



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

2016 GAS/ELECTRIC PARTNERSHIP

CONFERENCE XXIV SINCE 1994

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A perspective on key structural trends in LNG, natural gas, crude, and the potential impact of new power technologies on gas baseload and peaking



A *LNG: US and Australian LNG volumes coming on-line over the next several years, coupled with a slower growth rate of Chinese demand is expected to move the long-term LNG market from a balanced to a potentially loosening market from 2017-2022-with tightening in 2023+*

B *Natural Gas Supply/Demand: Gas production to 2020, and beyond, is expected to be driven by Appalachian gas*

C *Natural Gas Transport: Primary regional infrastructure and incremental export capacity is needed in Appalachia*

D *Crude Oil Transportation: Pipeline expansions in 2014-2015 and production slowdowns have collapsed differentials to pipeline transportation costs, but infrastructure is needed to optimize crude exports*

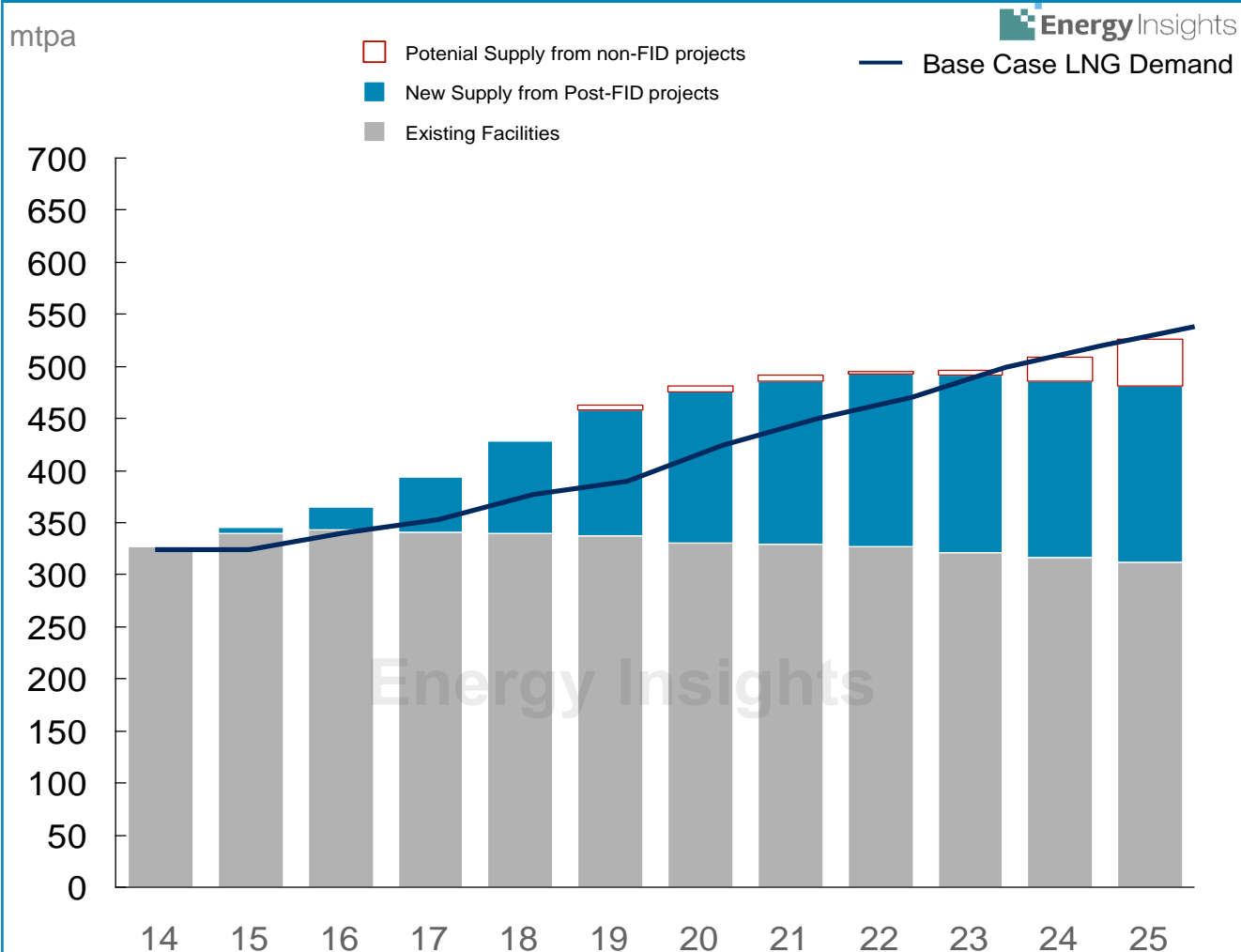
E *New Power Technologies: Transformational power generation technologies are expected to impact baseload and swing needs of gas-fired generators, 2020-2025+*

A

The LNG market is set to loosen further until 2022 as supply growth outpaces demand growth

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Global LNG Supply-Demand Balance, Loose 2017-22, turning tight quickly



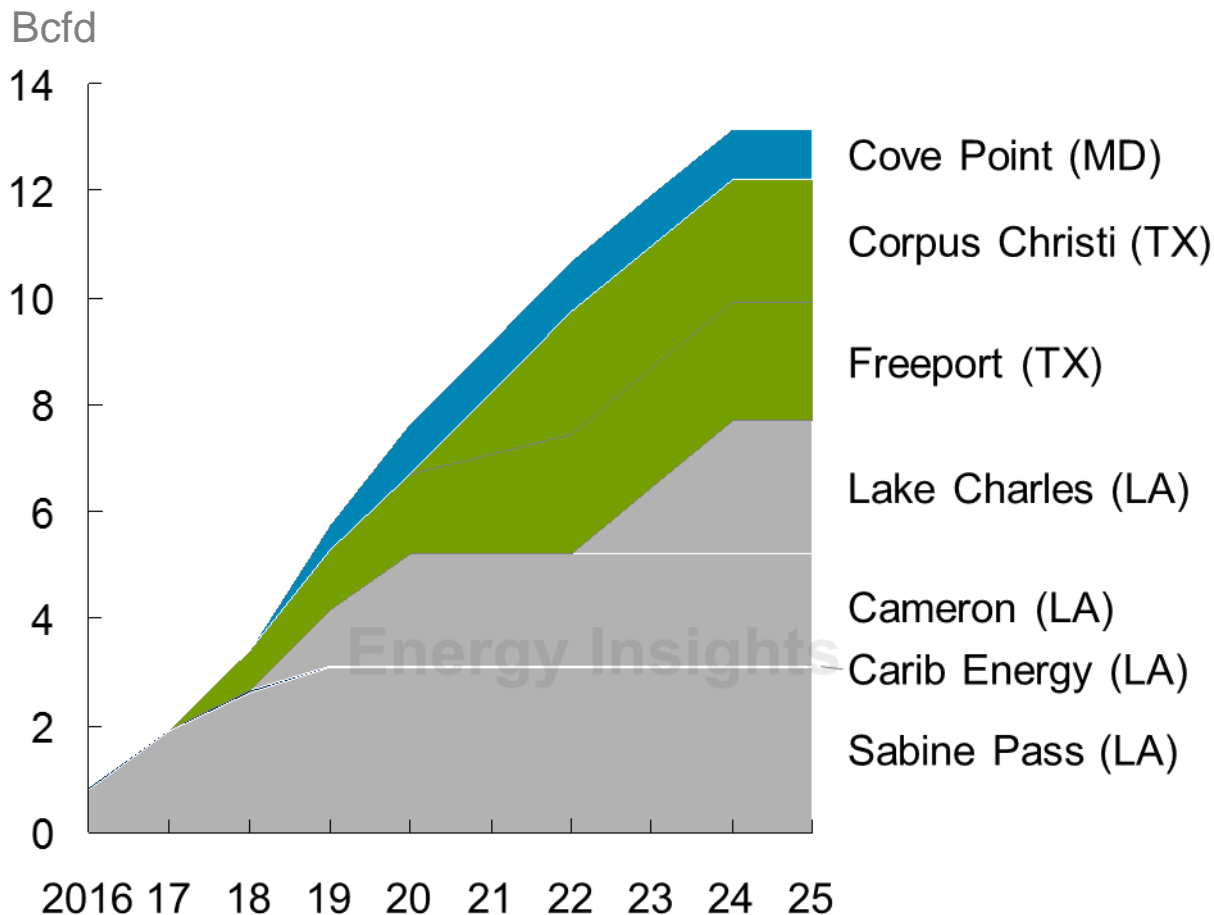
- **New US and Australian LNG capacity is coming on stream just as the recent surge in Asian demand has begun to slow**
- **2017 to 2022 sees the market over supplied for a short period as demand cannot keep up with capacity additions**
- **Low oil prices and an over supplied LNG spot market provide poor conditions for long term contracts and project FIDs, increasing the risk that from 2023 the market becomes tight**

A LNG exports will have a significant impact on US gas demand, although market conditions will limit new NA LNG export projects

North America LNG export capacity outlook

» Observations

Reference case LNG export capacity by 2025

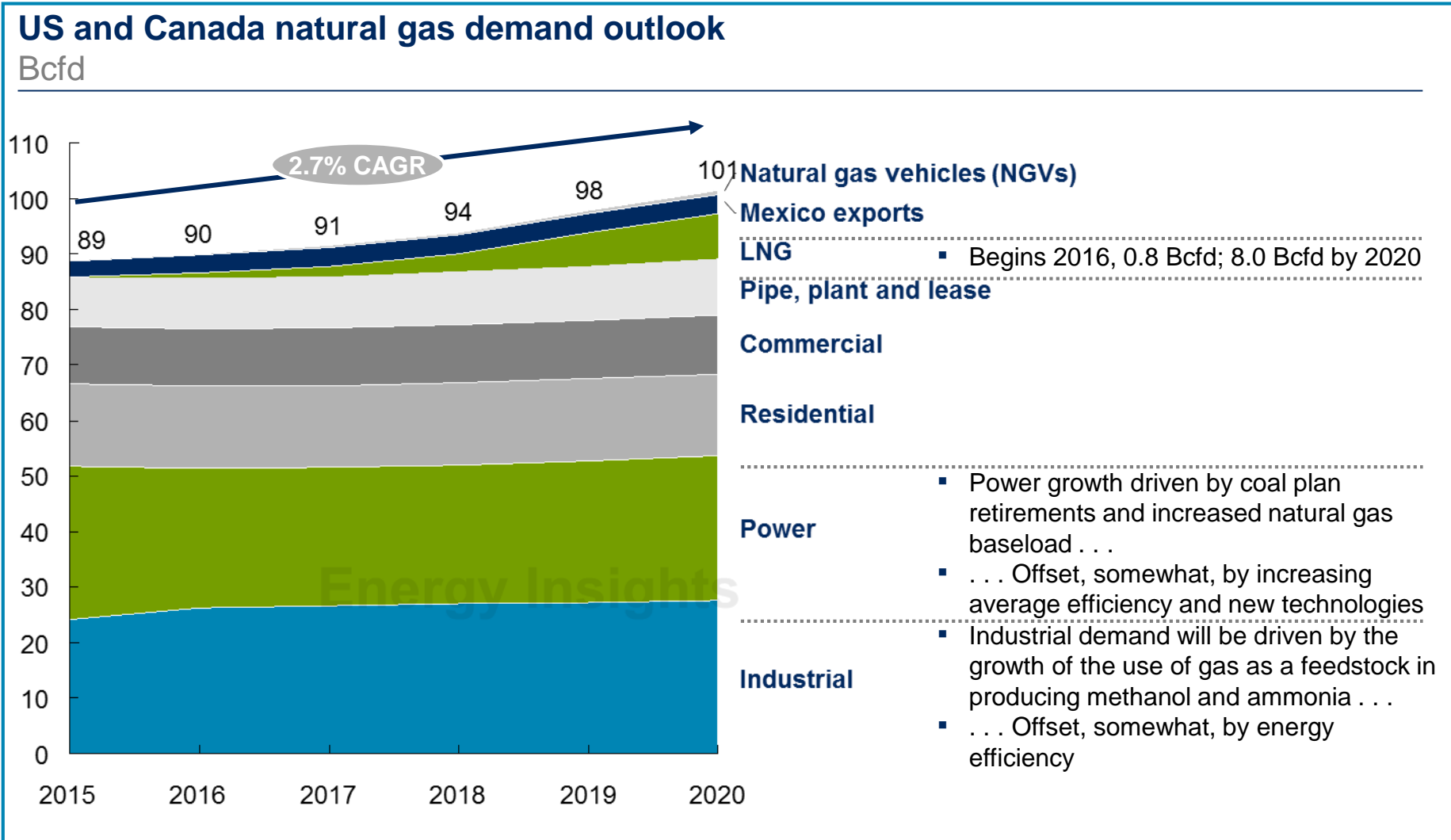


- An expected loose, global LNG export market, is projected to limit new projects, until global LNG market tightens in 2023+



- Of the North American terminals not under construction, we are projecting that **only Lake Charles goes FID** (Final Investment Decision) in time to export volumes by 2025

B To 2020 our reference case outlook for NA demand is for modest growth, increasing from 89 Bcfd (2015) to 101 Bcfd (2020), driven by LNG exports

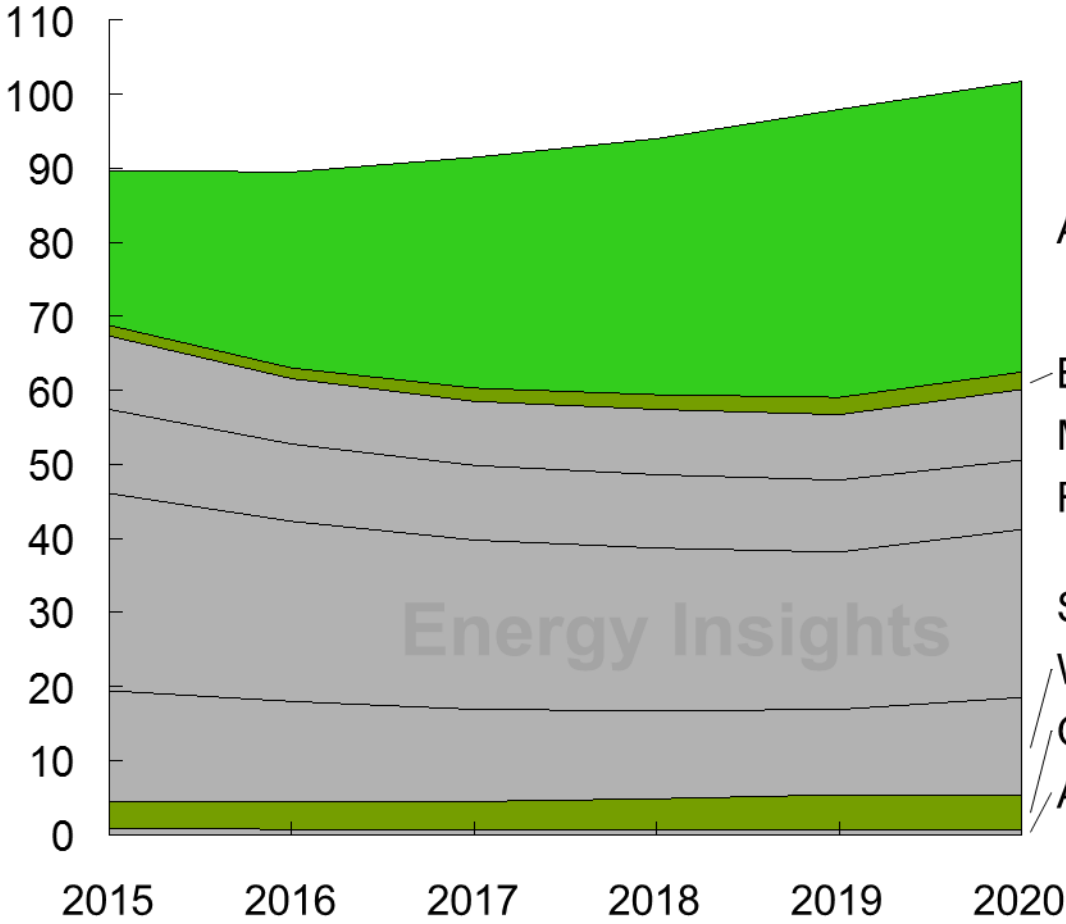


B Most incremental gas production, to meet this demand, is expected out of Appalachia

MODELED

Cumulative incremental production – “sufficient infrastructure case”

Bcfd, annual average



	2020 vs 2015 prod.	
	Bcfd	CAGR 2015-20
Total	12.0	2.5%
Appalachia	18.3	13.3%
Bakken	0.9	9.9%
Midcon	-0.4	-0.8%
Rockies area	-1.9	-3.7%
Southern Supply	-3.9	-3.1%
Western Canada	-1.9	-2.7%
Offshore	1.0	4.8%
Alaska	-0.1	-1.9%

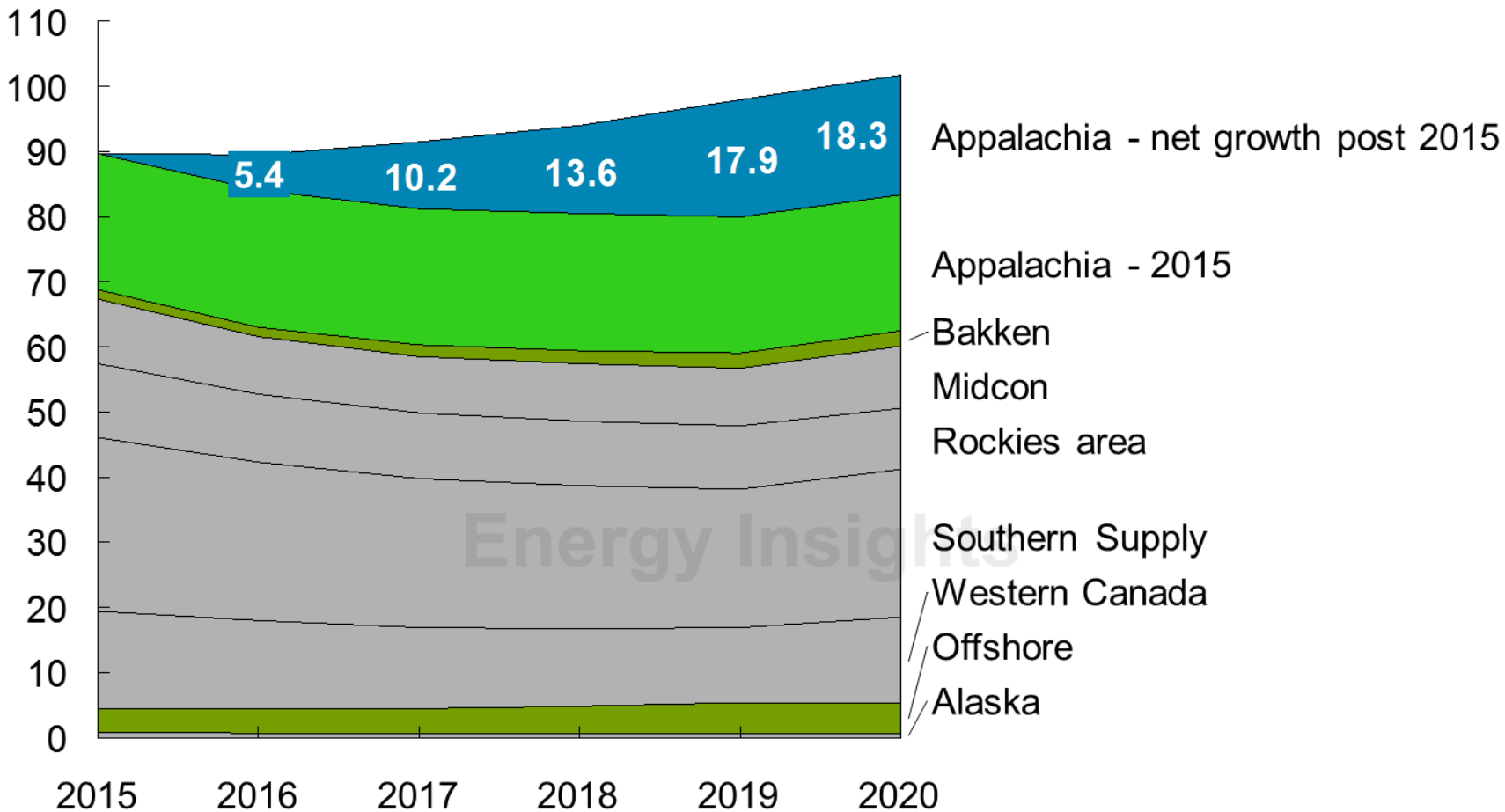
Energy Insights

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Cumulative incremental production – “sufficient infrastructure case”

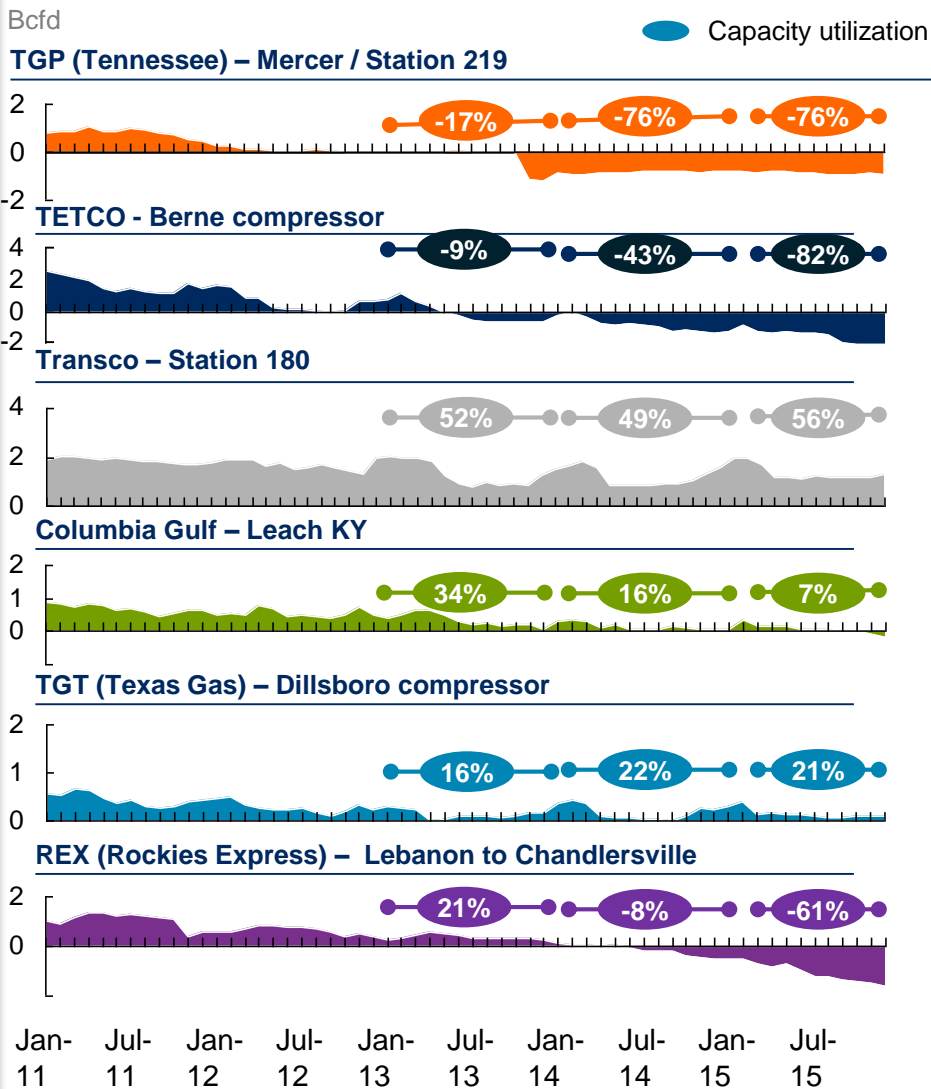
Bcfd, annual average



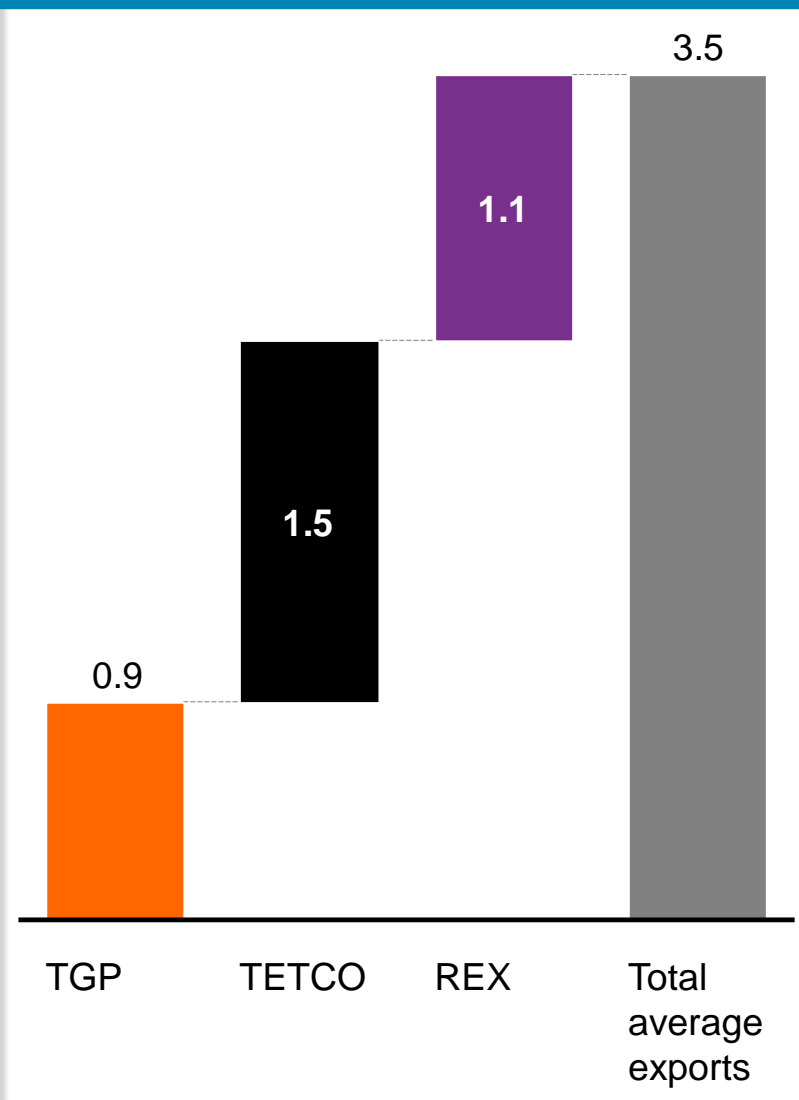


Marcellus gas production is displacing imports to the Northeast – flows on pipelines to Northeastern markets have accelerated reversals

Flows at key points – Bcfd flows and ave. capacity util./year



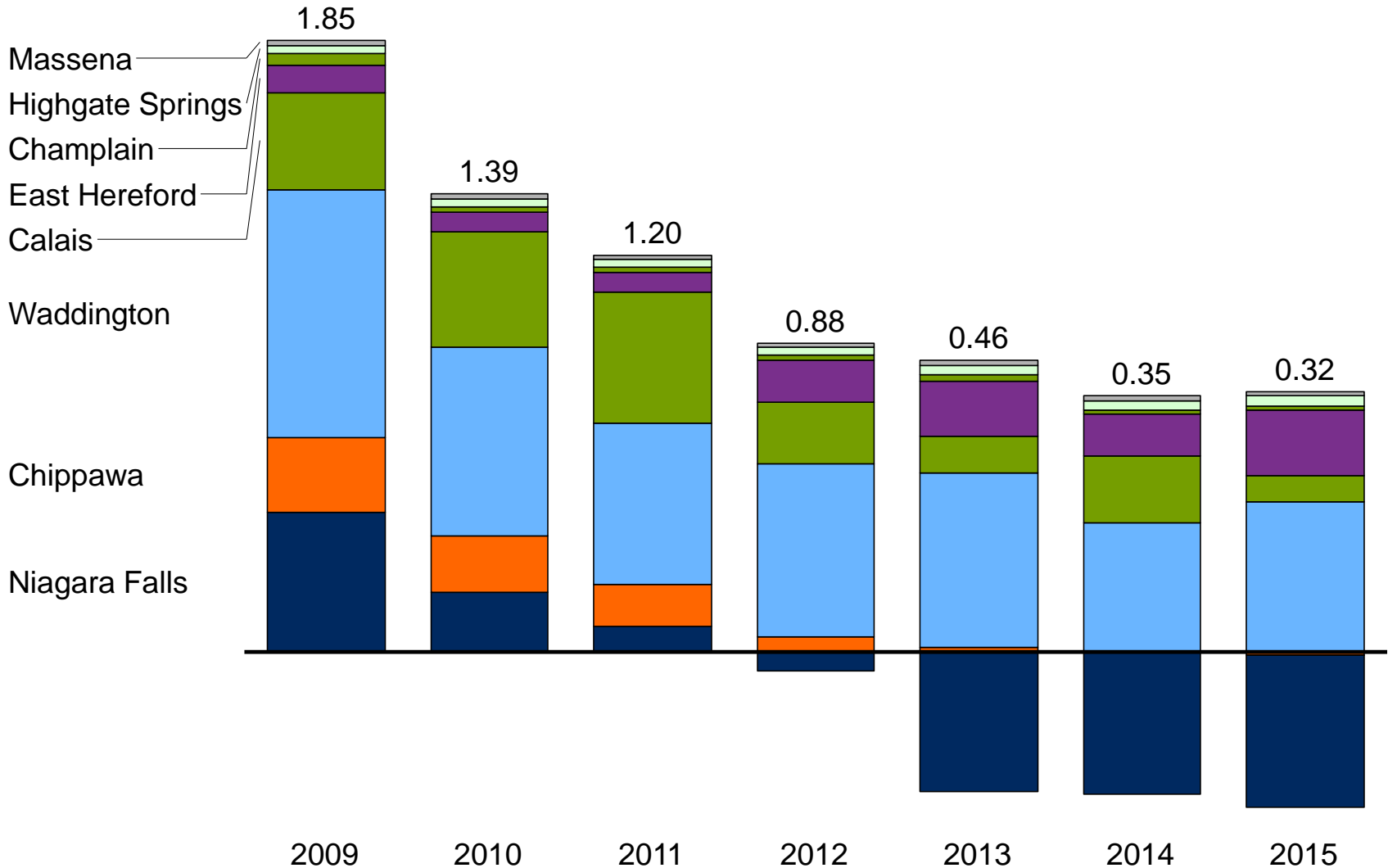
2015 net export volumes outside region (Ave. Bcfd)



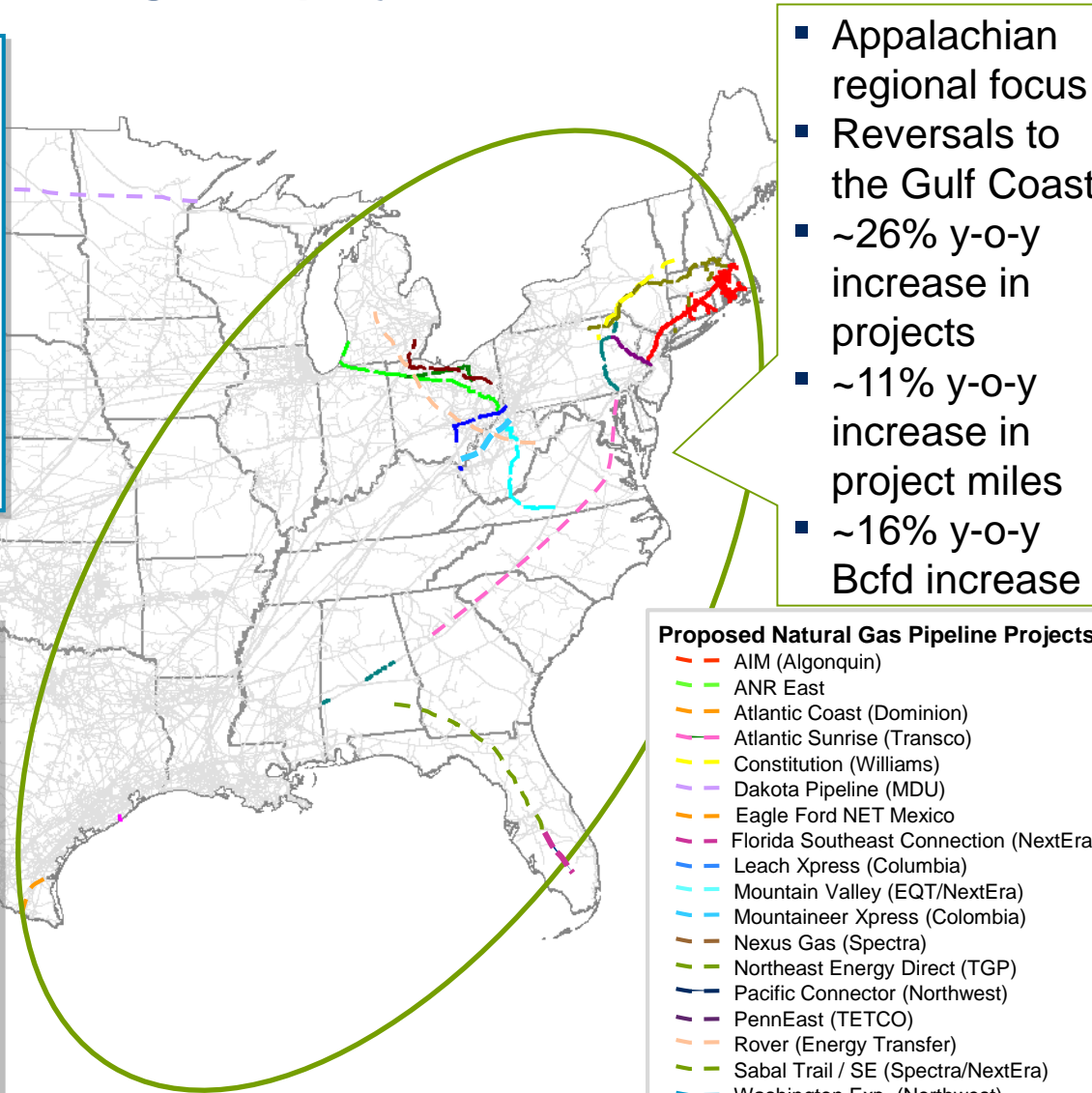
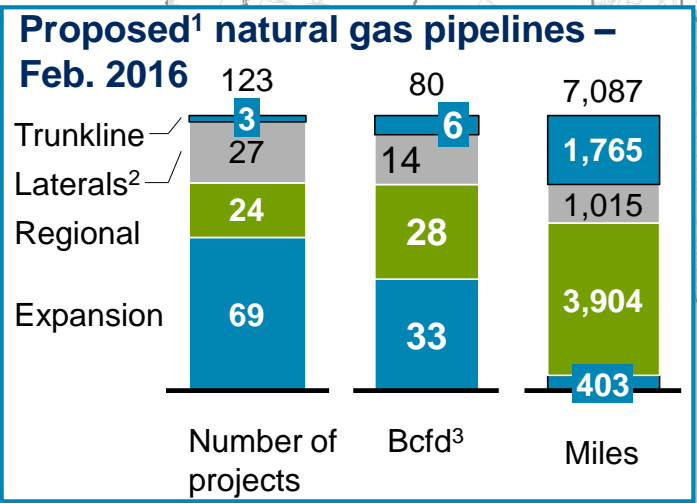
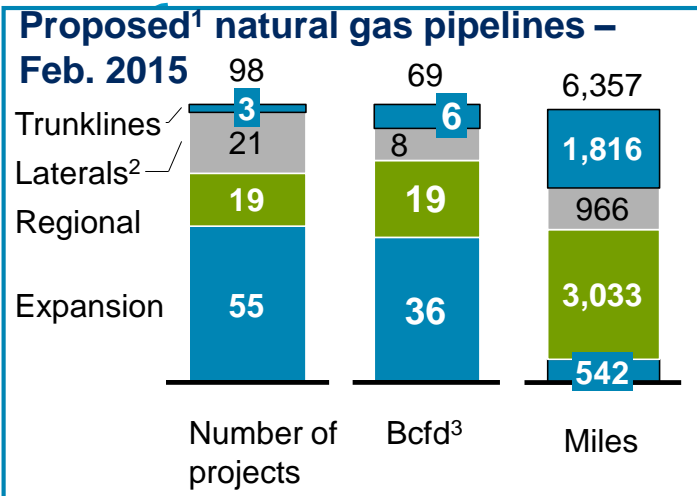


Marcellus gas production also displacing Canadian deliveries into the US, with flows into Canada from Niagara beginning in 2012

NE US receipts from Canadian pipelines (Bcfd)



Proposed¹ natural gas, interstate pipeline projects – continue expanding beyond regional projects to reversals to the GoM



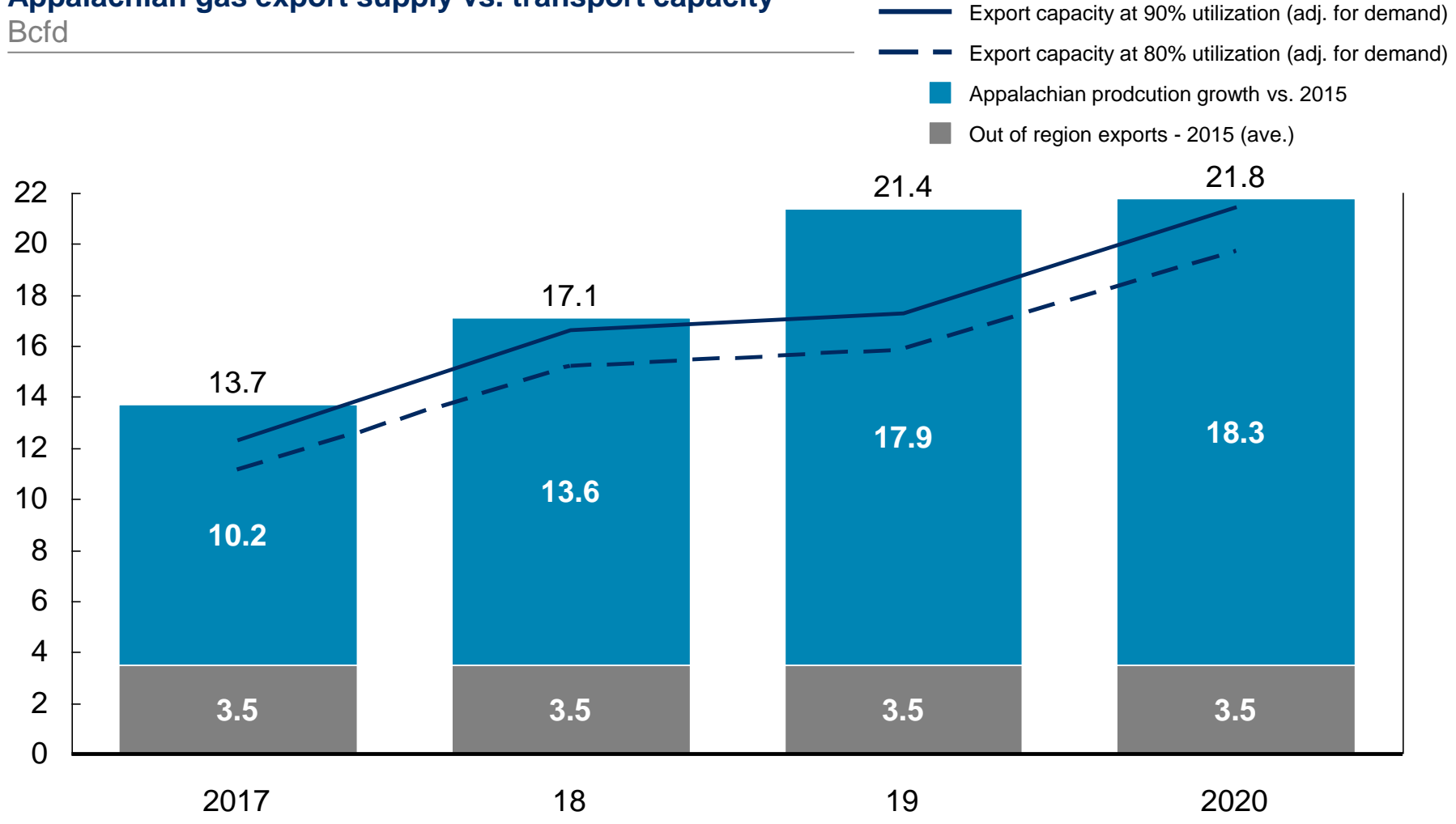
- Appalachian regional focus
- Reversals to the Gulf Coast
- ~26% y-o-y increase in projects
- ~11% y-o-y increase in project miles
- ~16% y-o-y Bcfd increase



Appalachian production set to outstrip export capacity, after taking into account regional demand increases, including Cove Point LNG exports

Appalachian gas export supply vs. transport capacity

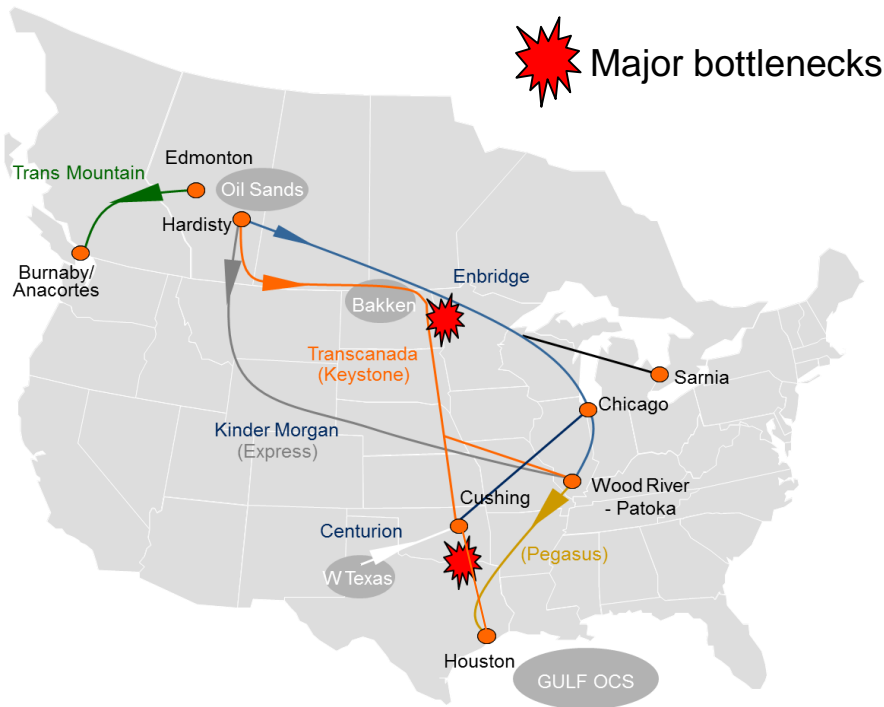
Bcfd



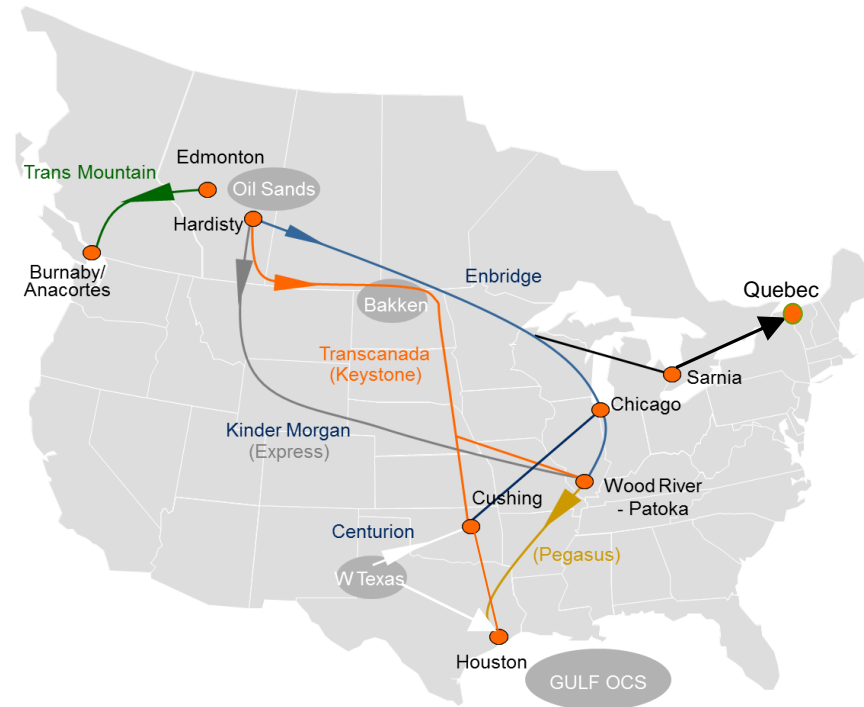
Note: Export capacity based interstate pipeline capacity and and incremental demand growth within the Appalachian/Northeast region.

D Pipeline bottlenecks between the Midwest and the Gulf Coast have essentially disappeared with pipeline expansions and builds

2013 – bottlenecked



2016 – bottlenecks relived

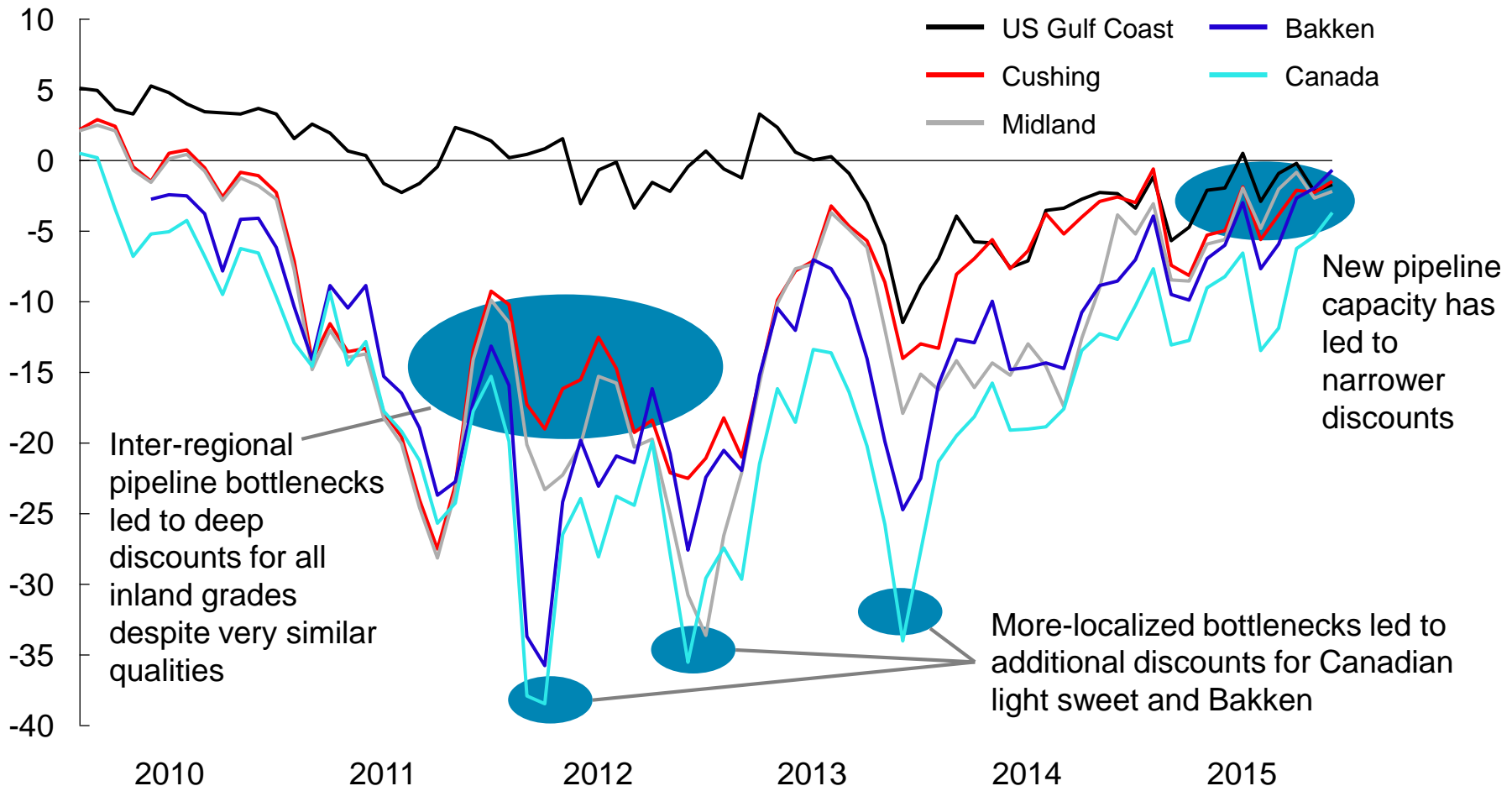


- With 2014-2015 expansions and production growth slowdowns, crude differentials have generally collapsed to pipeline transportation costs
- Crude by rail no longer is in the money in the East; imports are on the margin
- Crude exports have decreased Gulf delivered crude potential differentials to international markets but infrastructure is needed to optimize exports – including regional pipelines, storage, and export terminals

D As a result, North American inland crude discounts to Brent have narrowed to pipeline differentials in the last year

Quality adjusted light sweet crude prices as a differential to Brent, by location¹

\$/bbl, monthly average



¹ Spot prices of light sweet crude in each location, adjusted to WTI quality, as a differential to Brent FOB

E Transformational trends in power generation

1 Solar PV



- Installed costs down **~75% today vs. 2004**; **further cost declines of around 40% or more expected** by 2020
- Cost decline will drive **retail rate parity** by 2020-2025

2 Energy Efficiency



- **Technological breakthroughs** in HVAC and lighting: LED costs have come down by **>90%** in just 10 years
- **Smart appliances** enable 3rd parties to innovate around EE
- **Accelerating adoption** of building codes / appliance standards

3 Energy Storage



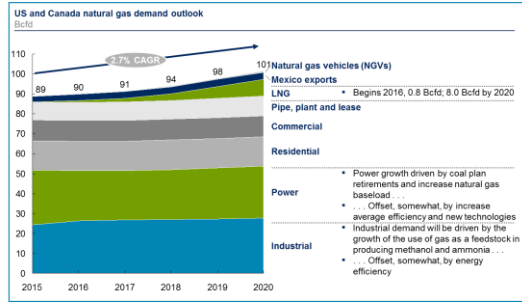
- Storage, combined with solar, EE and a small back-up generator, **could make “grid defection” economic for a small group of customers as early as 2025**
- Battery pack costs down from **\$1000 / kWh** in 2007 to **~\$380** today; could hit **\$100 / kWh by 2030** (90% decline in <25 yrs)

- **What is the impact on power generation loads?**
- **How will transformational trends in power generation impact baseload and swing needs of gas-fired generators, and pipeline new builds?**



Framing the impact of emerging power technologies on natural gas transmission and storage

To 2020 our reference case outlook for NA demand is for modest growth, increasing from 89 Bcfd (2015) to 101 Bcfd (2020), driven by LNG exports



Key elements and questions

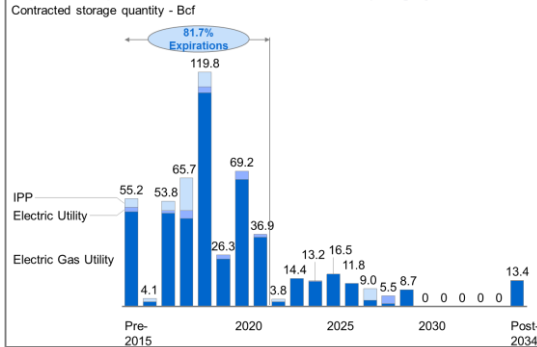
- In addition to coal retirements, **how will emerging power technologies impact gas-fired power demand to 2030?**
 - Base load? Swing?
 - Regional differences, and pipeline flow impacts?

Expiration of power contracts of FT – with most expiring by 2021



- Very little IPP and Electric Utility Firm Transportation contracted (most FT contracted by Electric Gas Utilities for R&C gas demand)
- 64.1% of power related FT (including Electric Gas Utilities) expiring by 2021
- **How will emerging power technologies impact FT for power generation, considering based load and swing needs?**

Expiration of power contracts of FS – with most expiring by 2021



- Very little IPP and Electric Utility Firm Storage contracted (most FS contracted by Electric Gas Utilities for R&C gas demand)
- 81.7% of power related FS (including Electric Gas Utilities) expiring by 2021
- **How will emerging power technologies impact FS for power generation, considering based load and swing needs?**

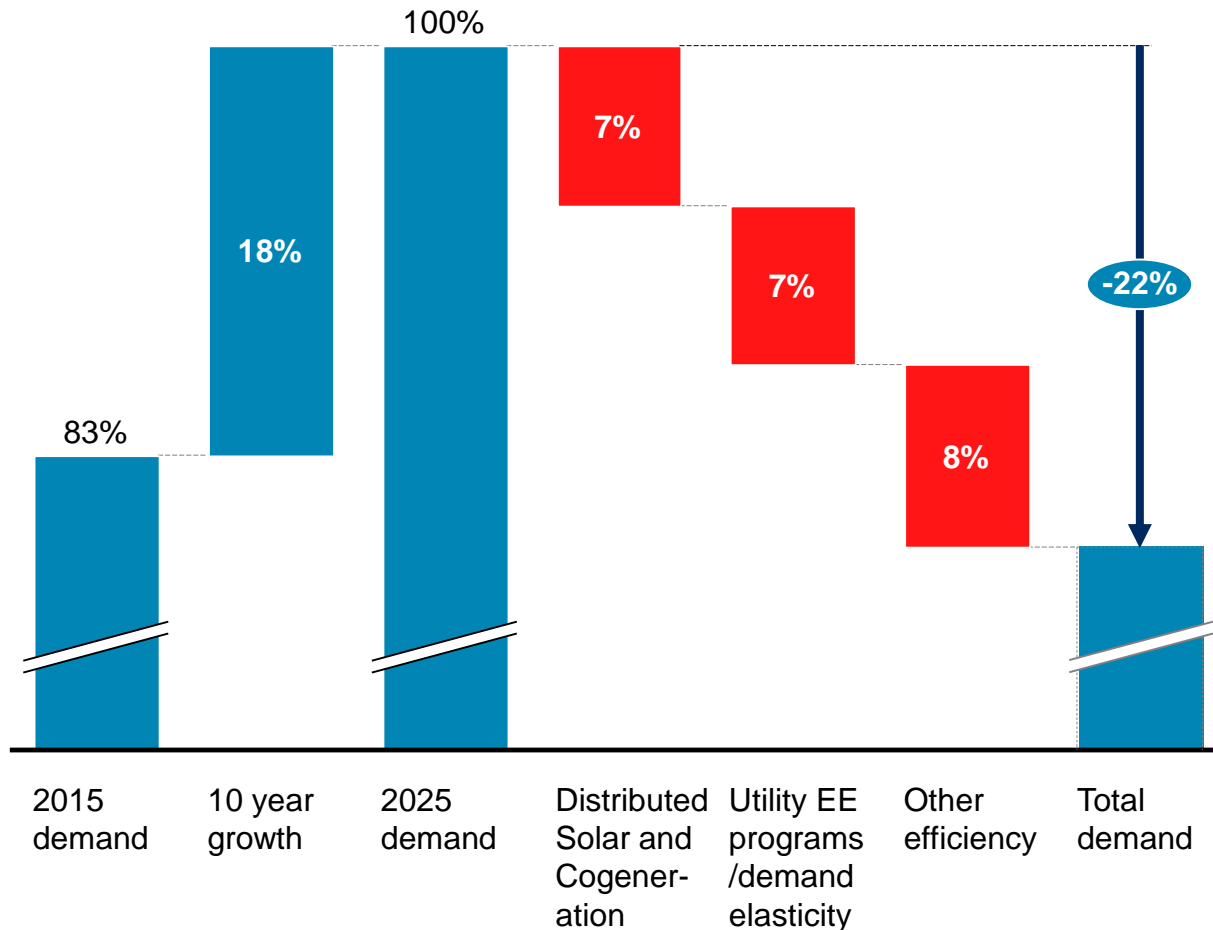


These trends may have significant implications for long-term demand and load growth for North American utilities

CALCULATED EXAMPLE

Calculated demand across selected US States

100% = baseline load forecast for 2025 Kwh load



- Solar and energy efficiency technologies **will reduce demand from for all generators**, so will have an impact on all fossil fuels, including gas
- All new power generation technologies **will likely have a greater impact on peak demand**, and especially on gas peaking, since gas is often the marginal fuel

E Examples of how new power technologies are impacting power generation loads

Countries (Italy)

Baseload

- Electricity demand in Italy decreased 26 TWh in 10 years and growth in renewables has displaced Gas and Oil generation
- Between 2013 and 2014, gas demand decreased 12% or by 7.9 bcm, and has declined 4 years in a row as a result of policies favoring renewables (RES – Renewable Energy Sources)
- RES share of electricity generation increased from 19%, in 2005, to 44%, in 2014 (including hydro)

Peaking

- Until 2011, Italian CCGTs ran during on-peak hours as an offset to their decreased competitiveness, but now this strategy is no longer sustainable, the peaking role of CCGTs has decrease materially

Buildings (DOE)

- Approximately 45% of DOE buildings, in a sample set, are expected to have a profit set of at least \$500/year in 2020 vs. 27% in 2015
- The economics are driven by lower expected power storage costs

Cities (Texas)

- In October 2015, Austin, Texas approved solar power from West Texas, with the goal for providing 55% of power from renewable sources by 2025
- Georgetown, Texas will be 100% renewable-power based, when a solar plant is brought on-line by the end of 2016

Pipeline and Midstream Operations Roundtable guiding questions



1 *Trends: What new trends are you seeing impacting North American pipeline 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 is the expected impact of the projected, dramatic increases in Marcellus and Utica production on the regional and interstate pipeline grids? Other basins?*

4 *NGLs: Are you seeing gas quality issues restricting flows into gas pipelines because of the lack of liquids take-away capacity, especially in Marcellus/Utica?*

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 develops and supports McKinsey proprietary tools and insights in Oil & Gas



A McKinsey Solution

- 70+ team of dedicated experts across 4 major hubs: London, Houston, Singapore, Wrocław
- Proprietary methodologies, insights, and data on global markets and supply chain
- Suite of integrated models and new online technologies
- 20-year track record and multiple offerings in benchmarking
- Focused Diligence capability
- Linked to McKinsey’s global network of energy experts

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- **Market Overviews – reports & subscriptions**

Informs strategic decision making and performance improvement by delivering robust forecasting and advanced market analytics on global crude, refined product, and natural gas markets

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- **Commercial due diligence**
- **Micro-market analysis**
- **Bespoke analysis**

Enables fact-based decisions for commercial due diligence, strategic planning, and business development through expert professionals and proprietary models

Benchmarking

- **Performance benchmarking**

Helps drive asset productivity and performance by providing in-depth quantitative benchmarks, objective assessments of comparative performance and practices, and actionable insights into major areas for improvement

Energy Insights provides several market analytics gas offerings

Gas solutions

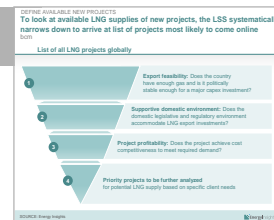
1 Global Gas Model

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



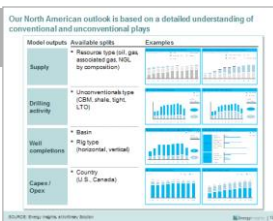
5 LNG Sourcing Solution

Detailed approach on how to source gas: when to source, where to source from (geography, terminal), and under what conditions to source



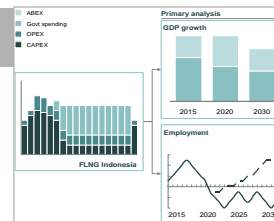
2 North America Supply Model

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



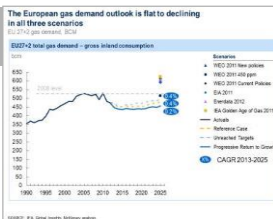
6 Gas Monetization Tool

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



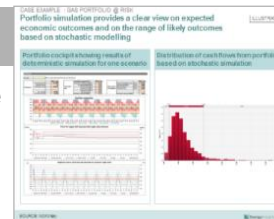
3 European Gas Model

Country-level demand-supply perspectives for EU28+2, including sector and country analyses and scenarios



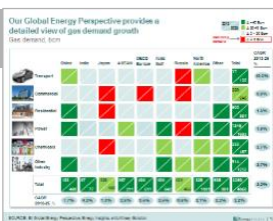
7 Portfolio @ Risk

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



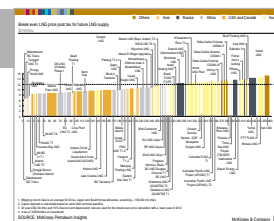
4 Global Energy Perspective

Forecasting capability of global fuel demand across sectors and regions, resulting in a gas demand outlook consistent with total energy demand



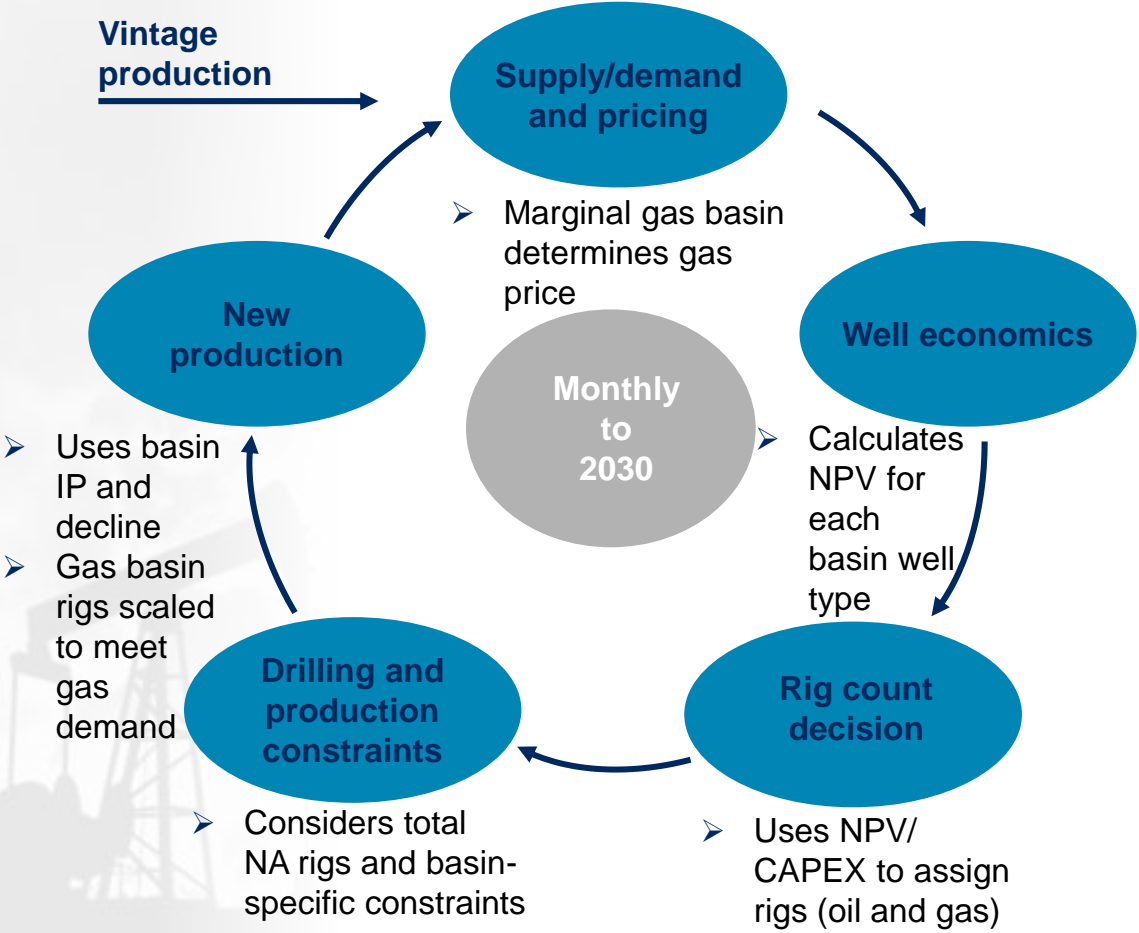
8 LNG Cost Curve

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



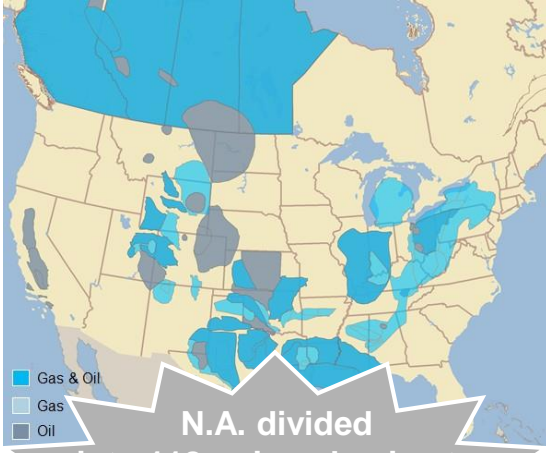
The North America supply model uses basin features to help forecast activity and produced volumes by sub-basin

NA Oil & Gas Supply Model schematic¹



Model outputs

- Drilling activity, wells completions and production broken down by:
 - **Basins, sub basins and well level** (40K-50Kwells per year)
 - Resource type (incl. shale gas, tight gas and Light Tight Oil (LTO))
 - Rig type (horizontal, vertical)



N.A. divided into 118 unique basins to take account of geology & local capability

¹ Does not cover Alaska, Gulf of Mexico offshore and Canadian oil sands

Contacts

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