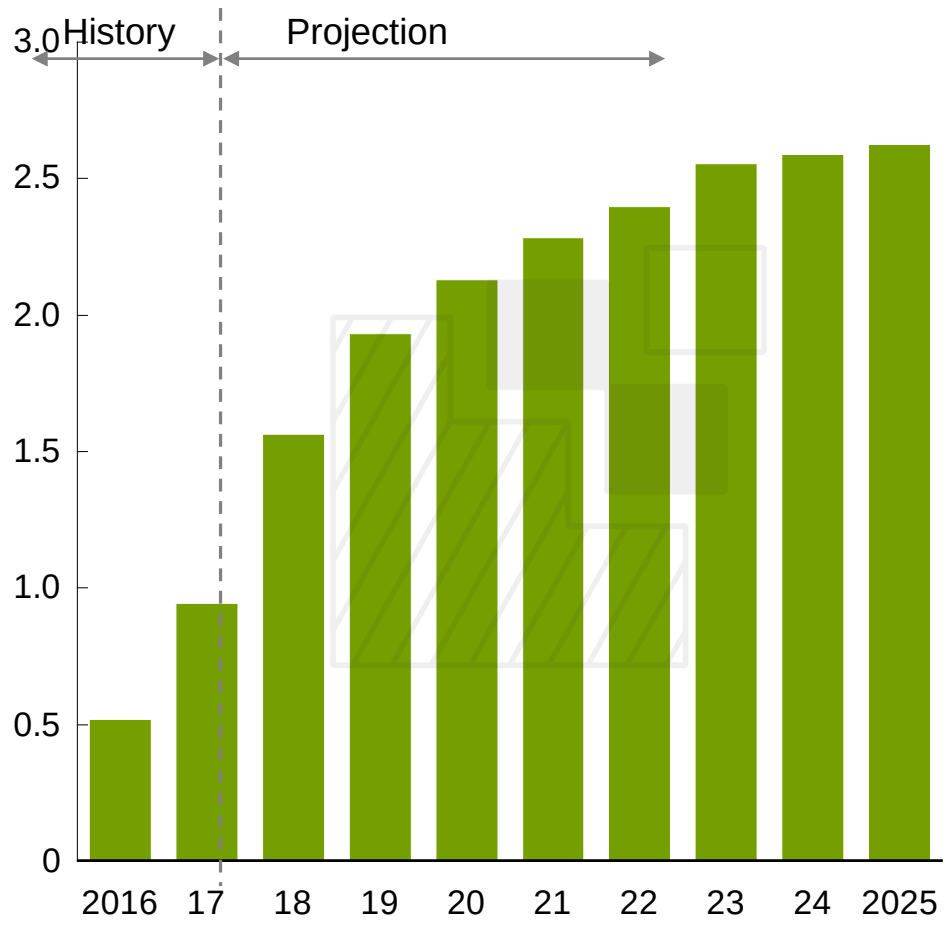
# E Future US crude production growth is likely to be exported primarily from the US Gulf Coast

## Main Considerations

- US crude exports have averaged over 900kbd in 2017
- Incremental domestic production is expected to be exported as domestic refineries have already maximized utilization of light crude and also are running at high utilization
- Implementation of the IMO's[2] marine fuels sulfur limits in 2020 would free-up additional light crude for exports as US refiners seek heavy crudes to fill conversion units due to wide light-heavy differentials in this time frame (heavy crudes become relatively inexpensive)

## US crude exports[1]

Million barrels/day




1 Assumes incremental production is exported; mostly from US Gulf Coast; 2 International Maritime Organization

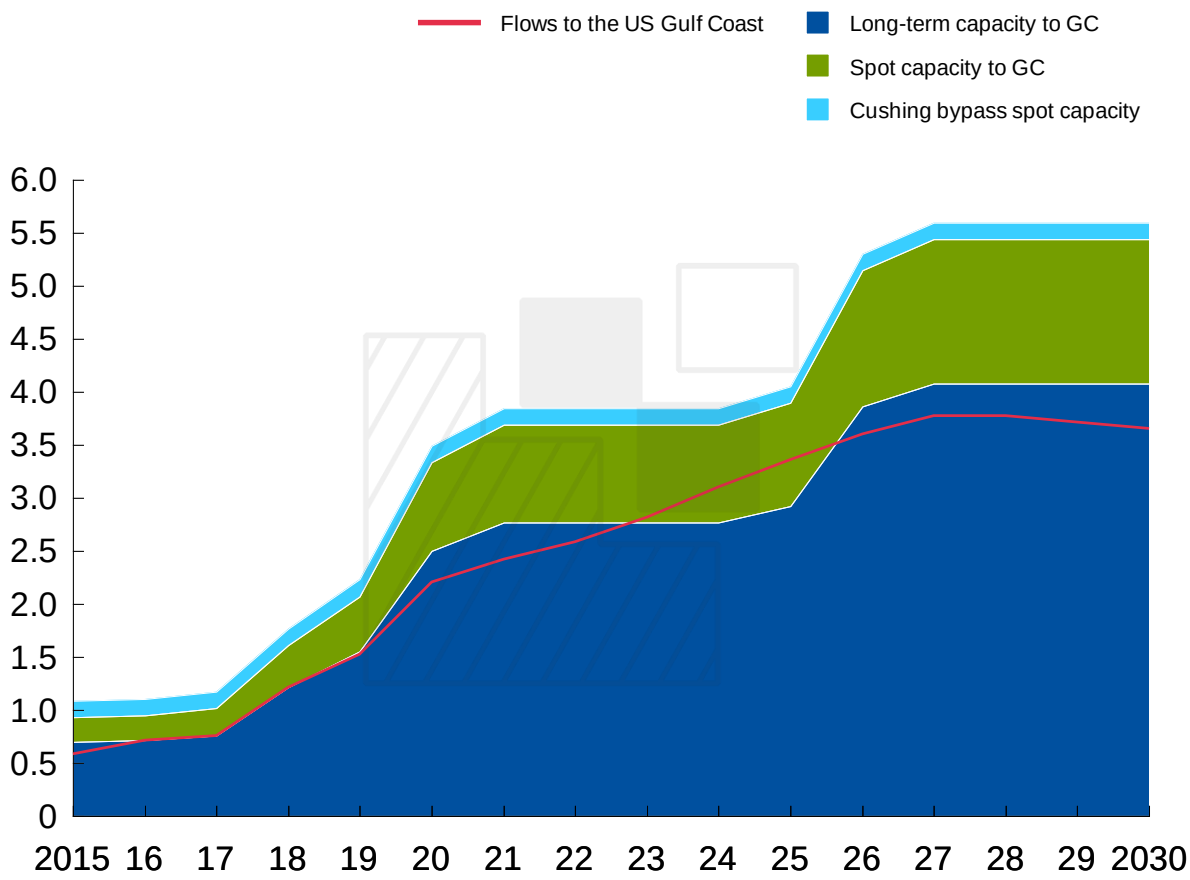
SOURCE: EIA Annual Energy outlook (AEO) 2017, team analysis

# New pipeline developments out of the Permian are expected to exceed rising Permian crude supplies

MODELED

## Permian – Gulf Coast corridor capacity and flow

Million b/d



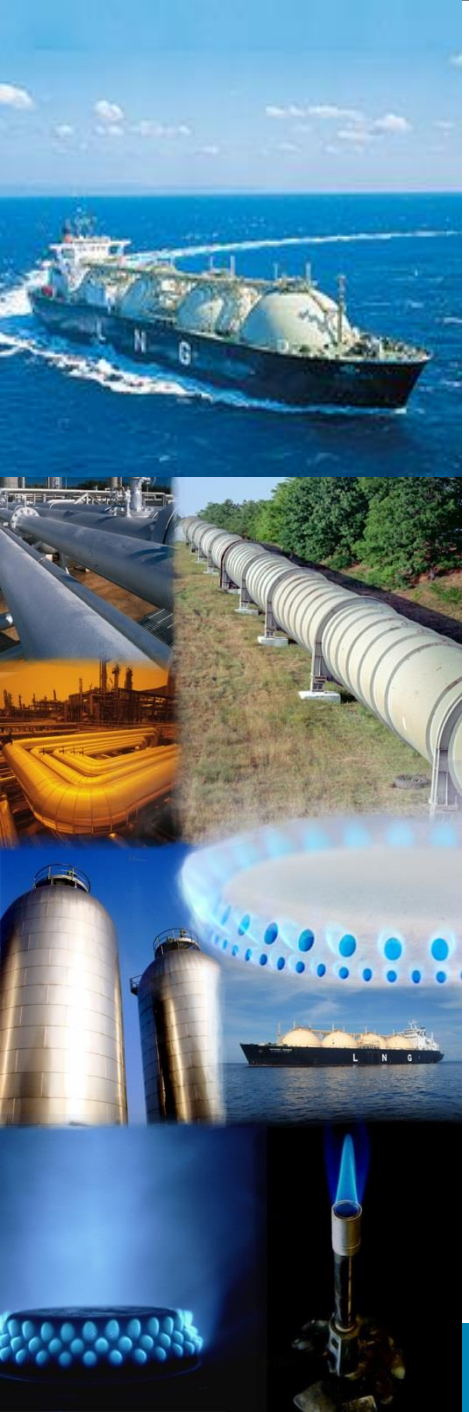

### Key takeaways

- Although there may be periods of short-term tightness, new pipeline capacity is expected to exceed Permian supply
- Sustained overbuild of pipelines leads to low utilization (marginal barrel is on long-term tariff), interspersed with periods of high utilization (marginal barrel on spot tariff)
- Upside to Permian oil supply could shift the marginal barrel to a more expensive tariff and deeper discounts on Permian crude

SOURCE: Energy Insights Global Downstream Model, Team Analysis

# Pipeline and storage investment roundtable – guiding questions

1. *Trends:* ***What new trends are you seeing impacting North American pipeline and storage operations?***
2. *LNG exports:* ***Do you see flow or operational issues associated with North American LNG exports as LNG export facilities come on-line?***
3. *Natural Gas:* ***What are the expected impacts of the projected, dramatic increase in Permian production, and the expected impacts of increases in SCOOP/STACK and Appalachian production on the regional and interstate pipeline grids? Expected impacts of exports to Mexico and potential LNG export feed-gas "flexing"?***
4. *Crude oil:* ***What are the infrastructure trends you are seeing with the increasing Permian crude production and increased crude exports?***
5. *Equipment:* ***Do you see changes in near-term equipment purchases now vs. this time last year (what has changed or is expected to change and why)?***



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# APPENDIX

# Energy Insights combines the expertise built up by McKinsey over 90 years with the agility of a start-up

## McKinsey Energy Insights

**4**

Hubs in Houston, London, Amsterdam, Singapore

**75%**

Of hires with energy backgrounds

**140+**

Practitioners


## McKinsey's Oil & Gas Practice

**#1**

Ranked energy consultancy[1]

**90%**

Of global oil & gas majors served

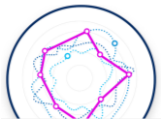
**1,300+**

Practitioners

1 Energy Consulting ranking, Vault survey (annual survey of consultants on the best consulting firms), McKinsey ranked no. 1 since 2004

# Energy Insights combines premier consulting expertise with one-of-a-kind analytics architecture

## What we do



### Market Intelligence

Informs daily decisions by delivering robust forecasting and market analytics on global crude, refined product, natural gas markets, and oilfield services.

### Diligence Support

Our dedicated global diligence team combines hands-on oil and gas industry expertise, and house analytics, with thorough understanding of the private equity cycle and diligence dynamics

### Performance Improvement

Helps drive asset productivity and performance by providing quantitative benchmarks and actionable insights into major areas for improvement.

## How we do it

*Our dedicated global energy team combines…*

**Industry experts:** Our people bring deep, hands-on oil and gas industry expertise, both field and corporate level

**Flexible delivery model:** From standard perspectives, access to models and analysts, to bespoke research and workshops, we can tailor the delivery to meet every client's need

**In-house analytics:** An ecosystem of proprietary market models with bottom-up methodology enables us to build comprehensive perspectives and latest market insights into the energy market

**Transparent assumptions:** We define inputs and provide transparent assumptions for every "what if" scenario, giving you high-degree of granularity

*…to support your day to day decisions with confidence, and help identify and capture opportunities within the energy market*

SOURCE: McKinsey Energy Insights

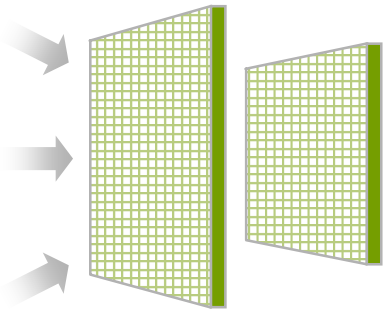
# The bottom-up methodology of our models enables us to build comprehensive market perspectives including the latest market insights

***Flow of McKinsey Energy Insights model development***

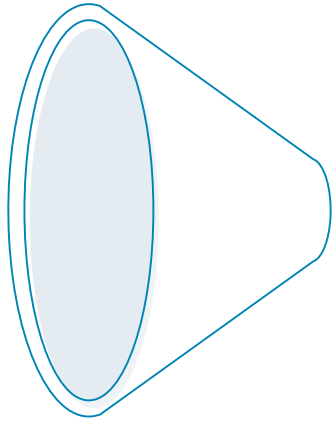
**Consolidate data sources**

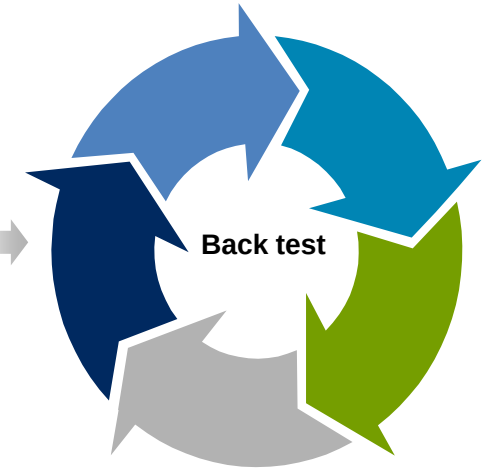
- Proprietary McKinsey data and insights
- Comprehensive 3rd party data sources
- Scraped news sources and publications

**Overlay model insights**



**Aggregate at scale**






- Aggregate wide breadth of data sources
- Add proprietary sources, (e.g., multi-client cost benchmarking in the Marcellus Shale)

- Refine and shape data through proprietary analysis, (e.g., evolution curves for drilling)
- Leverage deep historical data in model for pattern recognition

- Aggregate full range of inputs at scale in advanced analytical tools
- Develop scenarios

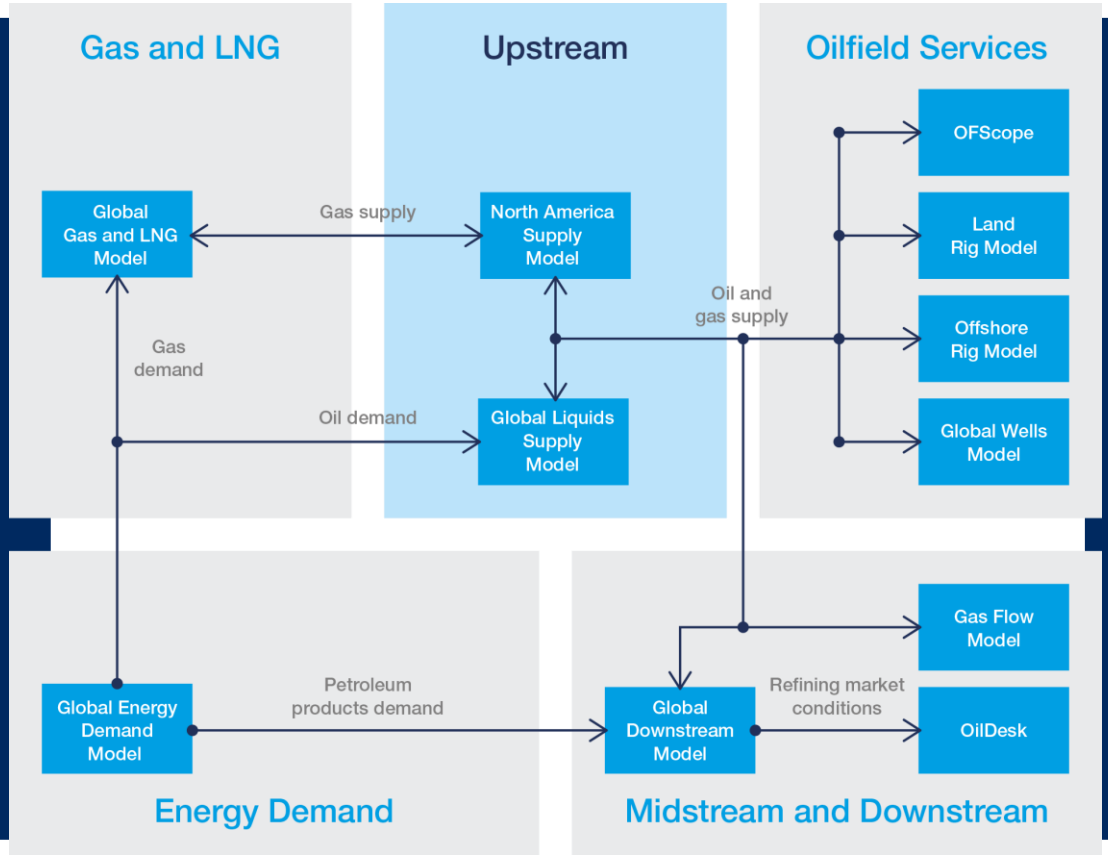
- Compare the predictions of the model to historical outcomes
- Validate and test variance drivers with internal and external experts
- Refine the model continuously over multiple years

SOURCE: McKinsey Energy Insights

# Our models are working together to help us deliver independent yet fully consistent market perspectives along the entire energy value chain

**Primary models and data**

- Large amounts of primary data
- Critical quality control processes involving global expert network and research
- Granular and consistent database building




**Advanced analytics**

- Can require extra primary data but at a lesser scale
- Advanced analytics based on proprietary algorithms
- Output often provides unparalleled insights into how global trends impact subsectors and even

**Consistent**

SOURCE: McKinsey Energy Insights

# Energy Insights provides several market analytics gas offerings

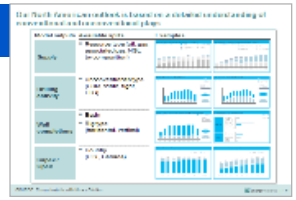
NON EXHAUSTIVE

## 1 Global Gas Model

Forecasting capability of supply, demand, infrastructure, and resulting global gas flows with flexible scenarios to allow 'what-if' analyses

## 2 North America Supply Model

Forecasting capability of basin-level unconventional production and cost – accounting for geographic and commercial developments



## 3 LNG Buyers Survey

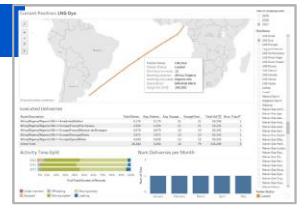
A proprietary survey of 45+ LNG buyers representing >80% of the market on their most pressing concerns and needs

## 4 NA Flow Basis Model

Gas flow and basis differential model, which deprives pipeline utilization and price differentials across 80+ nodes in North America

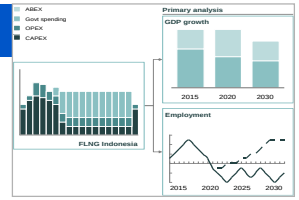
## 5 LNG Flow Tool

Tool focuses on tracking the global LNG fleet on a daily basis; monitoring of flows, analyzing the supply-demand balance; and assessing activity and performance of LNG plants and terminals



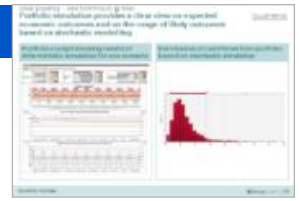
## 6 Gas Monetization Tool

Tool allowing fact-based decisions on how to monetize gas reserves (e.g., LNG, power, industry) by optimizing for profits, jobs, GDP




## 7 Portfolio @ Risk

Tool to simulate (probable) price developments in various regions to understand and minimize value at risk for a portfolio of gas projects



## 8 LNG Cost Curve

Bottom-up perspective on LNG liquefaction costs, LNG project feasibility, price structure, and export capacity

SOURCE: Energy Insights

# Clients have the flexibility to engage with McKinsey Energy Insights in a variety of ways

**Energy Insights website**
www.mckinseyenergyinsights.com

Local Regional Global

Tailored Benchmarks

Access to Analysts

Diligence Support

Custom Workshops

Annual Subscription to our Perspectives

Access to our Models

# Contacts

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