

North American Gas Perspectives

Summary outlook

June 2018



Energy Insights
By McKinsey

Six key supply and demand drivers impacting North American gas prices

Supply and demand

	Drivers	Share demand growth to 2030	Current market condition/disruptions	Sensitivities
Demand	LNG 	55%	Global LNG market is expected to be long until 2024, although US terminals' utilization at ~80%, with potential as a seasonal exporter	Potential swing of ~2 bcfd from 2021-24 based on changes to global demand
	Mexico 	14%	Falling domestic production and increasing power and industrial demand will drive the need for gas imports as new pipelines are commissioned	Lower US import gas demand due to weak Mexican GDP and/or additional associated gas production from deep-water/shale
	Industrial/petchem 	15%	Inexpensive gas feedstock will enable North America to be a net methanol and ammonia exporter, from net importer	A potential of 2-3 bcfd demand growth with additional announced capacity by 2030
	Power 	13%	Gas will continue to offset coal retirements for power generation but growth will be tempered by rapid development of renewables post-2020	Higher regional price volatility due to increased usage of unpredictable renewable generation
Supply	Unconventional 		Technical breakthroughs will keep boosting shale gas production while driving down costs, especially for the next 2-5 years in marginal plays like the Haynesville	Innovations in water procurement/disposal leading to additional cost savings as well as targeting secondary shale plays from existing wells
	Associated gas 		Associated gas , especially from the Permian and SCOOP/STACK, could increase downward pressure on gas price	~14 bcfd of incremental associated gas may be produced by 2030

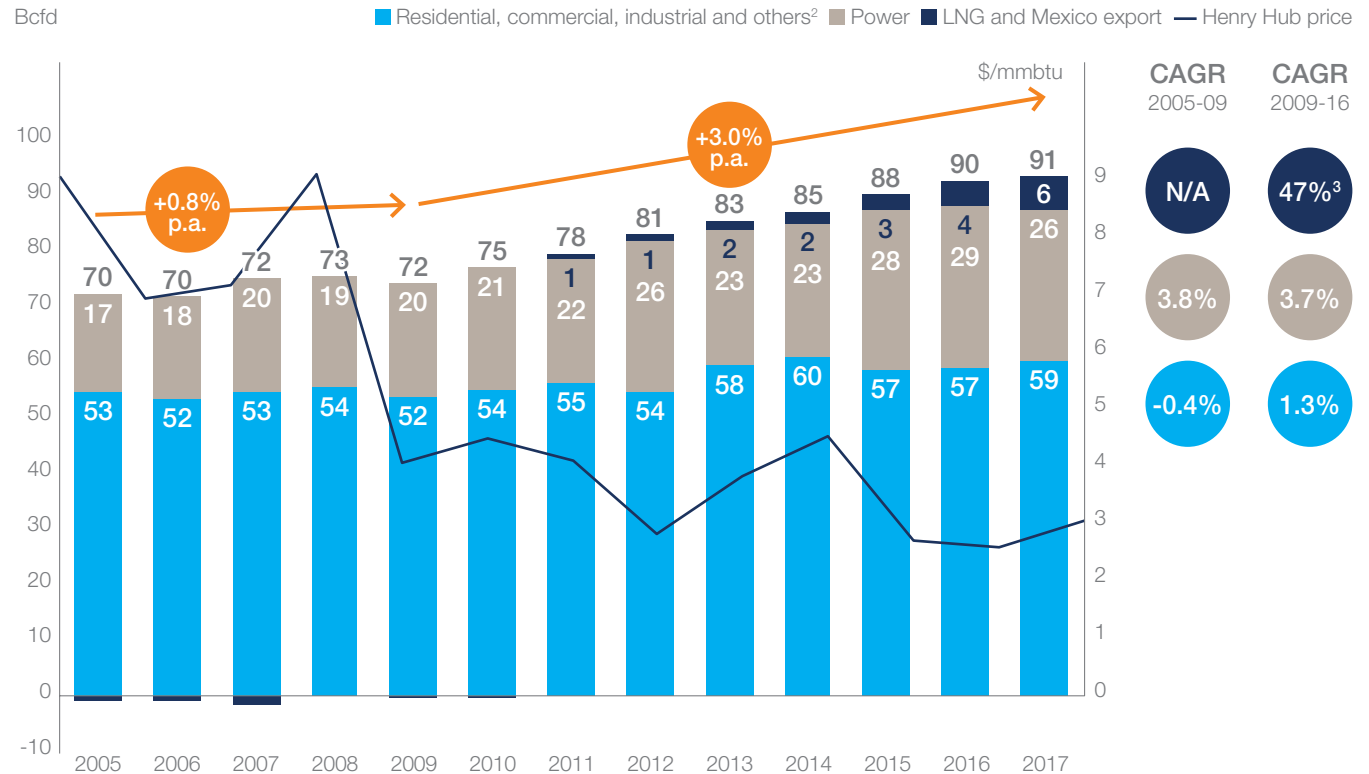
Gas demand in North American was flat until 2009; since then, it has grown at ~3% p.a. with 70% gas price drop

Seasonal heating and power continue to drive the market, with power driving the most growth in gas demand since 2005 (an increase of 12 bcfd).

North America has transitioned from being a LNG importer to an exporter.

Rapid growth rates in gas exports to Mexico added 3 bcfd in gas demand.

North American gas demand by sector¹ and Henry Hub price



Note: individual numbers may not equal total due to rounding

¹ Net of balancing items ² Others include natural gas vehicles and pipe, plant and lease fuel, which is gas used for pipeline fuel, consumption at gas plants, lost during transportation, and for usage for compressors and equipment at lease sites ³ CAGR starting from 2011 to 2016

Source: EIA, NEB, NYMEX, McKinsey Energy Insights

Gas supply has shifted from conventional to unconventional; shale gas has grown at 27% p.a., reshaping the North American gas supply outlook

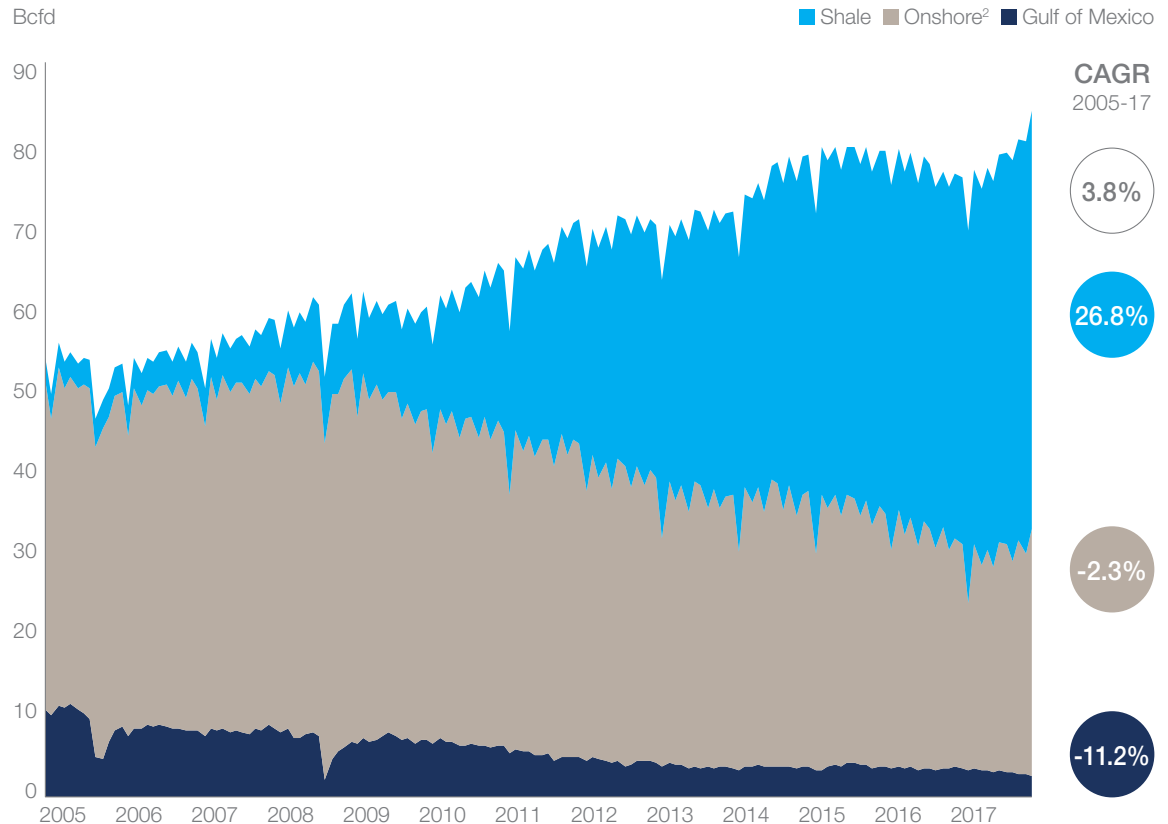
Shale virtually exploded from nothing to the driving force of gas supply.

Gas production has remained resilient despite low prices:

- High grading of drilling programs
- Increasing well sizes in Marcellus
- Improved rig productivity (e.g., pad drilling, drilling days)
- Infrastructure de-bottlenecking, releasing choked wells
- Strong contribution from associated gas with the development of light tight oil

US dry gas production¹

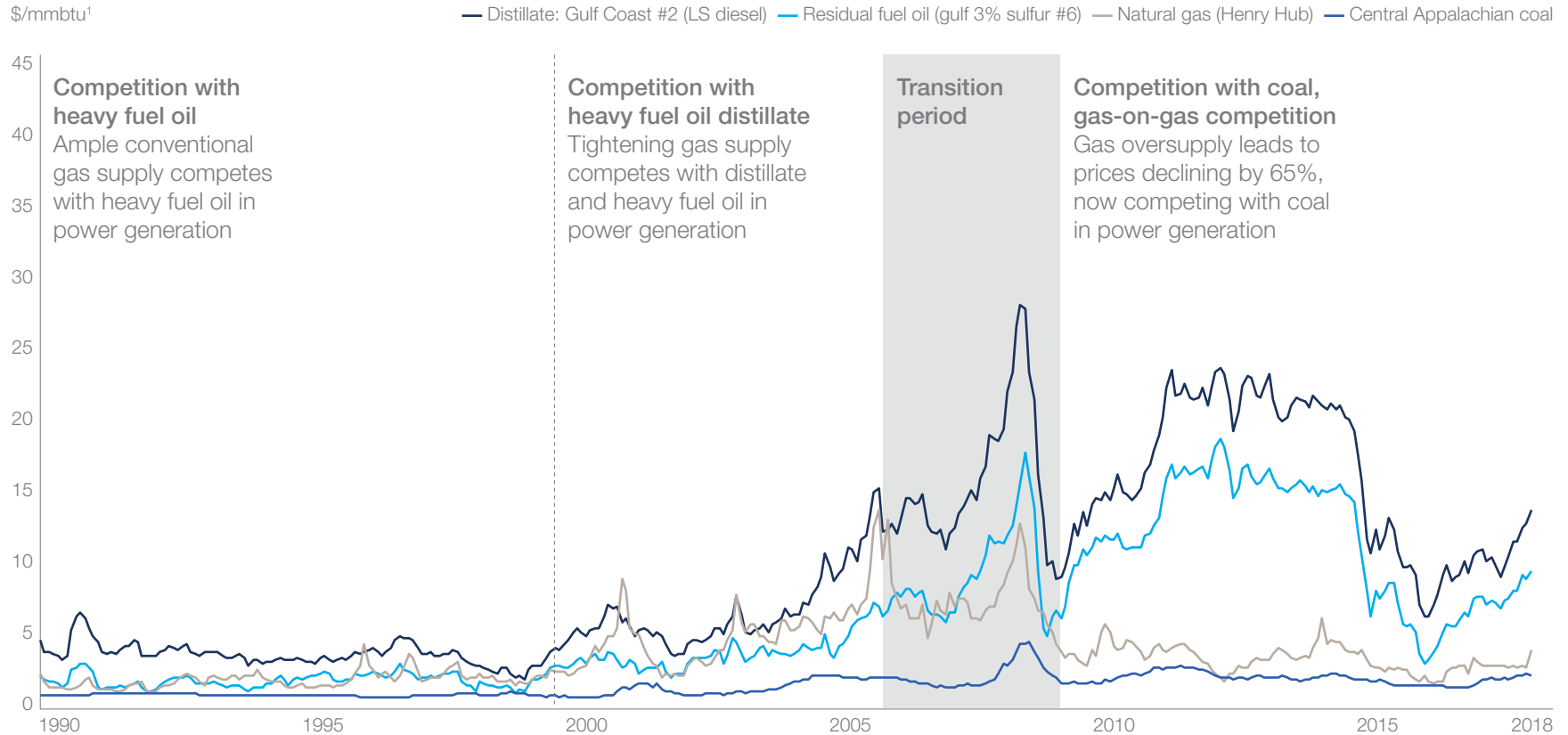
Bcfd



¹ Total dry gas production taken from EIA Natural gas dry gas production file ² includes Alaska
Source: Drilling Info; EIA; NASM; Baker Hughes

Shale gas boom has weakened gas prices into competition with coal in the power sector, as prices declined by ~65% post 2008

Historical commodity prices



¹ Converted at heat content of 6.29 for Gulf Coast RFO, 5.78 for Gulf Coast No.2, 26.45 mmbtu/ton for Central Appalachian Coal
Source: NYMEX; Bloomberg

Growing shale production from northeast has changed how gas flows in the United States in the last eight years

Growing shale production has changed the main supply areas:

- In 2008, gas in NA mainly comes from three areas: the gulf coast including the mid-continent, western canada and the rockies
- In 2016, significant growth in unconventional makes the marcellus/utica the largest gas producing area

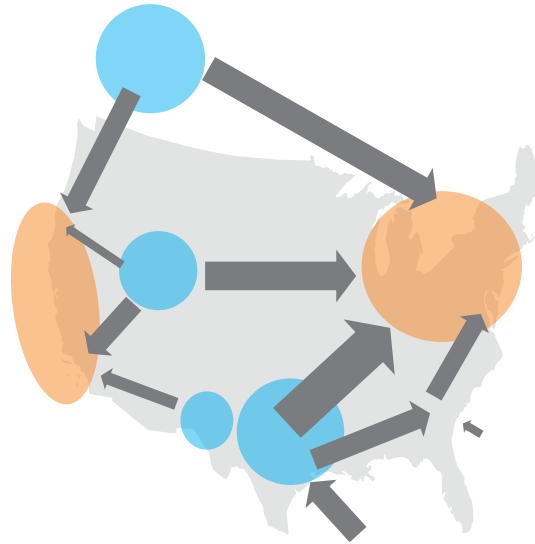
Growing demand in the south market has reversed flow from north to south:

- TX and LA enjoyed the largest demand growth of 2.2bcfd due to growing power and industrial demand
- >2 bcfd for mexico export in the past two years has changed the flow direction in south texas to move gas down south through agua dulce

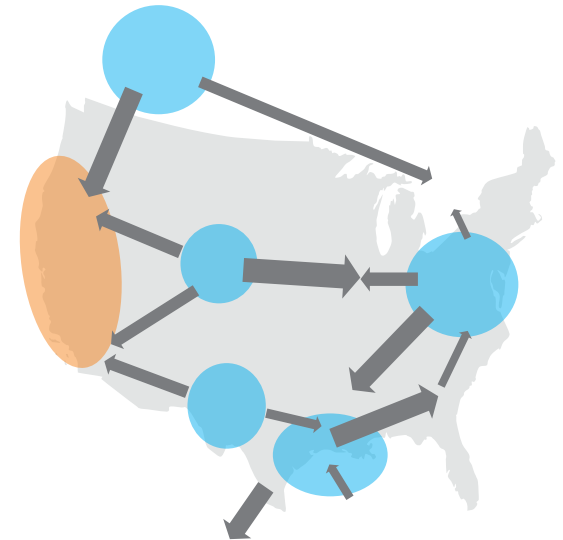
Major movements of piped gas across North America

■ Exporting region ■ Importing region ➔ Gas Flow

2008

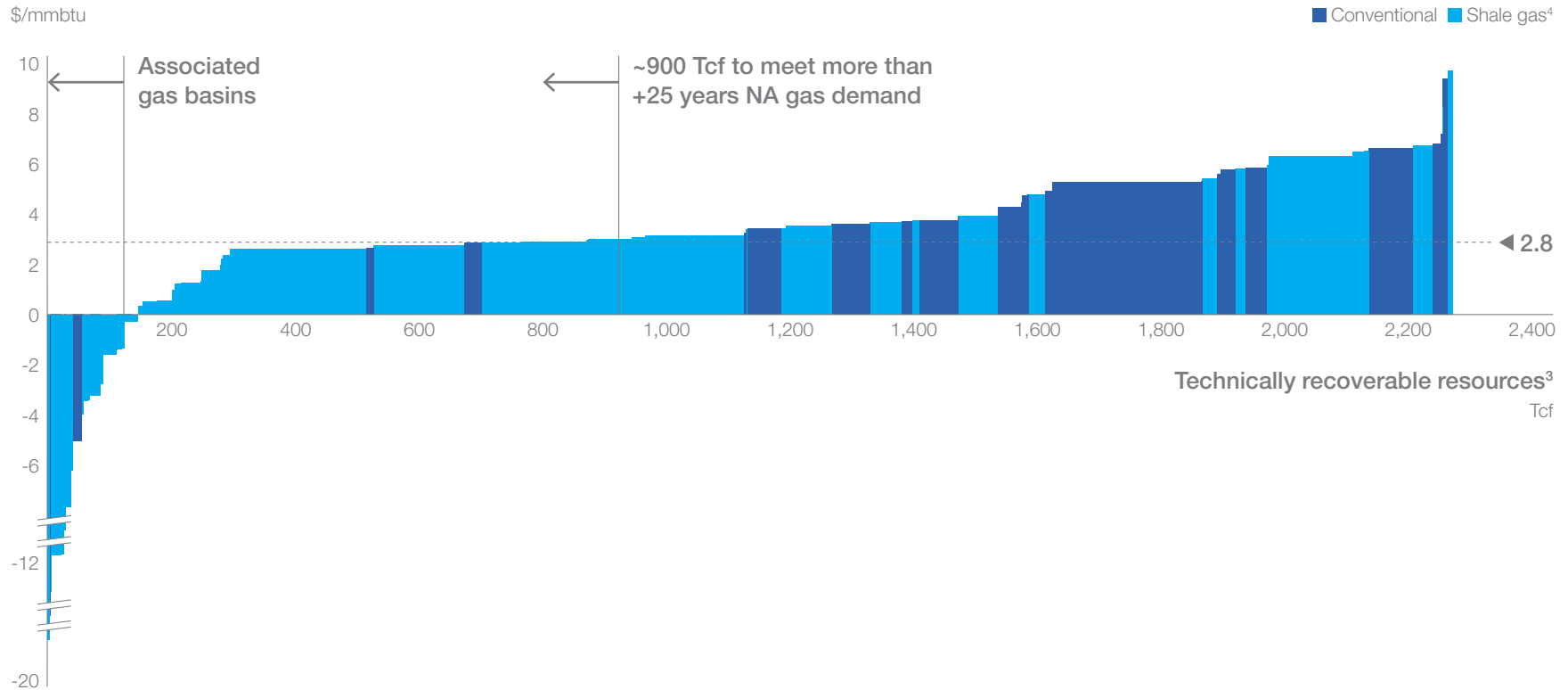


2017



North America can produce enough gas to meet +25 years of demand below \$2.8/mmbtu

North America half-cycle break-even price curve^{1,2}



¹ Break-Even price normalized to Henry Hub. Assumes \$60/bbl WTI and 10% IRR. Excludes finding and land costs (includes drilling and completion costs and all operating costs)

² Covers all the NASM gas basins with breakeven price below \$10/mmbtu, as per 2017 estimates ³ Assumes size of production area based on basin acreage, well density and average

EUR capture rate ⁴ Include shale gas formations and light tight oil formations

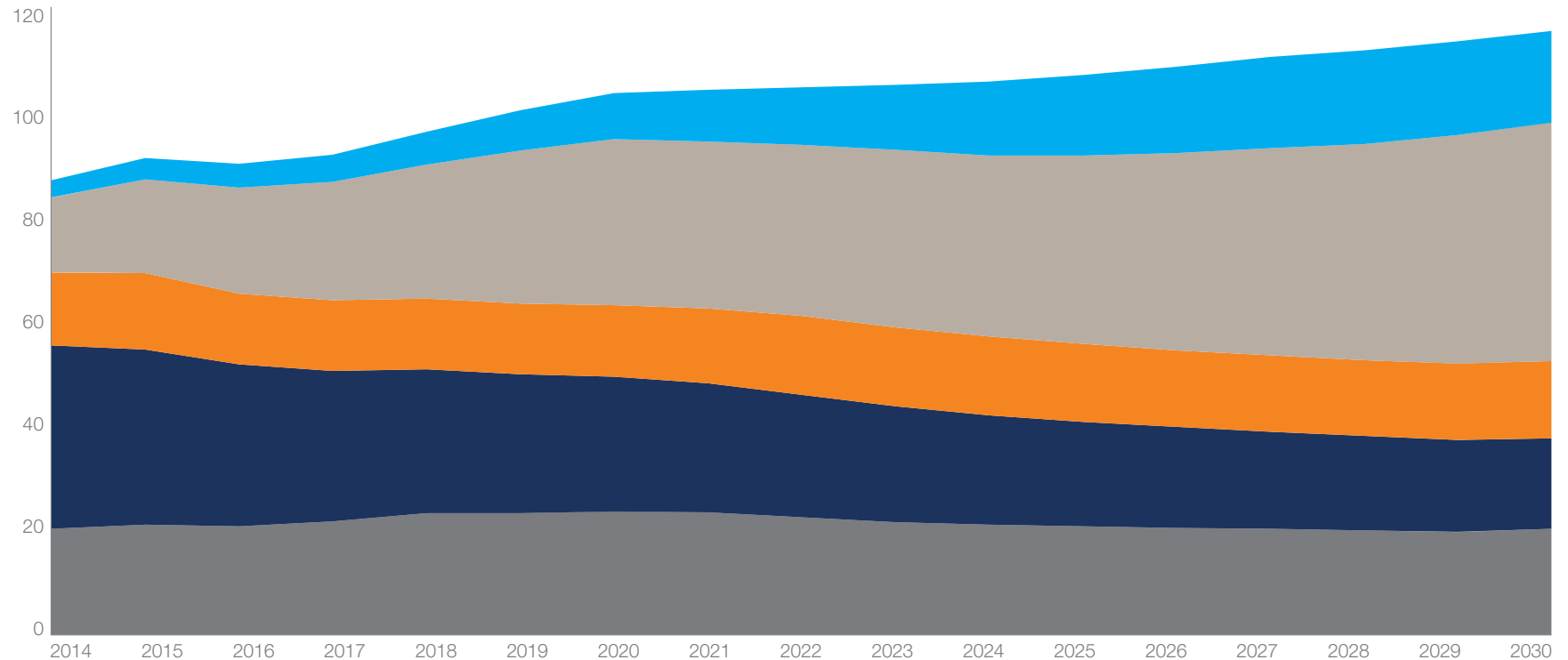
Source: Energy Insights North American Supply Model; press search

By 2030, the Permian and Appalachia will supply ~55% of the North American market

North American gas production by basin

Bcf/d

■ Permian ■ Appalachia¹ ■ Other associated gas ■ Other production ■ Other shale



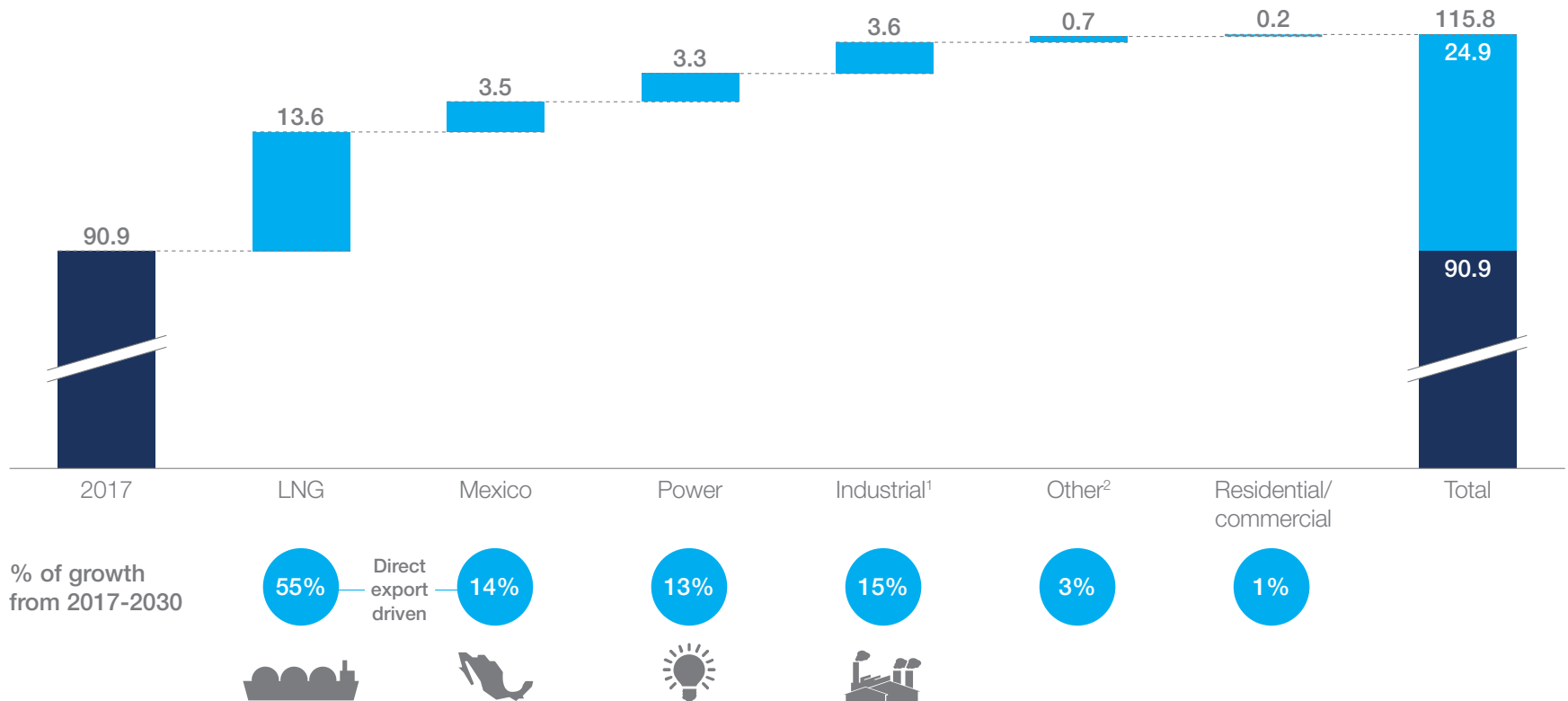
¹ Appalachia total production constrained at 24 and 28 Bcf/d in 2017-18, assuming 90% pipeline take-away capacity

Source: EIA; Energy Insights North American Supply Model

~70% of expected North American gas demand growth is linked to global drivers, mostly through LNG exports

North American gas demand growth by sector (2017-2030)

Bcfd



¹ Mainly global commodities developed using gas as a feedstock or fuel, driven by factors such as chemical export ² Includes pipe, plant, lease and NGVs

Source: Energy Insights, McKinsey experts

Despite global oversupply, utilization of US LNG export capacity expected to remain high (80-90%) through 2024 when new capacity comes online



Short- and long-term considerations

Short-term

In the short term, demand for US LNG increases as capacity comes online: utilization at US liquefaction facilities is about 90% from 2018-2020, due favorable economics and contracting

Medium-term

No additional N. American projects needed from 2021 to 2024 as new LNG supply comes online from Qatar, Iran and Mozambique. From 2021 to 2024, US LNG exports are flat at ~8.2 bcf/d with ~80% utilization

As the marginal supplier to the Pacific, US LNG exports are highly sensitive to Asian demand

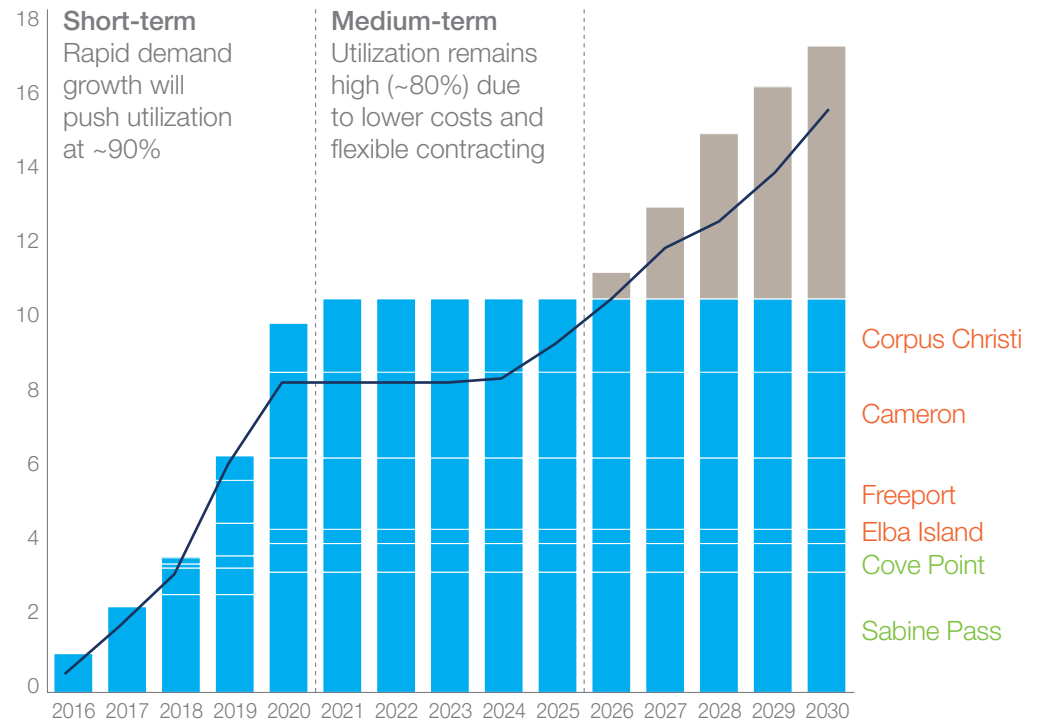
Long-term

Second wave of LNG starts from 2025 after existing terminals approach 90% utilization

US¹ LNG capacity² and demand outlook

Bcf/d

— US LNG exports, base case ■ Speculative³ ✕ Operating ✕ Under construction



¹ Base case does not require additional LNG exports from Canada, Alaska or Mexico ² Capacity assumes 100% utilization ³ 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

Supply and demand drivers will sustain current NA gas prices in short to medium-term but will eventually lower gas prices in long-term

Potential impact on gas price and gas price setting mechanism

▼ Lowers price ▲ Boosts price ■ Limited impact

	Key factors	Near-term (2018-19)	Medium-term (2019-21)	Long-term (post-2021)
Demand	Power: coal, nuclear, renewable – gas switching	▼ Coal/gas switching shifting between \$2-3/ mmbtu will keep prices low ▲ Early retirements and cancellation of under construction nuclear plants will increase gas demand	▲ As coal capacity is removed from the power mix, demand response from the power sector due to rising gas prices is limited ▼ Continued decline of renewable costs leads to additional renewable generation	▼ Gas demand decreases due to renewables displacing gas in the power sector, especially as power storage becomes increasingly economics
	Export (LNG, Mexico)	▲ LNG exports will have limited pricing impact with addition demand of ~2 bcf/d ■ Exports to Mexico will have limited pricing impact with an addition demand of ~1 bcf/d	▲ LNG exports can increase by ~2 bcf/d due to underutilized end-user and portfolio contracts ▲ Pipe capacity addition, CCGT and industrial investment in Mexico will further boost Mexican consumption of US gas by ~2 bcf/d	▲ LNG capacity expected to tighten post 2024, increasing LNG plant utilization ▼ Falling solar costs and a rebound in indigenous production slow Mexican demand growth for US gas imports
Supply	Appalachian supply	▲ With increased Appalachian supplies bottlenecked, marginal production will come from higher break-even basins to support LNG exports	▼ As more pipeline infrastructure comes online post-2019, inexpensive Appalachian supplies will continue to grow and limit price fly up potential	▼ Potential for further efficiency gains in drilling and completion decreases break-evens
	Associated gas supply	▼ With efficiency gains and a stable oil price outlook, drilling in oil basins is rebounding, with the Permian taking the lead	▼ At \$65/bbl, 'zero cost' associated gas production could increase by ~4.5 bcf/d by 2021, most of which is expected from the Permian	▼ Associated gas production continue to increase, making up ~30% of US gas production by 2030
	Others– (e.g., oil field service cost, drilling efficiency)	▲ OFS cost are expected to recover	▲ OFS costs could keep rising if a recovery of commodity price drives a boom in drilling ▼ Drilling efficiency increases and new completion technology will lower well and service costs	OFS costs could keep rising if a recovery of commodity price drives a boom in drilling ▼ Drilling efficiency increases and new completion technology will lower well and service costs
Net impact		■ \$2.50 - \$3.00/mmbtu	▼ \$2.50 -\$2.75 /mmbtu	▼ \$2.25 -\$2.75 /mmbtu



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