North American Gas Outlook to 2030

H1 2019

Energy Insights
By McKinsey

Executive summary

Demand

- US and Canadian LNG exports account for ~60% of demand growth and will reach ~20 bcfd by 2030
- Coal retirements will provide upside to gas demand in the near term but renewables will start to displace gas post-2025, although total demand continues to grow

Supply

- Appalachia will increase production to ~55 bcfd and supply ~40% of the North American market by 2030
- Associated gas, primarily from the Permian, is expected to increase production by ~12 bcfd and supply 25% of the N. American market by 2030

Gas flows and price volatility

- Appalachia expected to displace WCSB & Rockies in the Midwest and serve the southern Mid-Atlantic
- Permian expected to limit Appalachian flows south and will help meet USGC demand
- Pipe build, especially from Appalachia, expected to continue to decrease volatility

Price

- Shale has unlocked enough supply to keep prices ~$2.75/mmbtu over the longer term, with likely bias to the downside

North America gas demand expected to grow at a modest ~2% p.a., driven by strong exports, despite peak demand for power in sight

Outlook

Mexico export 2.7 bcfd of demand growth, new takeaway pipelines, less LNG imports, and flat local production results in higher US exports to Mexico

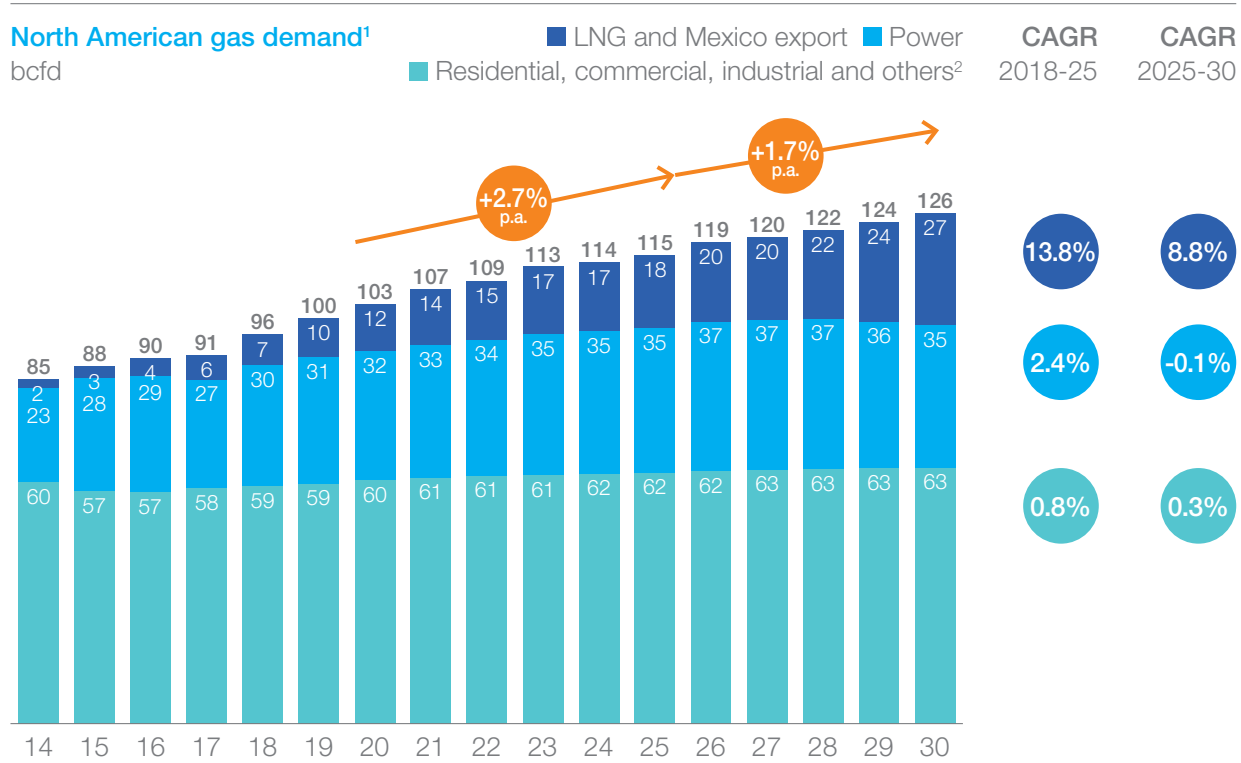
LNG export US and Canadian LNG projects are competitive, even in a long global LNG market, leading to utilization rate being maintained above 70%

Power Expected to grow another 5 bcfd as additional ~70 GW of gas capacity comes online by 2025, but will flatten from 2026 as it faces strong competition from renewables

Residential and commercial Expected to stay flat as floor space growth is mostly offset by continued efficiency improvements

Industrial Growth will be driven by increasing use of gas as a feedstock in producing methanol and ammonia

Pipe, plant and lease fuel Use of gas at fueling compressor stations and lease sites is expected to grow slightly as production grows

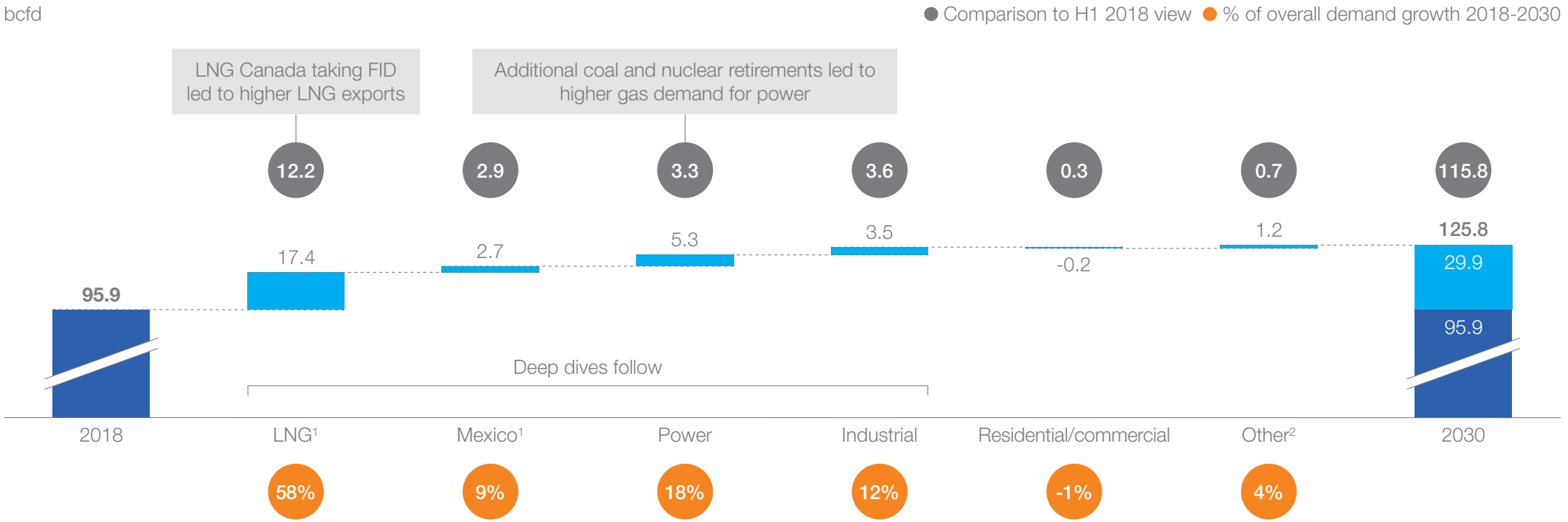


1 Dry gas consumption in US and Canada 2 Includes pipe, plant, lease, and natural gas vehicles (NGVs)
Source: McKinsey Energy Insights Global Energy Perspective Model; EIA; NEB

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

US and Canadian gas demand growth by sector (2018-2030)

bcfd



1 Direct export driven **2** Includes pipe, plant, lease, and natural gas vehicles (NGVs)

Source: McKinsey Energy Insights GEP Model; EIA; NEB

North American LNG exports will grow quickly until 2023 then plateau until a second wave of capacity comes online from 2025

Short term (to 2021)

- Global LNG supply overcapacity puts pressure on US liquefaction capacity utilization, which has among the highest marginal costs. Balancing out global LNG overcapacity is equivalent to an average US LNG capacity utilization rate of 70% from 2019-21
- Construction delays primarily at Cameron and Freeport prevent new capacity from coming online until the global LNG market has recovered in ~2021

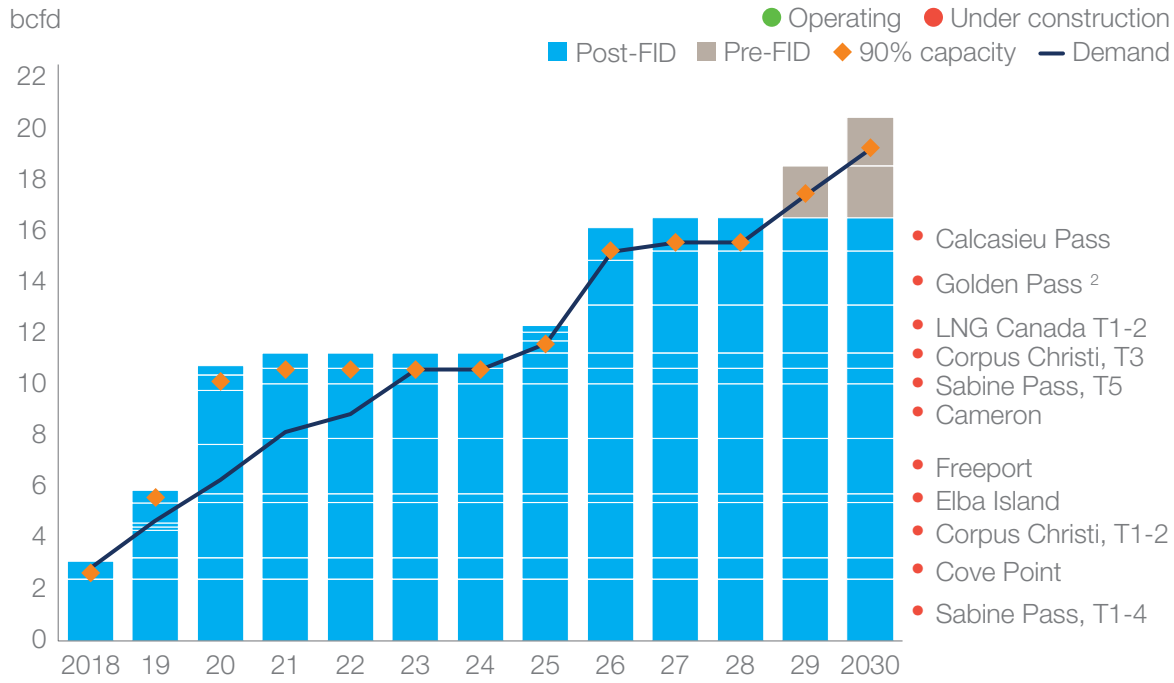
Mid term (2021-24)

- Slowdown in North American projects is expected from 2021-24 as new international LNG supply comes online, primarily from Qatar
- US LNG exports are sensitive to global gas demand, as the marginal supplier to the Europe and Asia

Long term (2025-30)

- Post FID plants (LNG Canada, Golden Pass and Calcasieu Pass) come online in 2025[1]
- From 2028-29, there will likely be room for 2-3 most cost-advantaged LNG projects from North America to fill the global LNG supply gap

North American LNG capacity and demand outlook



1 Assumes delays to start in mid-2025
2 Assumes delays to start in mid-2025
Source: McKinsey Energy Insights; team analysis; press release

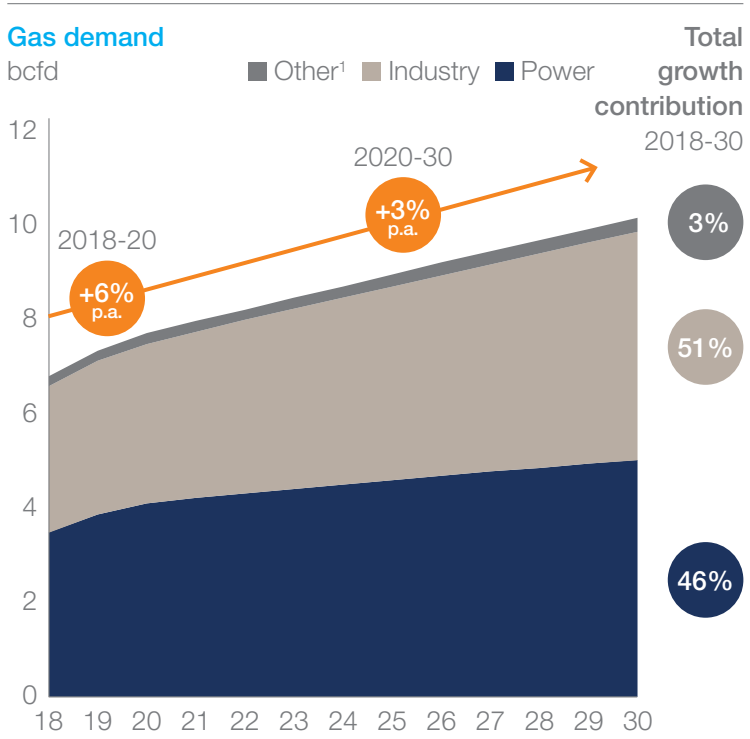
Mexico's dependence on US gas imports increases as gas demand grows and domestic production declines

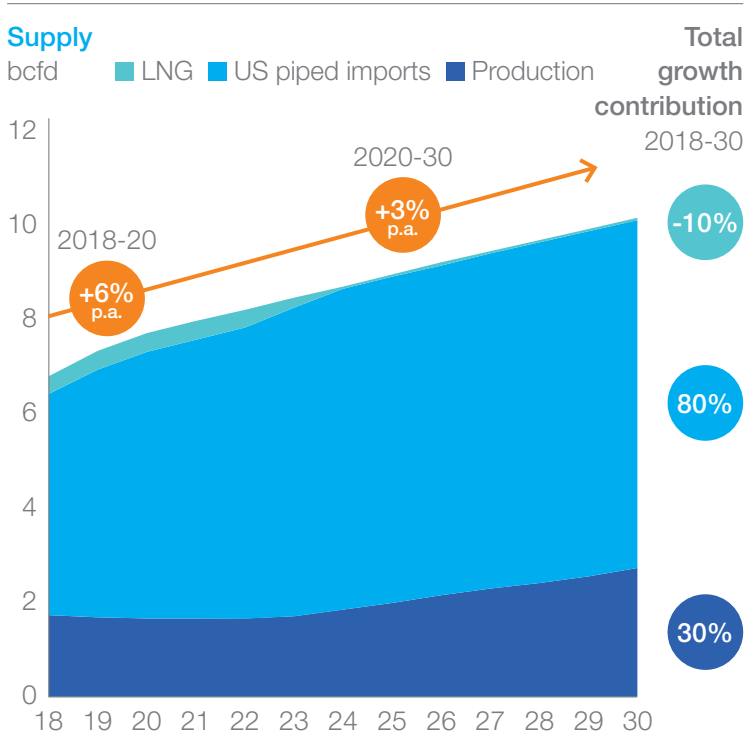
Gas demand

- Gas demand will increase due to growth in the industrial and power sectors
  - Nearly 18 GW of new gas fired CCGTs expected to be added by 2020 effectively removing fuel oil from the power mix
  - Industrial demand growth is driven by export oriented manufacturing as well as methanol/fertilizer projects

Gas supply

- In the long term, growth of US exports to Mexico will slow due to an increase in Mexico's domestic production
- LNG is being displaced by US imports, except for a small volume to prepare for an emergency



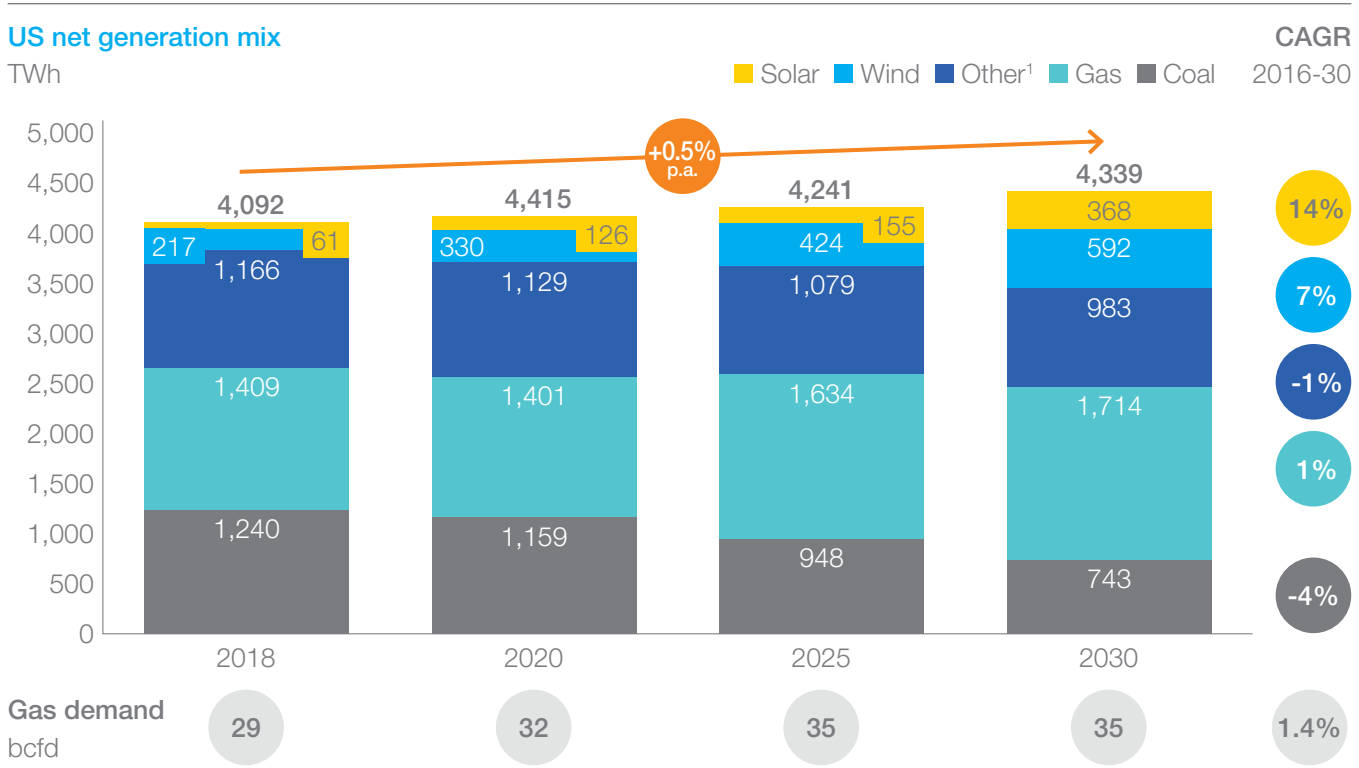


1 For example: residential, services and NGVs
Source: McKinsey Energy Insights; CRE; CFE; SENER

Gas continues to gain market share from coal, despite facing more competition from renewables post-2020

Key implications

- As coal retires, gas generation increases to meet evening and night time loads
- Gas demand for power generation continues to grow until ~2025, but as high-efficiency CCGTs replace existing low-efficiency OCGTs/CCGTs, gas consumption decreases despite growing generation
- Falling power storage costs are enabling deployment of renewables at scale over a 10-20 year timeframe, enabling solar and storage to replace gas for peaker plants

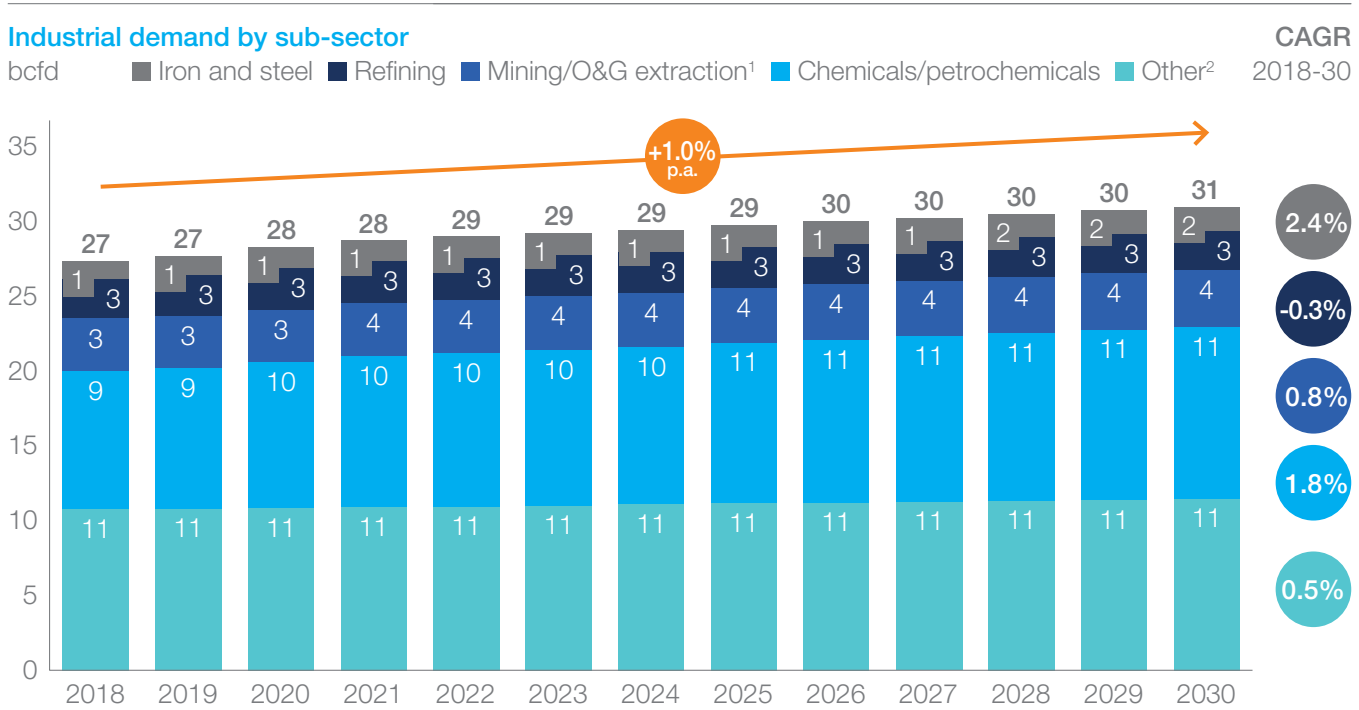


1 Other includes hydro, nuclear, oil, and coal co-fired with biomass, as well as biomass, waste, and geothermal
Source: McKinsey Energy Insights Global Power Model; EIA

Industrial gas demand growth is limited except for chemicals

Key drivers

- Industrial consumption will grow slowly over the next 10 years, with chemicals driving 60% of the growth, as the use of gas as a feedstock in chemicals increases, particularly in ammonia and methanol
- Demand for gas in steel and iron will grow relatively quickly due to increasing capacity of direct reduced iron (DRI) facilities and increasing local steel utilization driven by tariffs on imported steel



1 Includes oil sands 2 Agriculture, construction, metal, food processing, textile and leather, plastics, wood/wood products, non-specified energy/ commercial/transformation, and paper

Source: McKinsey Energy Insights Global Energy Perspective; McKinsey Energy Insights Global Liquids Supply Model; EIA; CERI natural gas market review 2016

The Appalachian and Permian basins will supply ~53% of the North American market by 2030, and represent 83% of the growth

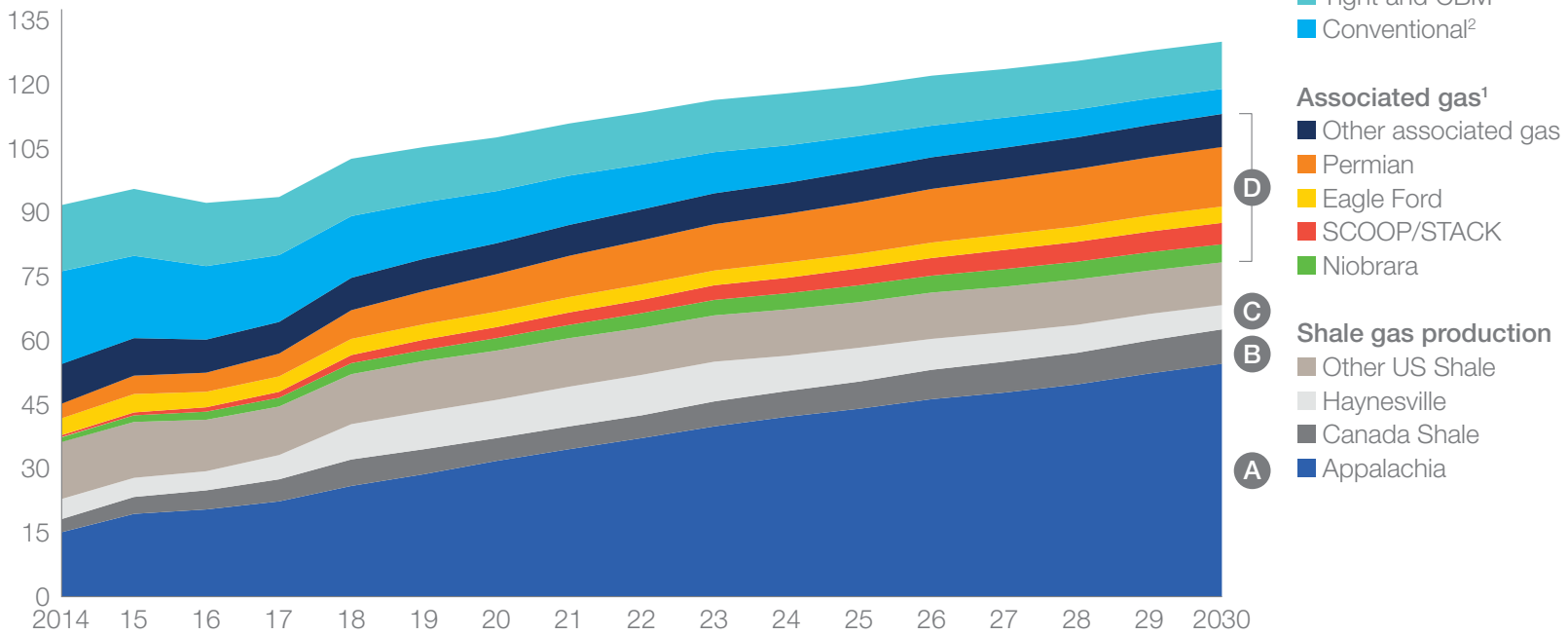
A Appalachia
Production grows at 6% p.a. as the basin is debottlenecked in 2018-19

B Western Canadian Sedimentary Basin (WCSB)
Steady growth in Montney production with possible upside with Western Canadian LNG

C Haynesville
Renewed interest due to close proximity to LNG export terminals and attractive well economics

D Associated gas/Permian
Permian production will increase by ~7.2 bcfd from 2018 to 2030

Total projected natural gas production
bcfd



1 Includes conventional and unconventional 2 Includes conventional gas basins, Alaska, and offshore
Source: EIA; McKinsey Energy Insights North American Supply Model

In 2025, growing Appalachia and Permian production will push Canadian and Rockies gas out of Midwest and Eastern markets[1]

Two dynamics are fundamentally changing how gas moves in North America in 2025:

Growing production from Appalachia, SCOOP/ STACK and the Permian

- An increase of 14 bcfd production from Appalachia will back out Canadian and midcontinent gas
- Growing associated gas production in the Permian and SCOOP/STACK areas will require additional midstream build-out

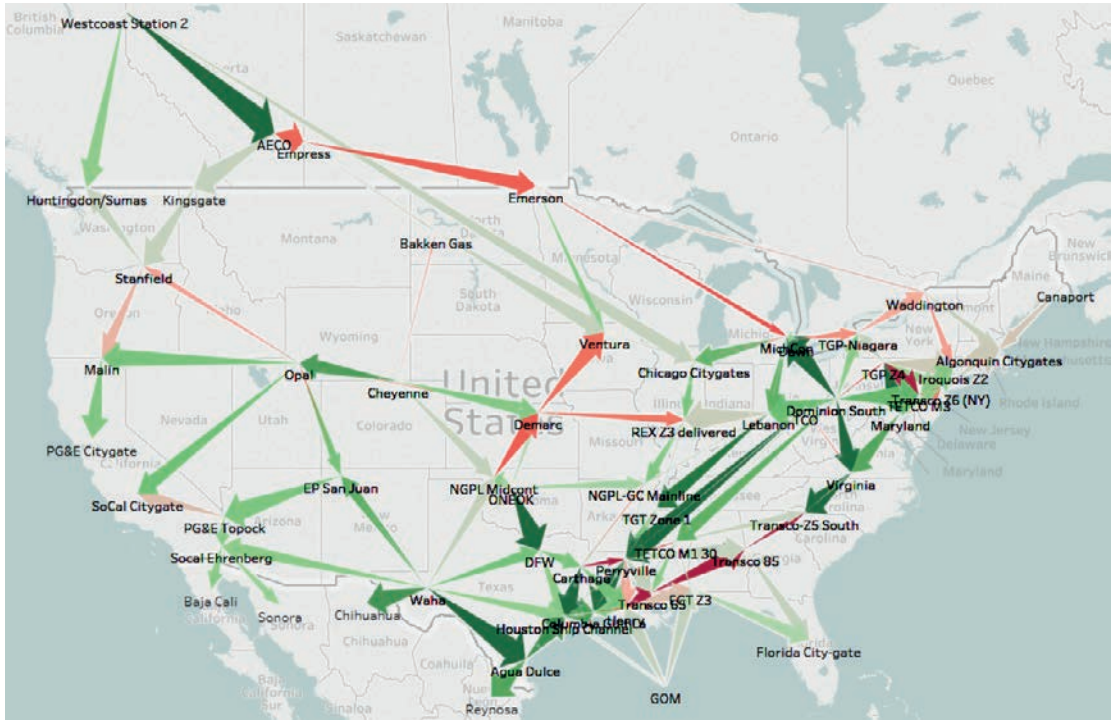
Rising demand in US Gulf Coast market due to LNG and Mexico exports

- Increases of ~17 bcfd demand by 2030 will require new pipes to connect Northeast and west Texas basins to the Gulf Coast
- Increasing competition between WCSB and Rockies in the western market will keep western Canadian prices low

Gas flow in 2025[1]

Flow change compared to 2018, mmcfd

-2,000 +2,000



1 Average winter flow in 2025 with arrows size proportional to 2025 flow volume

Source: EIA, McKinsey analysis

Supply and demand drivers sustain current North America gas prices in mid term but eventually lower gas prices in long term

	Key factors	Potential impact on gas price and gas price setting mechanism	
		Mid term (to 2025)	Long term (post 2025)
Demand	Power	↑ Coal retirements limit competition allowing regional gas prices to rise higher before gas generation becomes regionally uneconomic ↓ Continued decline of renewable costs leads to additional renewable generation	↓ Renewables displacing gas in the power sector, especially as power storage becomes increasingly economic
	LNG	↑ LNG exports can increase by ~2 bcfd due to underutilized liquefaction capacity	↑ Global LNG supply/demand expected to tighten, increasing US LNG plant utilization
	Mexico	↑ Pipe capacity additions, CCGT and industrial investments in Mexico will further boost Mexican consumption of US gas	↓ Falling solar costs and a rebound in indigenous production slow Mexican demand growth for US gas imports
Supply	Appalachian supply	↓ As more pipeline infrastructure comes online post 2019, inexpensive Appalachian supplies will continue to grow and limit price fly-up potential	↓ The second wave of new pipeline capacity addition in the Appalachia, if realized, would lower gas prices nationally
	Associated gas supply	↓ At $60/bbl, "zero cost" associated gas production could increase by ~8 bcfd by 2025, most of which is expected from the Permian	↓ Associated gas production continue to increase, making up ~27% of US gas production by 2030
	Drilling costs	↓ Drilling efficiency increases and new completion technology will lower well and service costs	↓ Drilling efficiency increases and new completion technology will lower well and service costs
	Net price impact	↓↓ $2.50 to $2.75 mmbtu	↓↓ $2.25 to $2.75 mmbtu

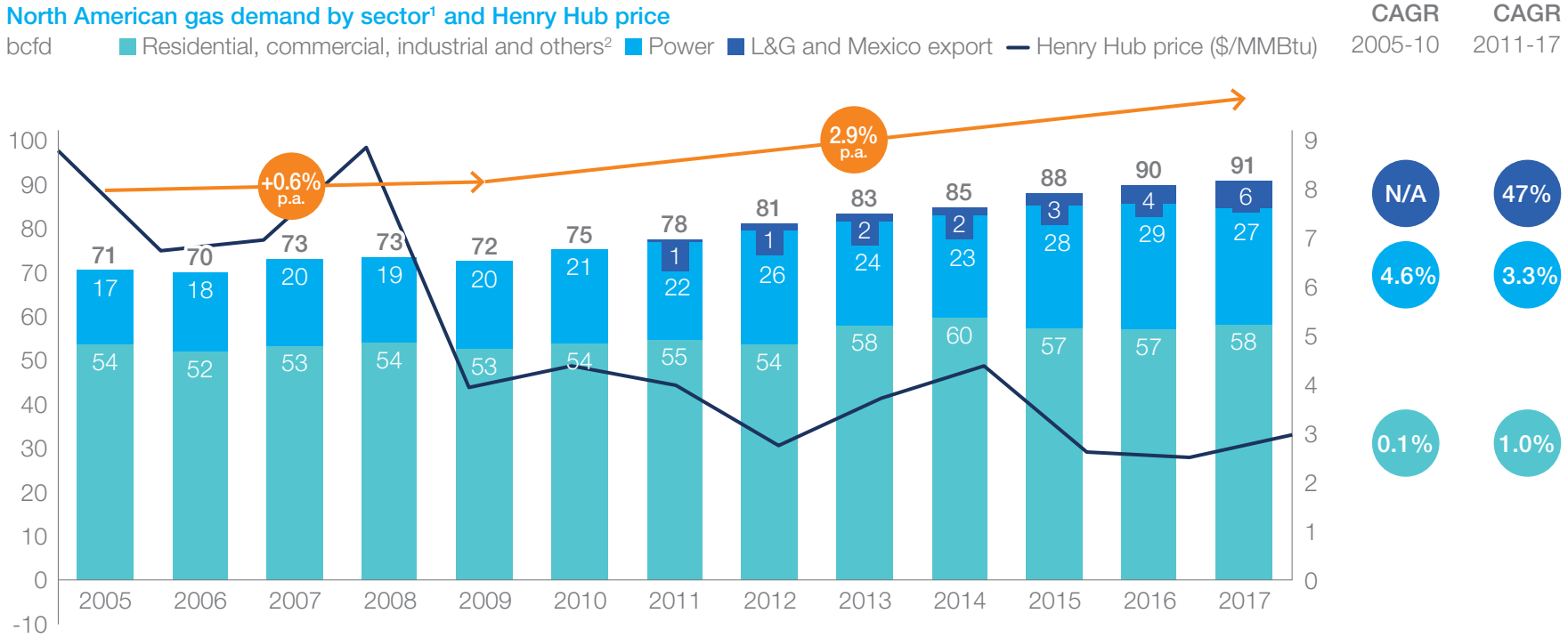
↓ Lowers price ↑ Boosts price

Source: EIA, McKinsey analysis

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

- Seasonal heating and power continue to drive the market, with power driving the most growth in gas demand since 2005, an increase of 10 bcfd
- North America has transitioned from being a LNG importer to an exporter
- Rapid growth rates in gas exports to Mexico have added 6 bcfd in gas demand

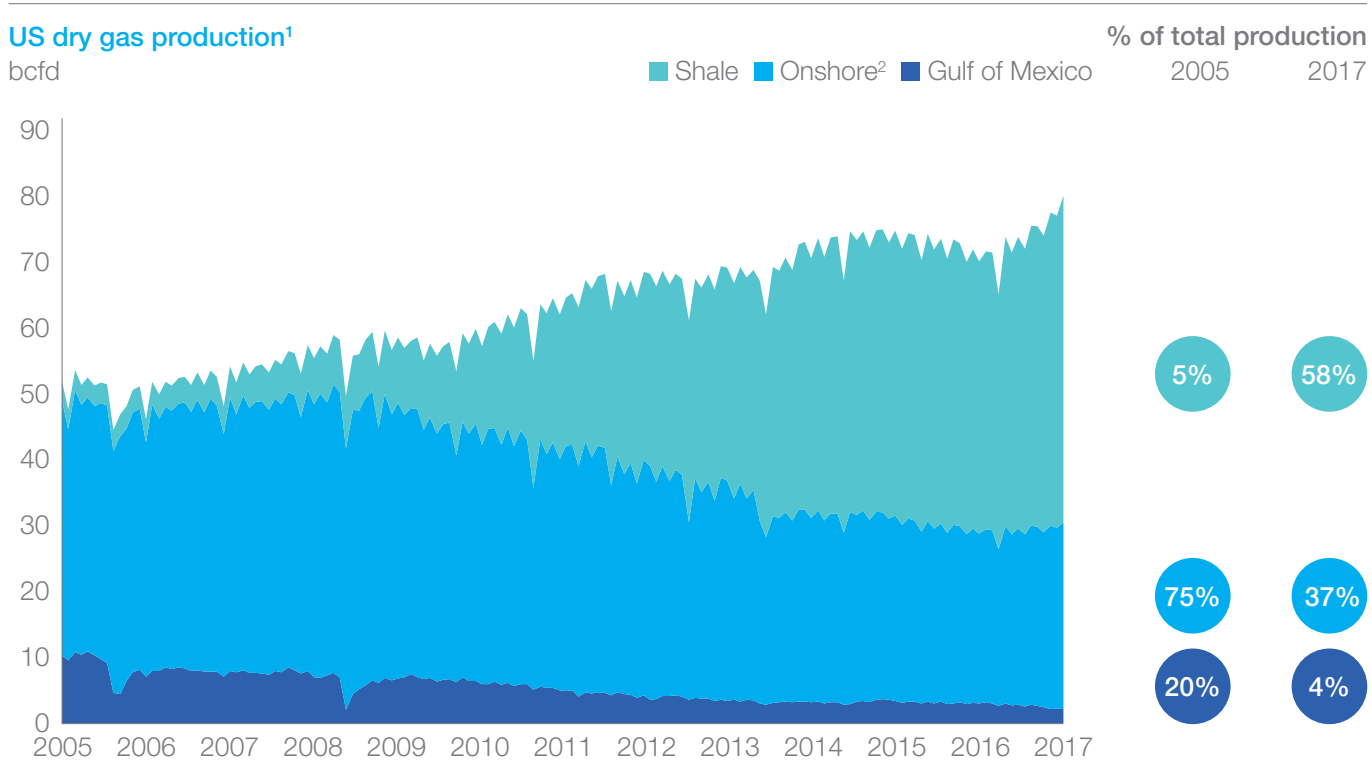
North American gas demand by sector[1] and Henry Hub price



Note: individual numbers may not equal total due to rounding **1** Net of balancing items **2** Includes 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
Source: EIA; NEB; NYMEX; McKinsey Energy Insights

Gas supply shifted from conventional to unconventional; shale gas grew at 25% p.a., reshaping the North American gas supply outlook

- Shale exploded from virtually nothing to become the driving force of gas supply.
- Gas production has remained resilient despite low prices:
  - High grading of drilling programs
  - Increasing well design intensity in Marcellus
  - Improved rig productivity (e.g., pad drilling, drilling days)
  - Infrastructure de-bottlenecking, releasing choked wells
  - Strong contribution from associated gas of light tight oil plays

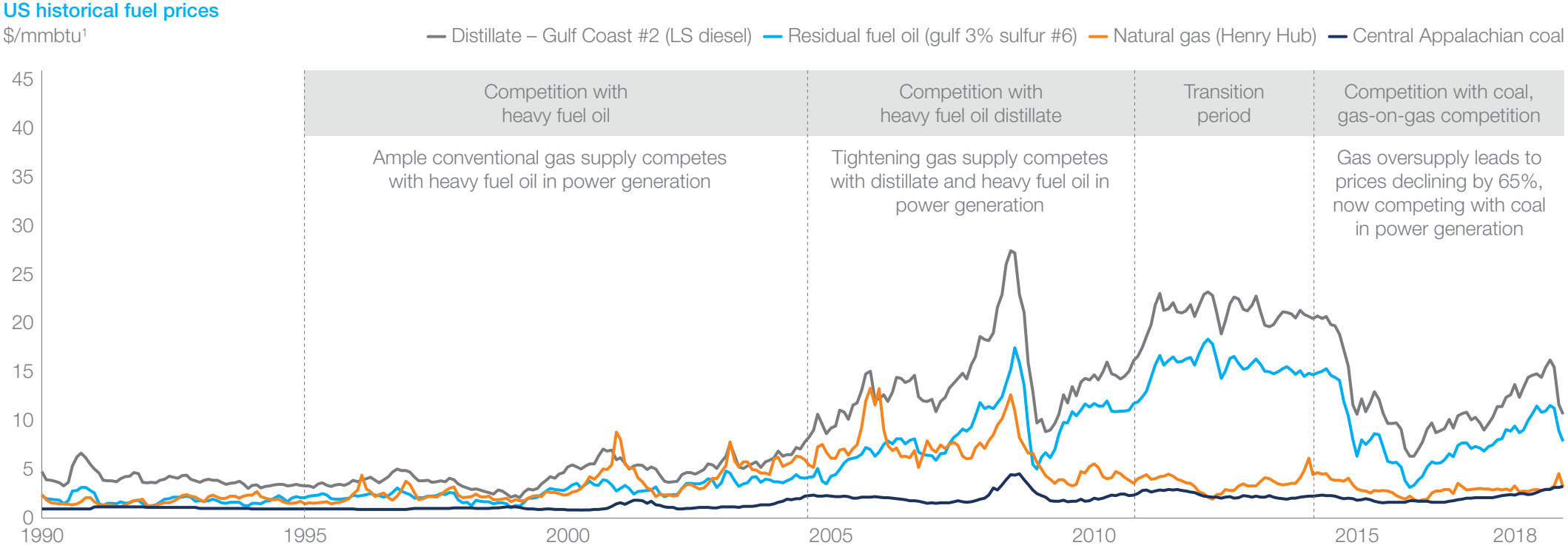


1 Total dry gas production taken from EIA natural gas dry gas production file **2** Includes Alaska
Source: SOURCE: Drilling Info; EIA; Energy Insights North American Supply Model; Baker Hughes

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

US historical fuel prices

$/mmbtu[1]



1 Converted at heat content of 6.02 for Gulf Coast RFO, 5.72 for Gulf Coast No.2, 25 MMBtu/ton for Central Appalachian Coal, and 24 MMBtu/ton for Illinois Basin Coal; SOx, NOx or CO_2 costs not included
Source: NYMEX; Bloomberg

Growing shale production in the Northeast has changed how gas flows in the United States over the last decade

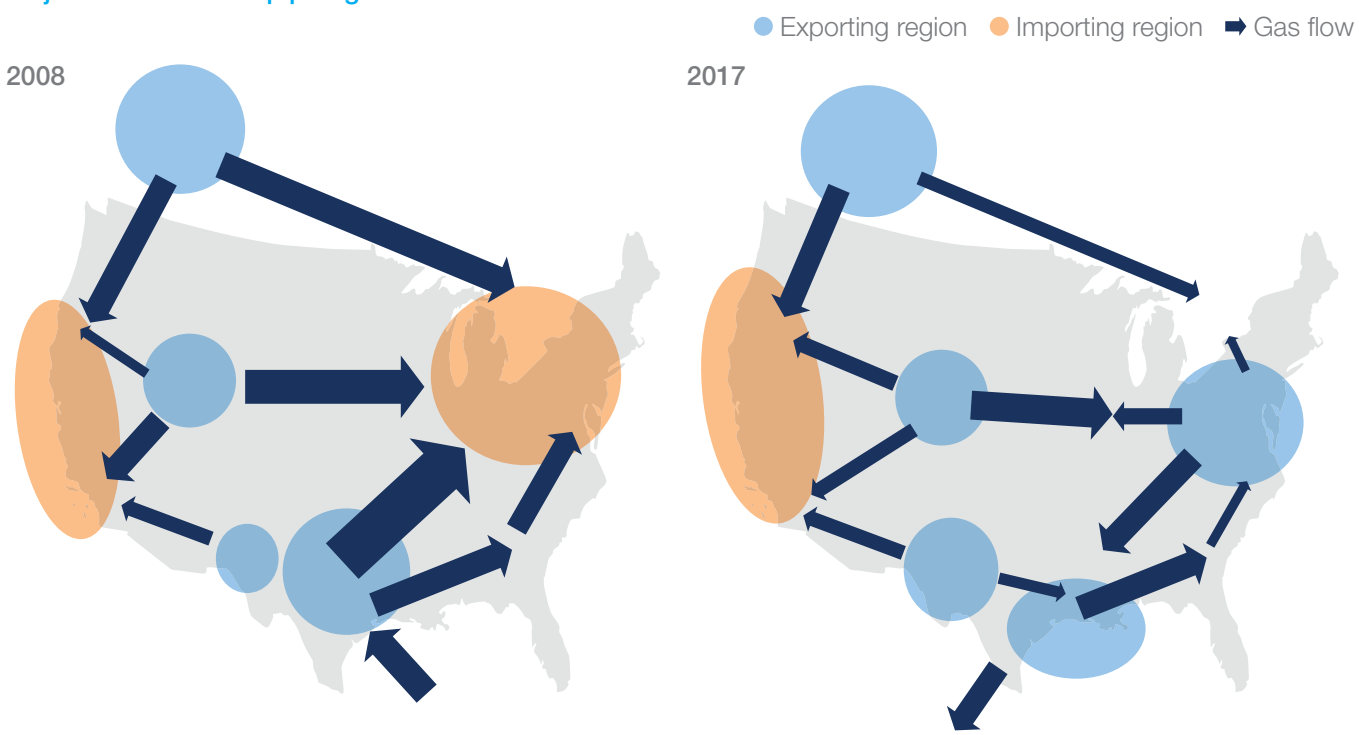
Growing shale production has changed the main supply areas

- In 2008, gas in NA was mainly supplied by three areas: the Gulf Coast (including Mid-Continent), Western Canada, and the Rockies
- In 2017, significant growth in unconventionals has made the Marcellus/Utica the largest gas producing area

Growing demand in the Gulf Coast states has since reversed the south to north flows of 2008

- TX and LA enjoyed the largest demand growth of a combined 1.9 bcfd due to growing power and industrial demand
- >2 bcfd of growth in export demand to Mexico over the past three years has reversed flow directions in South Texas, as gas now moves south through Agua Dulce

Major movements of piped gas across North America



SOURCE: McKinsey Energy Insights North America Gas Flow Basis Model; McKinsey Energy Insights North American Supply Model; EIA

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