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Oil and Gas Markets: Comparative Contrasts

For the Gas/Electric Partnership, Opportunities in Infrastructure - February 2019

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Key Insights

North America has a vast economic natural gas resource base (>1,300 Tcf at $4.00), but gas-on-gas competition is concentrating production in three major areas that are the most economic. The crude oil markets are well supplied, but yet-to-finds are required by 2030.

- More than 900 Tcf of gas at sub-$3.00/MMBtu.* However, this resource is largely in **Appalachia, associated gas, and Canada's Montney** play.
- Henry Hub prices will be driven by Gulf Coast market dynamics (as reflected in local storage). Key factors influencing this market include the pace/timing of Appalachian and associated gas production growth, and of power sector and export demand growth (LNG, Mexico).

The use of Henry Hub as a global gas index leaves both US and global markets sensitive to oil pricing

- Oil prices will have an inverse effect on Henry Hub through associated gas production.
- The US Lower 48 is expected to be the swing supplier until the LNG market grows into new liquefaction capacity.

By the mid 2020s, export demand and the power sector drive gas demand growth, and raise prices, but not rapidly. Oil prices reflect peak crude oil demand around 2030.

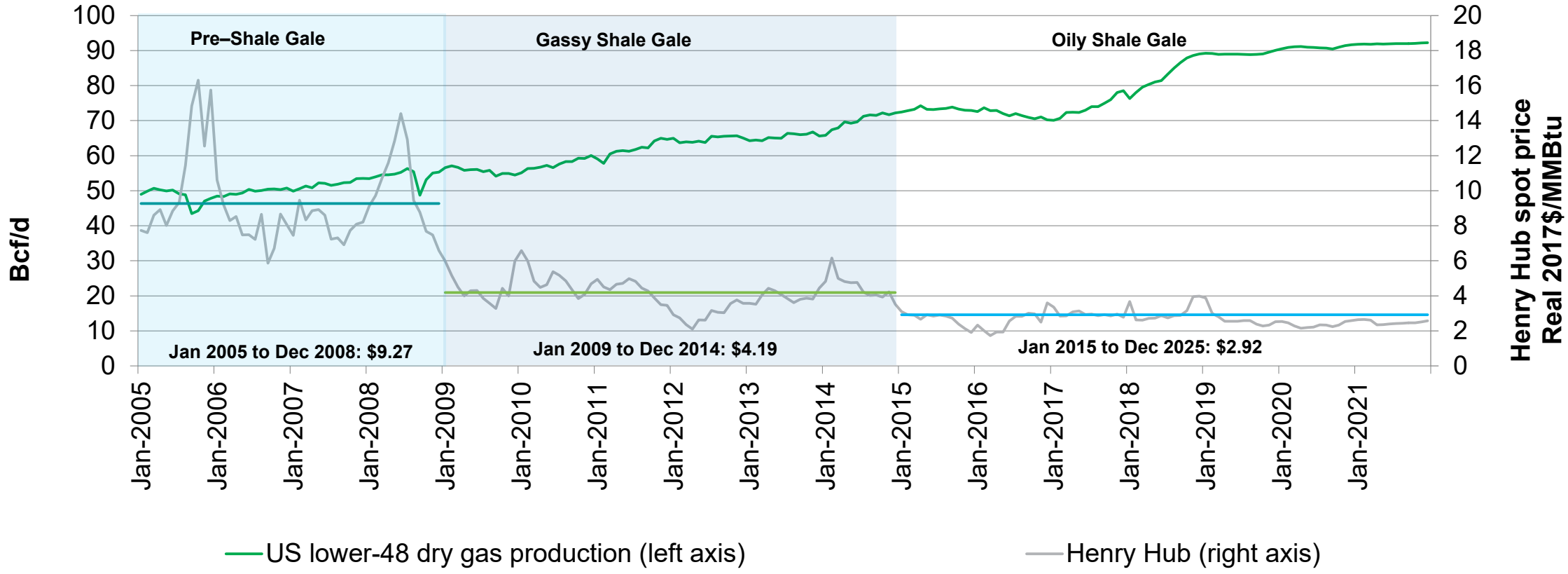
- LNG demand growth, and growth in gas exports to Mexico appear *relatively* certain, up to 12-13 Bcf/d.
- Power sector gas demand potential is increasingly uncertain, but the reality of coal and nuclear retirements longer term leaves plenty of room for gas to grow – even with strong growth in renewables, batteries, etc..
- For crude, recent OECD demand gains are likely to turn negative within 2-3 years, while developing world demand growth continues, but slows over time.

*North America is defined as US Lower 48 plus Canada. Estimate includes proved developed producing reserves (PDP). Excluding PDP, we estimate that 1,150 Tcf is available at below $4/MMBtu and 780 Tcf is available at below $3/MMBtu. Appalachia and associated gas together account for two-thirds of the estimated economic resource base. When Montney is added in, these areas account for an estimated 80% of the total.

Supply: we can identify the gas, but not necessarily the crude

The Shale Gale has been an evolving story of falling prices and growing production

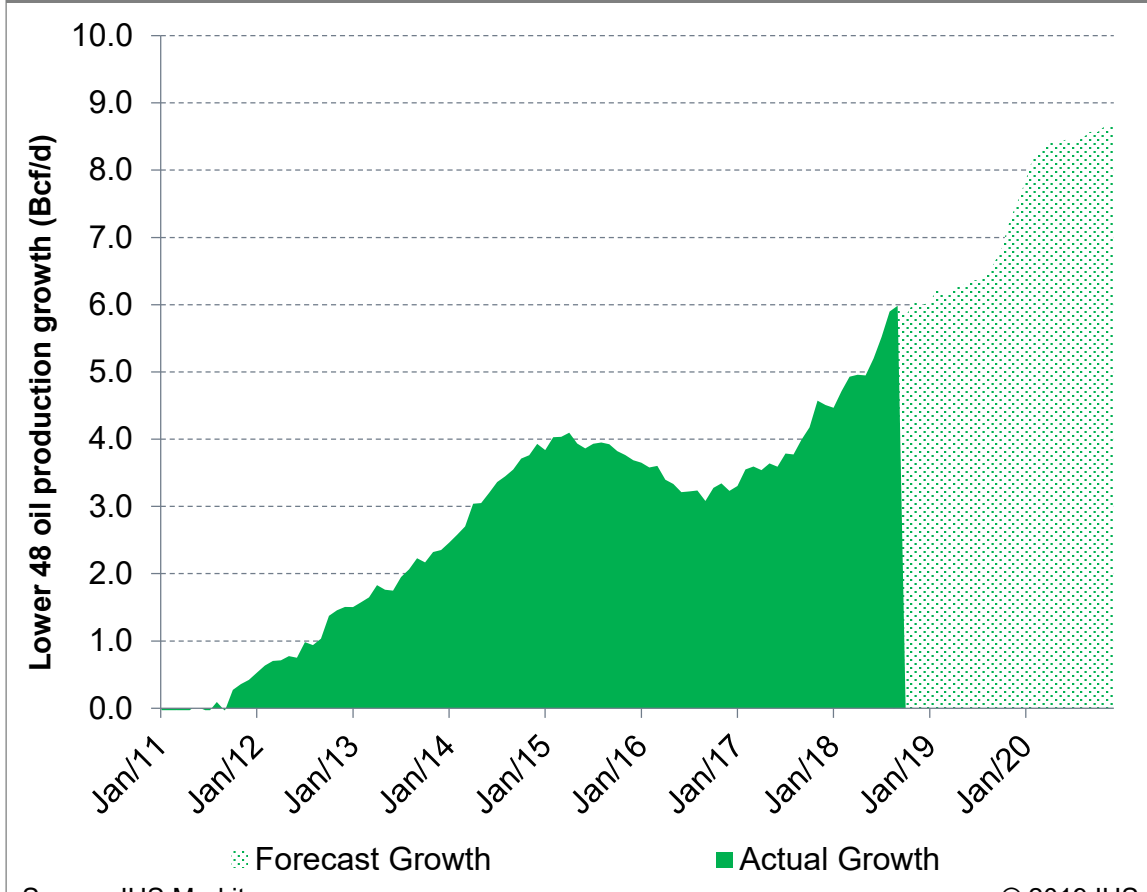
Pricing eras of the Shale Gale



Note: IHS Markit December 2018 North American Natural Gas Short-Term Outlook.
Source: IHS Markit, EIA, Intelligence Press

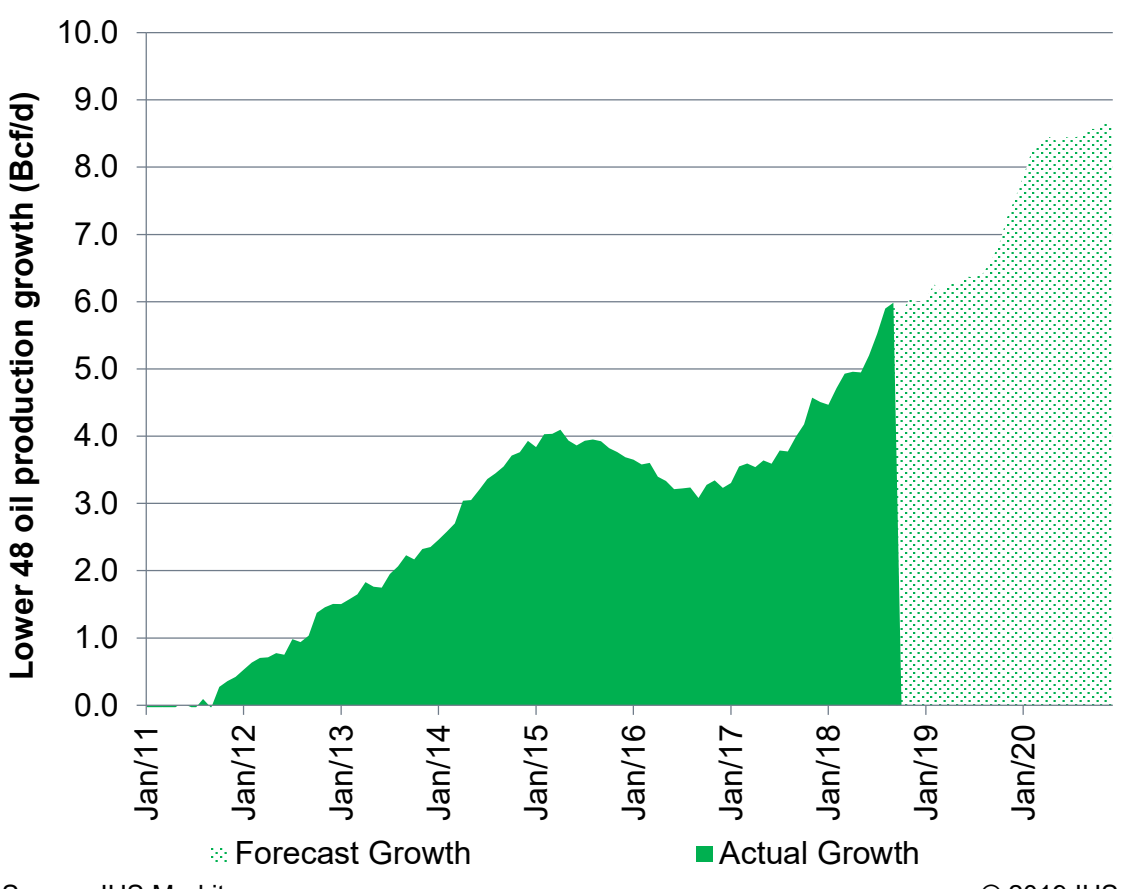
Fracking in oil has led to rapid growth of oil production and a lot of associated gas

US Lower 48 oil production growth relative to January 2011



Source: IHS Markit

US Lower 48 oil production growth relative to January 2011



Source: IHS Markit

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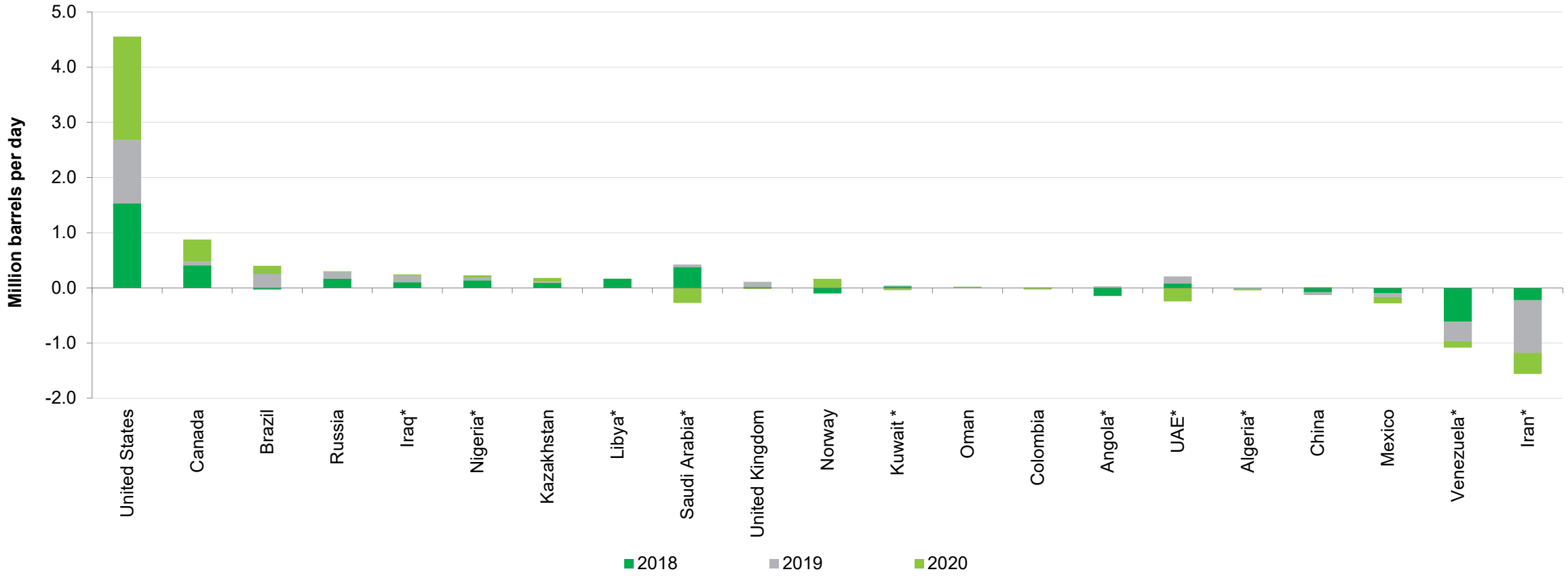
United States is the fastest national source of crude oil supply growth – by far

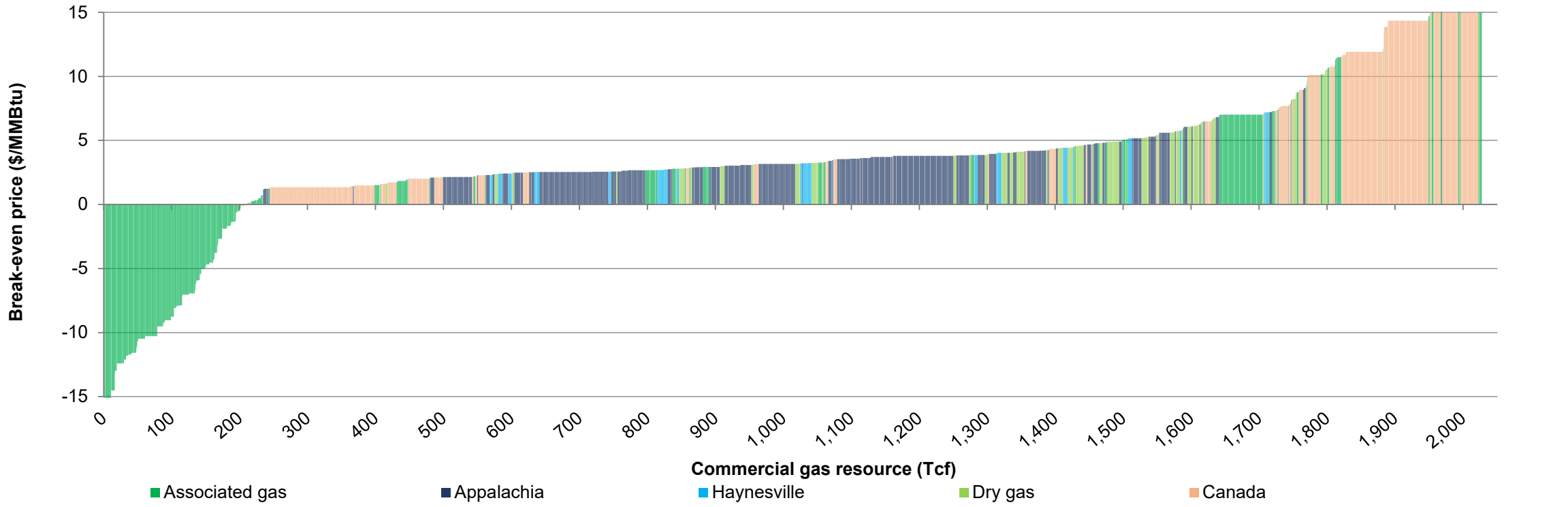
Annual change in crude oil output for large global producers, 2018–20



Note: * indicates OPEC member
Source: IHS Markit

With associated gas added to the economic resource base, we currently have about 1,500 Tcf of flowing and yet-to-be-drilled gas economic below $4/MMBtu

North America gas cost curve

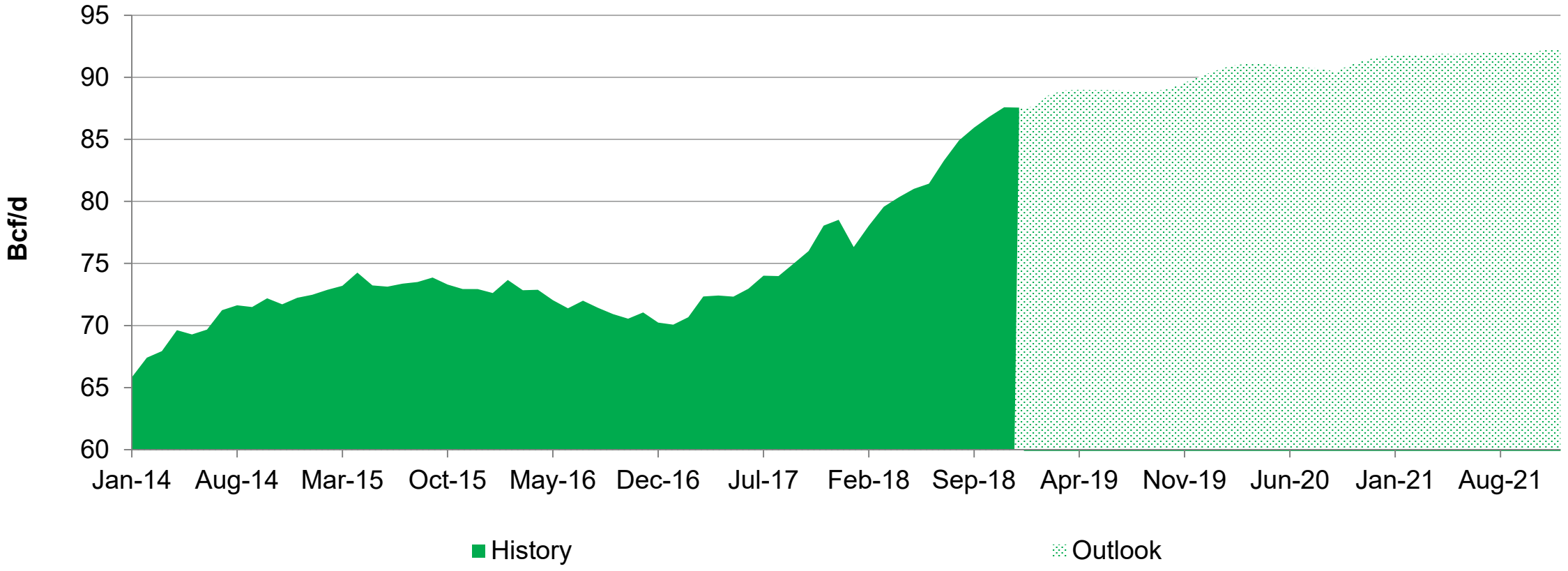


Source: IHS Markit

- At present, IHS Markit has identified around 210 Tcf of flowing gas and 1,310 Tcf of yet to be drilled gas that can be produced below the $4/MMBtu gas price. Additional resources could be economical if operators successfully reduce well costs or further improve well productivity.
- Appalachia and associated gas contribute to the majority of the US resource base that can be produced under $4/MMBtu.

Huge 2018 growth, up nearly 11 Bcf/d winter to winter, means a lot of gas for 2019 and beyond, and time required for demand to grow into this production

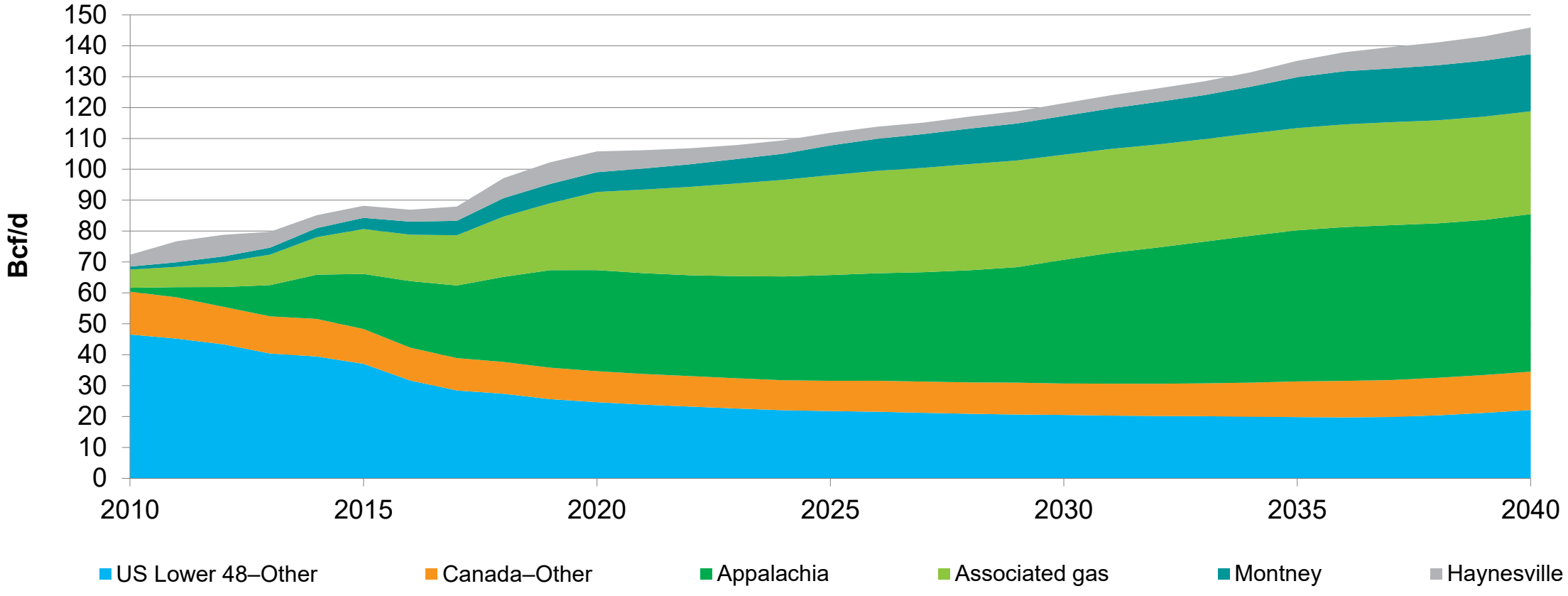
US lower-48 natural gas production history and outlook



Source: IHS Markit, EIA, PointLogic

North American gas production growth is driven almost entirely by Appalachia, associated gas, and Montney

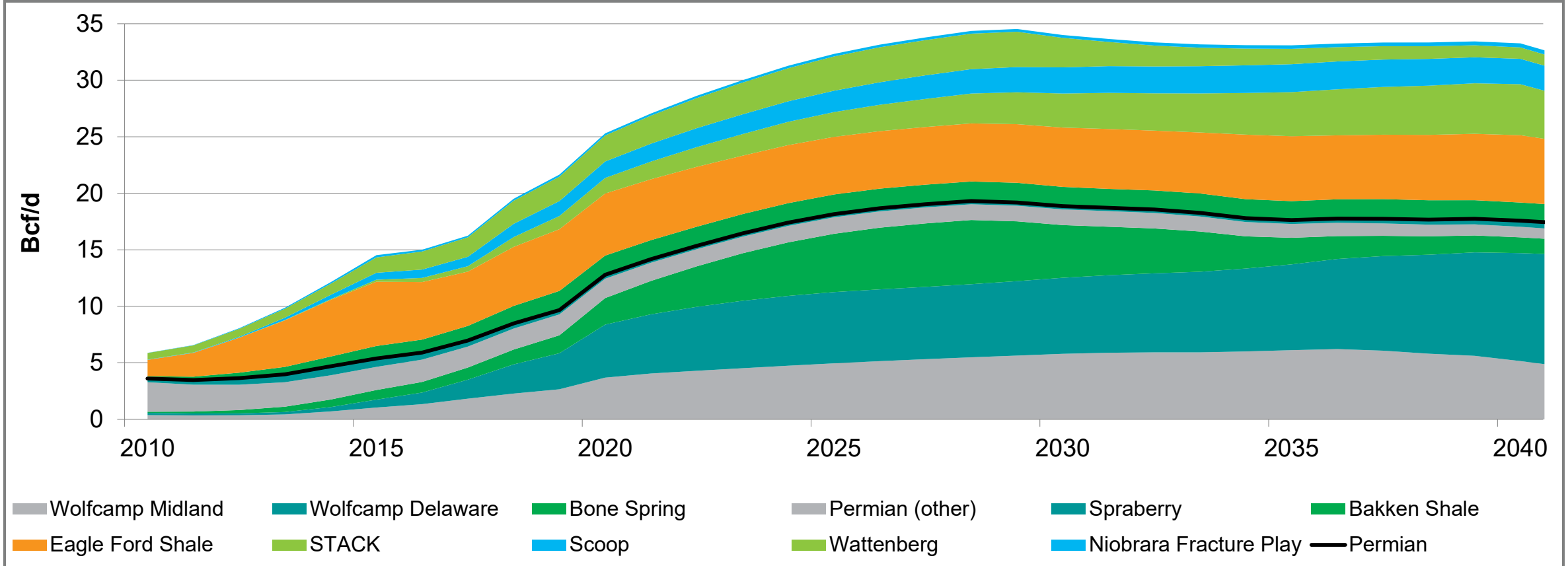
North American natural gas production by major source



Source: IHS Markit

Associated gas production is dictated by the fortunes of oil, not Henry Hub pricing, with Permian growth set to ramp up sharply

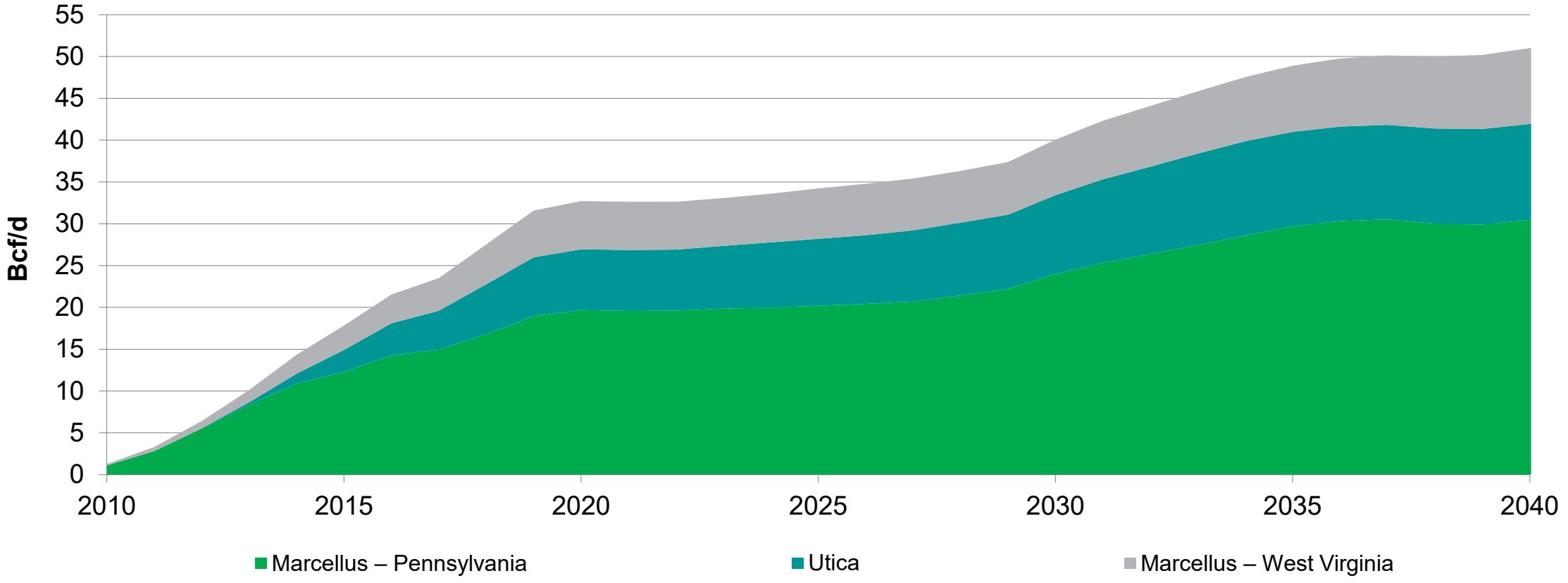
US lower-48 associated gas production by play



Source: IHS Markit

Appalachian gas production growth is both enabled and constrained by infrastructure capacity

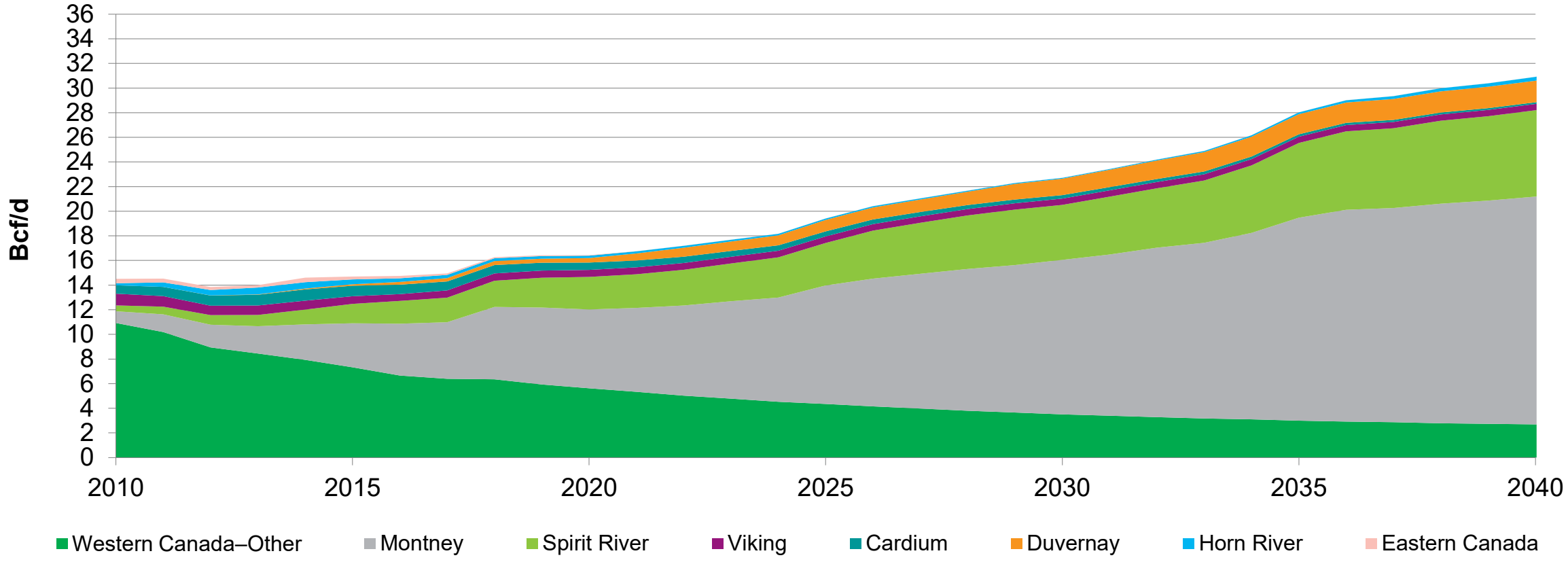
Appalachian production by play



Source: IHS Markit

Canadian gas production growth is concentrated in Montney, driven by condensate demand

Canadian production by play

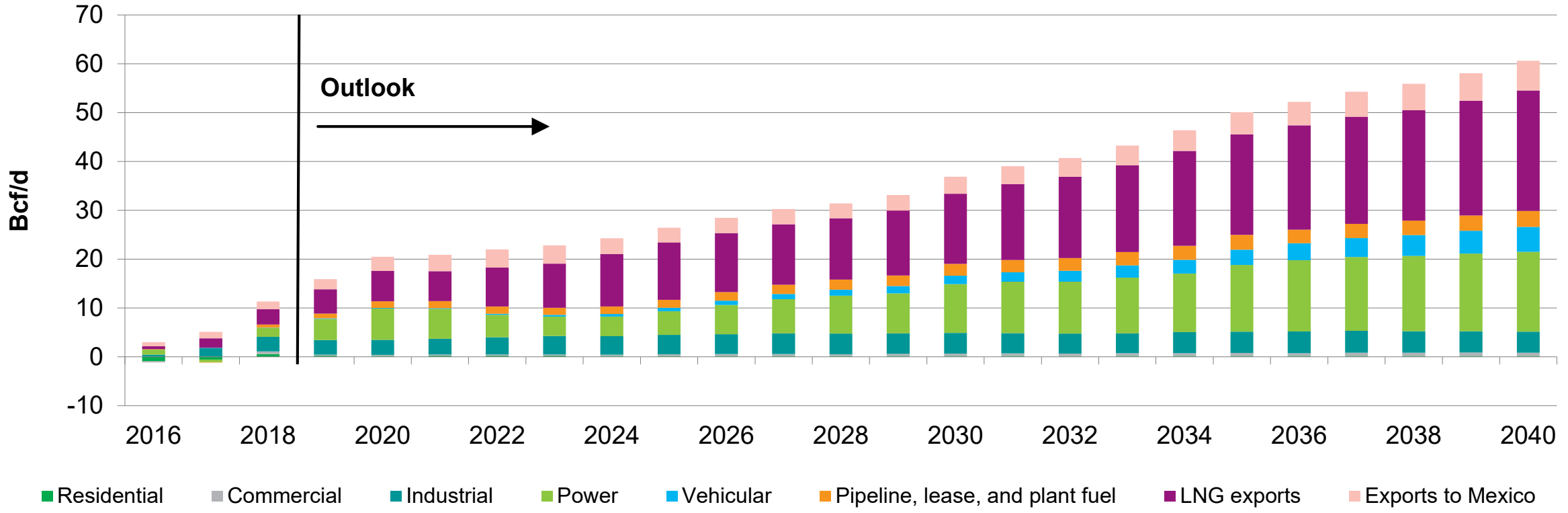


Source: IHS Markit

Gas Demand: Exports are now the leading growth sector, but power still contributes

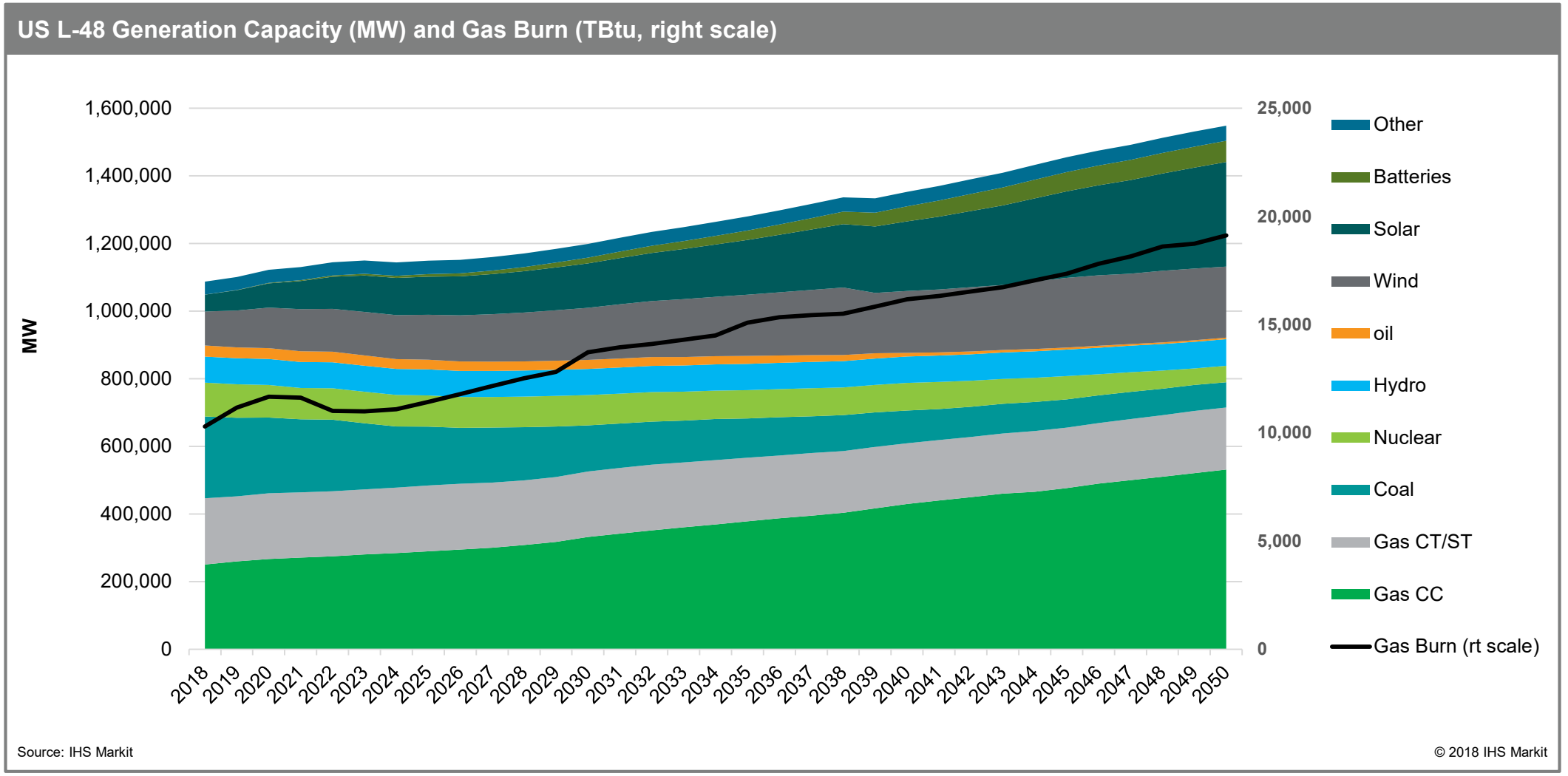
Exports and power sector drive demand growth, but exports are now clearly the larger driver

North American gas demand growth relative to 2015 by sector



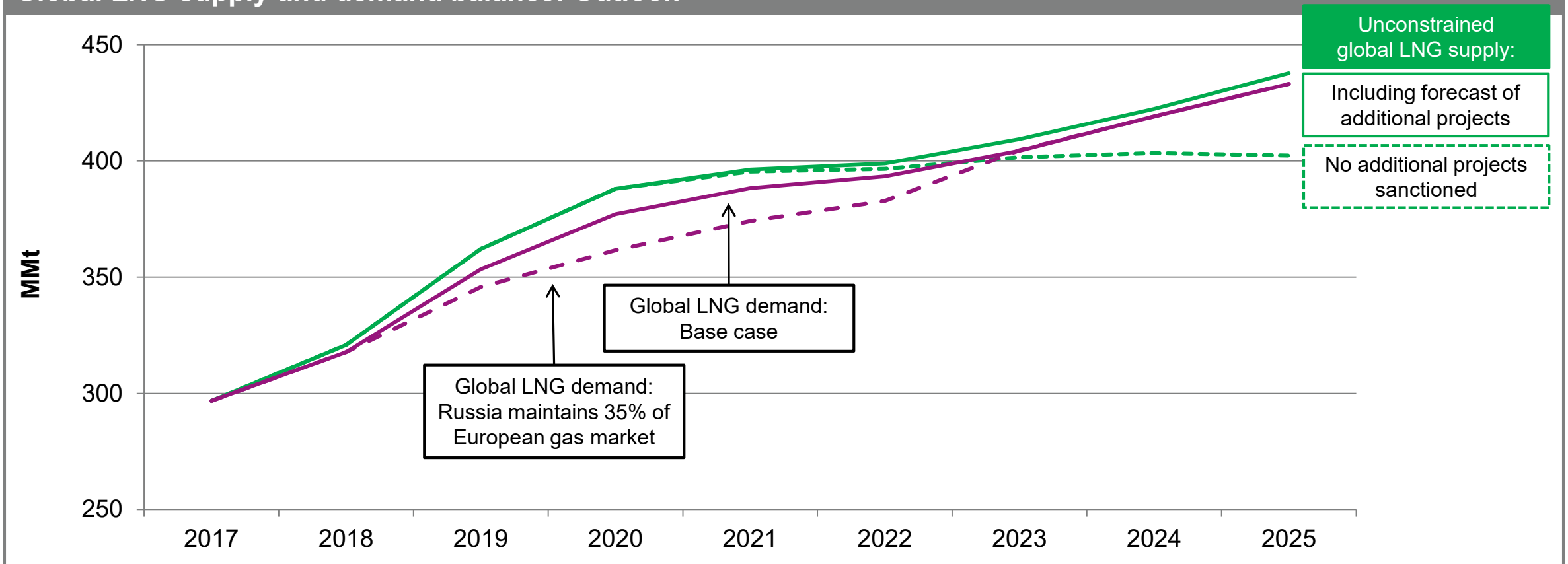
Note: IHS Markit August 2018 North American Natural Gas Long-Term Outlook.
Source: IHS Markit, EIA, Statistics Canada

Even with strong growth in battery and renewable capacity, gas burn continues to increase as coal and nuclear generation is retired



Global LNG market is heading into a period of oversupply

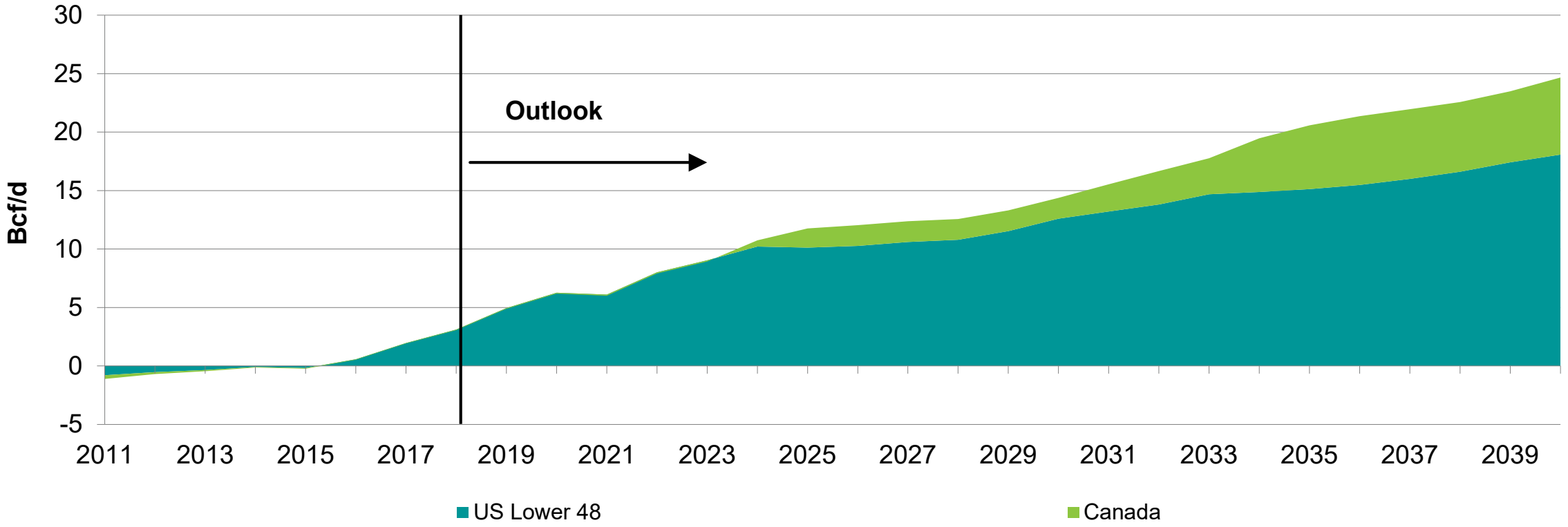
Global LNG supply and demand balance: Outlook



Source: IHS Markit

US LNG export growth is pushed back by global oversupply; Canada is challenged by capex for large-scale greenfield projects

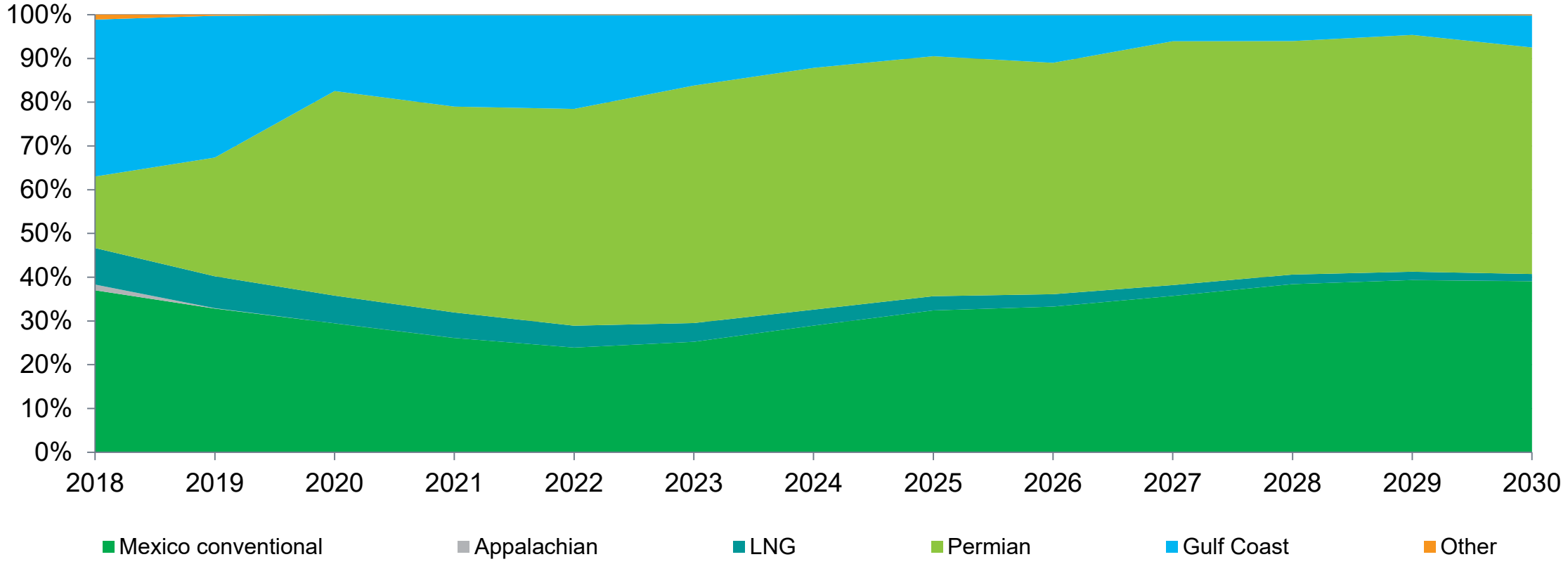
North American LNG exports



Note: LNG exports shown here represent gas deliveries from the North American pipeline grid to LNG export terminals, excluding subsequent liquefaction losses/fuel use. Negative values, shown during the import period, indicate regassified sendout into the domestic grid.
Source: IHS Markit, EIA

Mexico's dependence on Permian and Eagle Ford gas increases as domestic production temporarily stagnates

Mexico sources of gas



Notes: Excludes pipeline, lease and plant fuel.
Source: IHS Markit

Longer-term strategic uncertainties

A large resource base is becoming more established as fact
The economic resource at $4/MMBtu is greater than the production requirement through 2040; HOWEVER….

The existence of a resource is almost irrelevant to the size of the investment opportunity

Ability to capture power demand growth

- Power load growth is moribund — < 1% annually.
- Subsidized renewables and socialized transport and distribution are crowding out almost every other source of generation.
- Ultimate gas demand growth for electric generation is still likely positive, but the pace of growth is decelerating.
- Matching firm services to power system needs remains challenging (e.g., requiring firm gas transportation in 15-minute increments).

The social license to fracture, build infrastructure, and develop markets is increasingly contentious.

- No stage of the permitting process occurs without increasingly organized and intense intervention, affecting project timelines.
- Will the “Keep it in the ground” view gain broad traction?
- There is the potential for “decarbonization” of the heating sector longer term.
- Is the current US administration an enduring shift or a short-term window of opportunity?

The ultimate size and impact of export markets

- Mexico’s ultimate import need will be driven by its renewables policies, economic growth, and domestic production.
- LNG export potential is driven by a host of global factors, but the United States is the high variable cost supplier and exports will be volatile when the global market is in excess.