

North America: A future LNG superpower?

AICHE South Texas Local Section
September 6, 2018



Outline

- ▶ **About ADI Analytics**

- ▶ North America: A Future LNG Superpower?

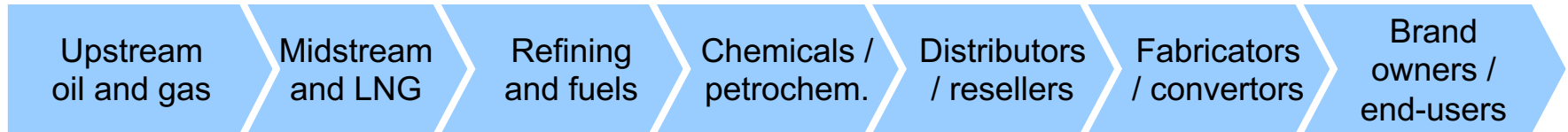
ADI Analytics is a boutique consulting firm serving energy and chemical companies with passion, rigor, and expertise



Fortune 500 and mid-sized companies, start-ups, investors, and governments have hired us to shape decisions globally



ADI's acquisition of CMR brings clients expertise, experience, and an integrated view of the hydrocarbon value chain



ADI is a management consulting firm specializing in oil and gas, power, chemicals, and industrials. It has completed 300+ projects for 100+ clients since 2009.

www.ADI-Analytics.com

ADI acquired key assets of Chemical Market Resources (CMR) in 2017. Since 1990, CMR has provided market research and management consulting services through 500+ projects for 200+ clients in petrochemicals, chemicals, plastics, and polymers.

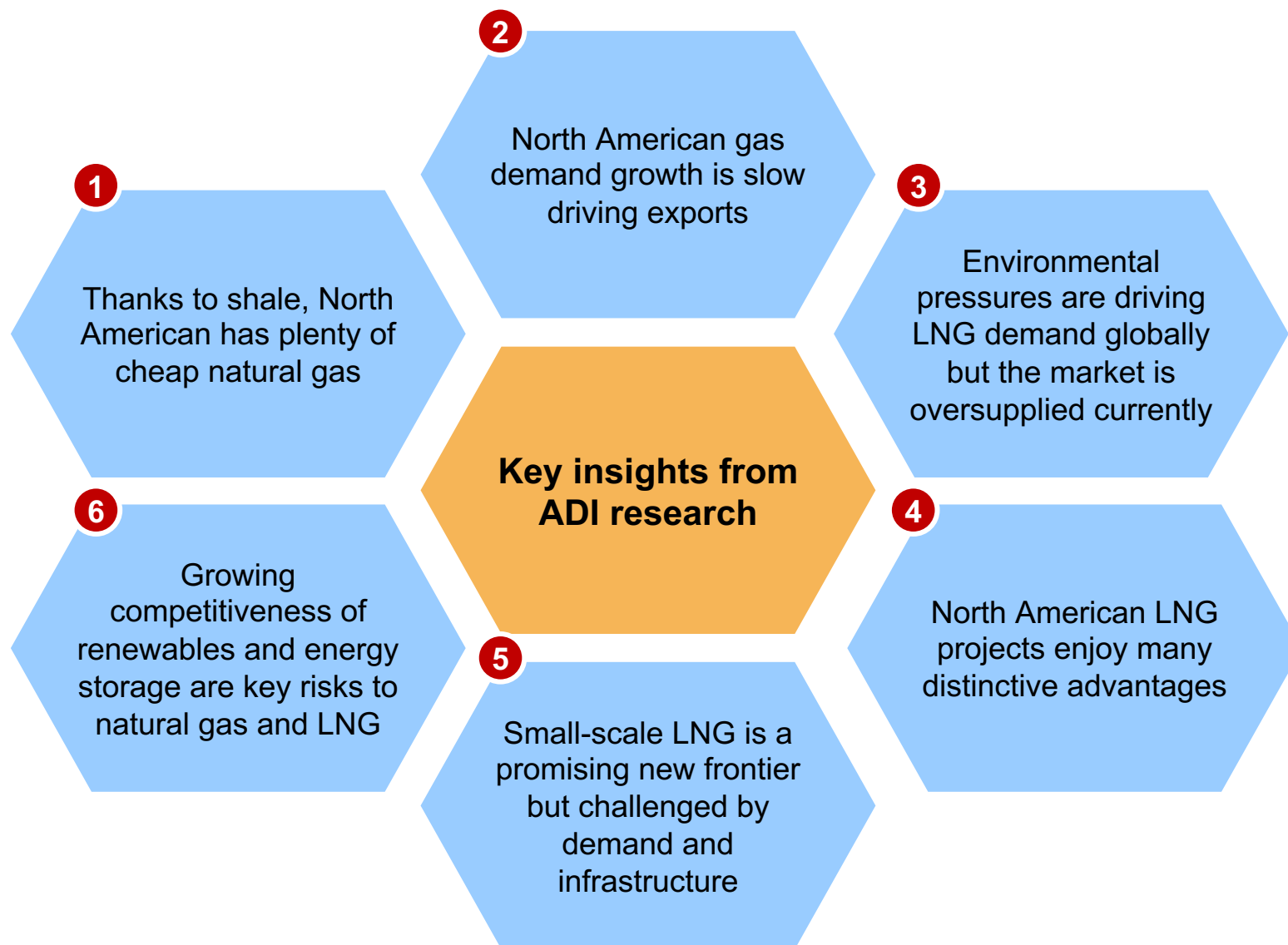
www.CMRHouTex.com

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- ▶ About ADI Analytics

- ▶ **North America: A Future LNG Superpower?**

Key messages



Key messages

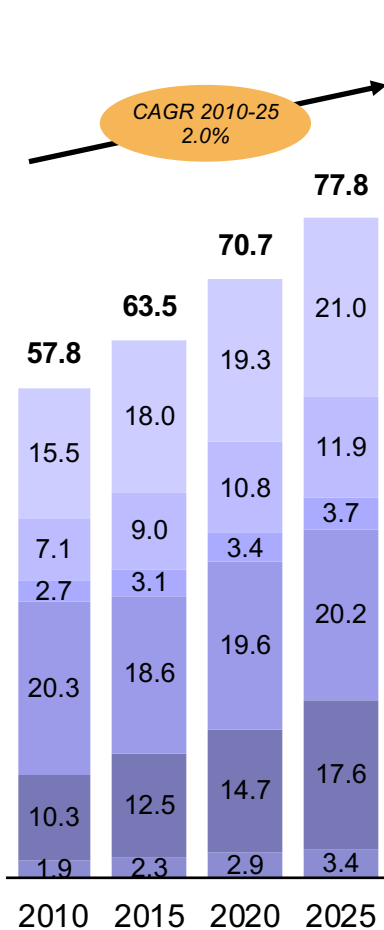
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Thanks to shale, North American has plenty of cheap natural gas

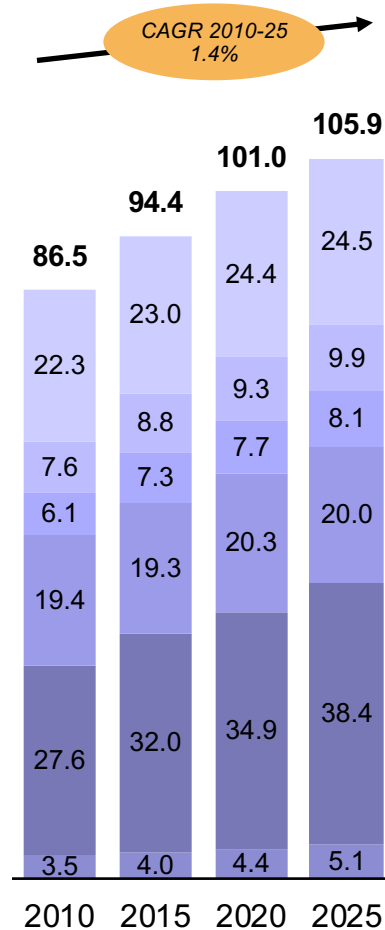
Key insights from ADI research

In the long term, global resource and commodity demand is expected to rise led by power and natural gas

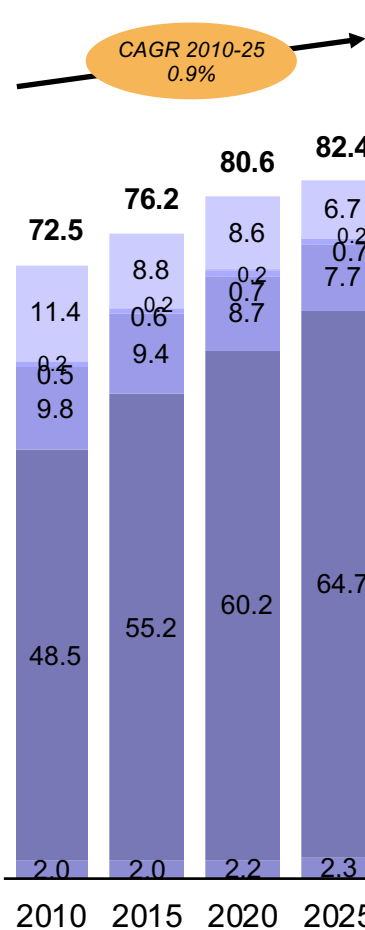
Natural Gas Demand
(MM BOE / Day)



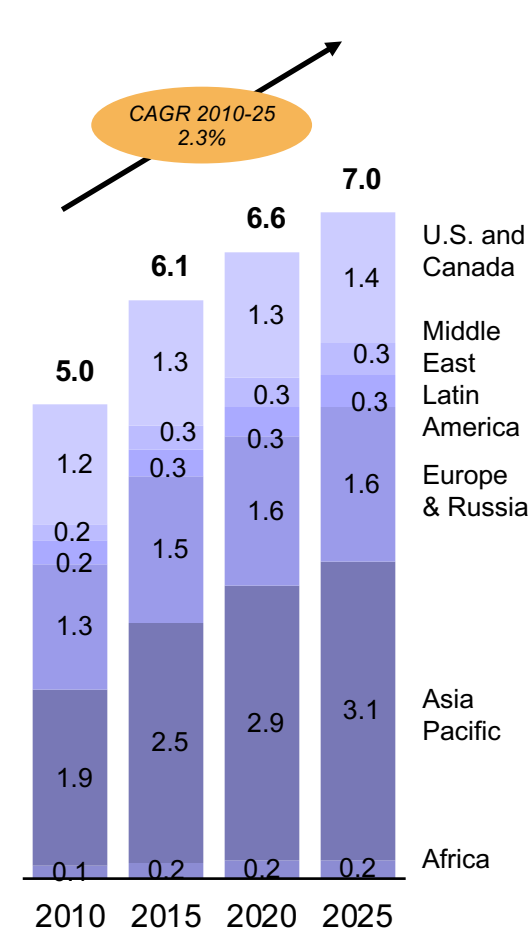
Oil Demand
(MM Bbl / Day)



Coal Demand
(MM BOE / Day)

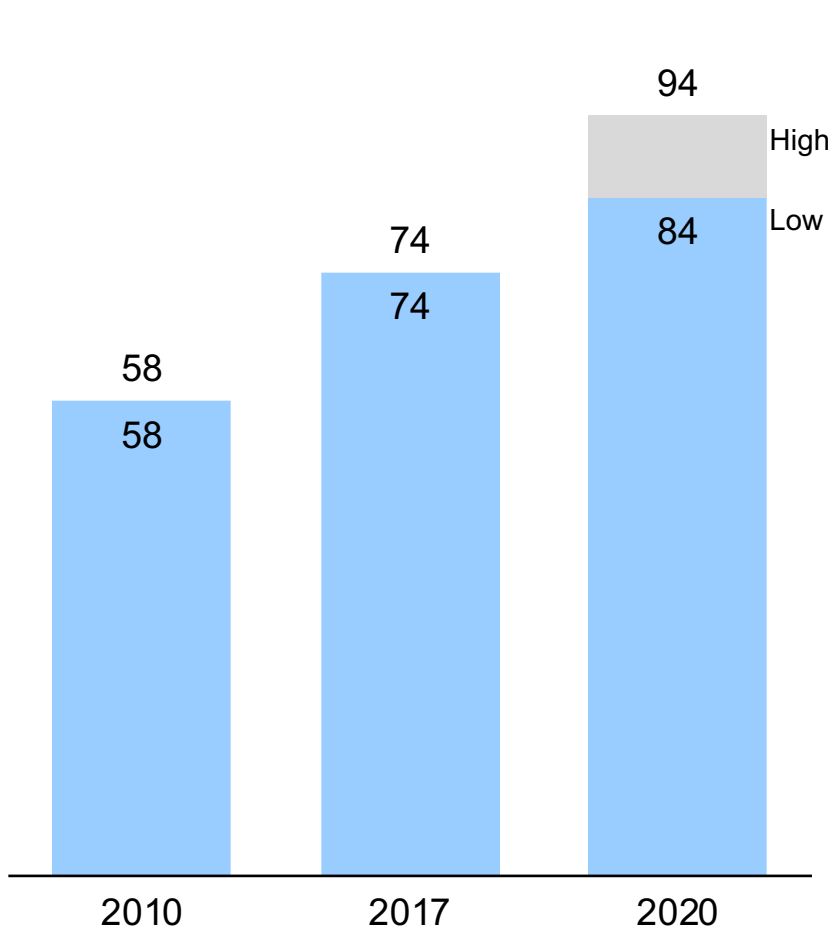


Electricity Generation
(Capacity, Terawatts)

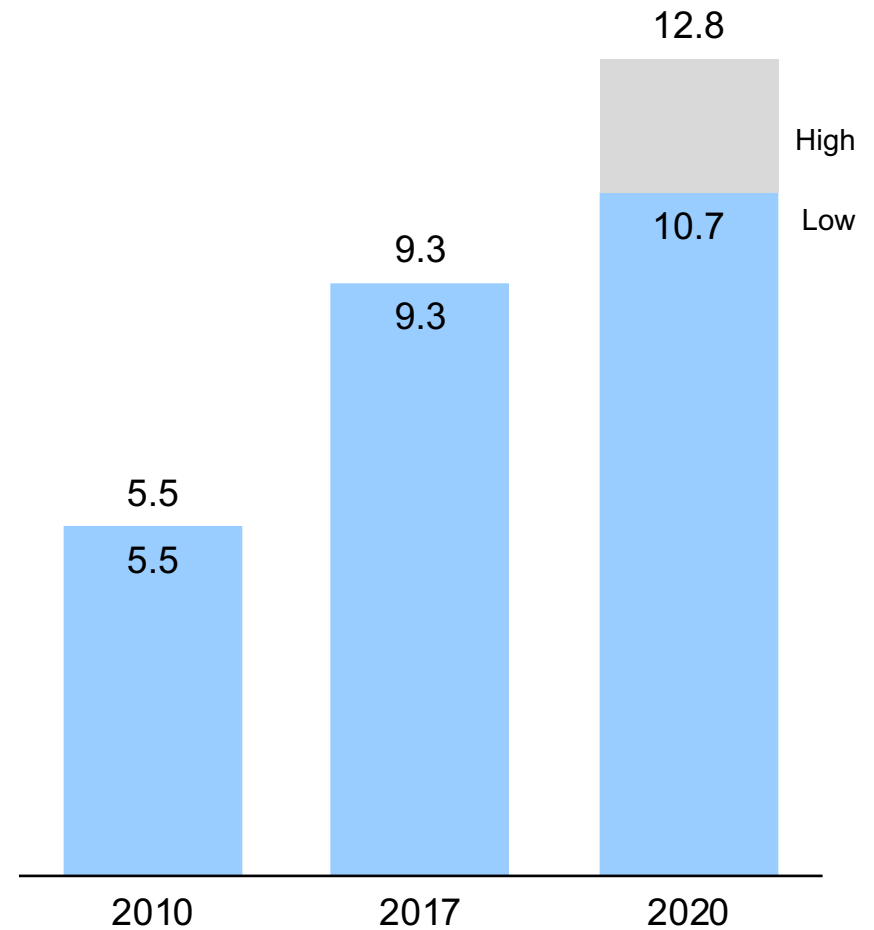


U.S. oil and gas production will continue to rise at a robust pace driven entirely by growth in unconventional

U.S. Natural Gas Production Forecast (Billion Cubic Feet Per Day)

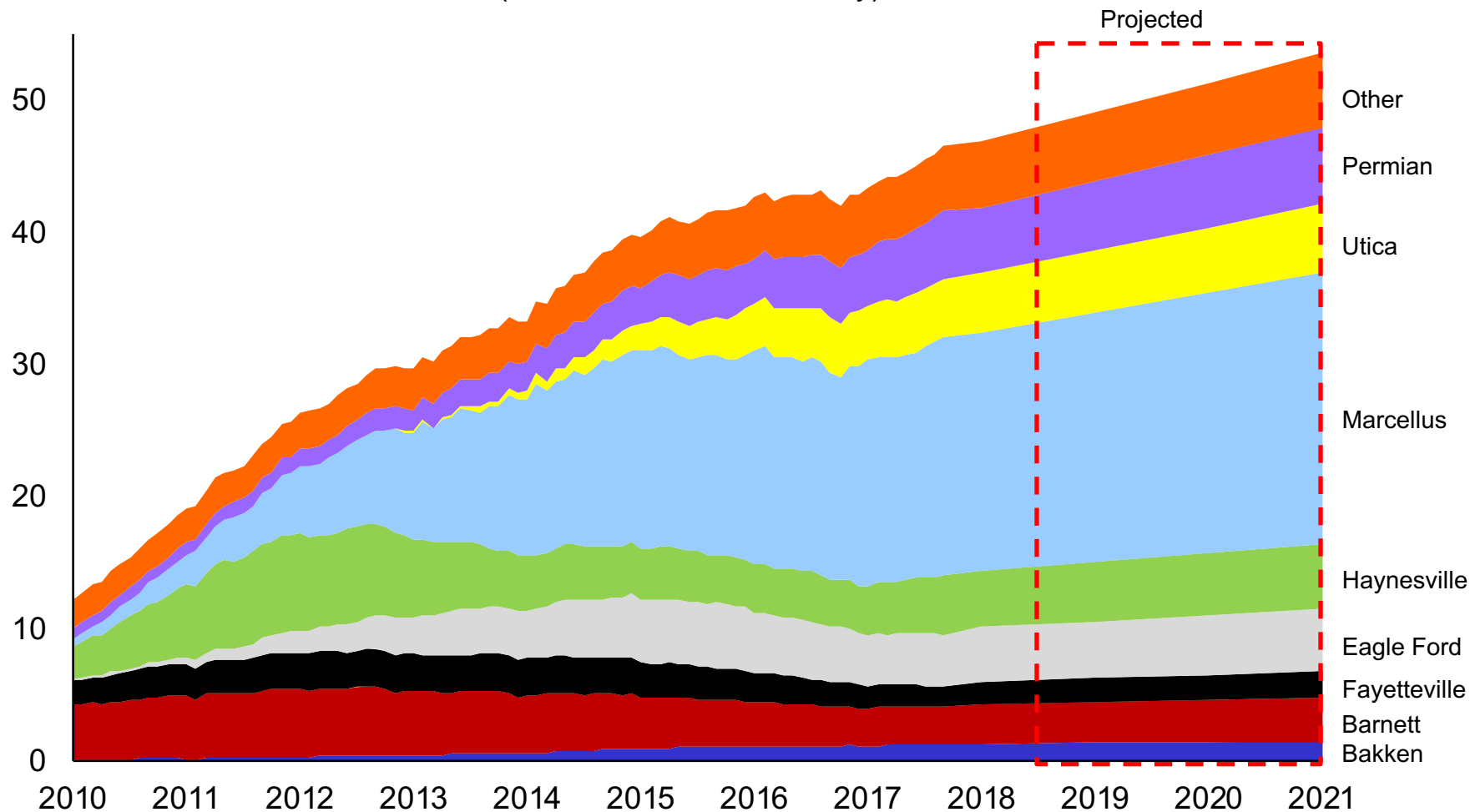


U.S. Crude Oil Production Forecast (Million Barrels Per Day)



Gas supply has grown significantly with most of the growth coming from Marcellus and that will continue through 2020

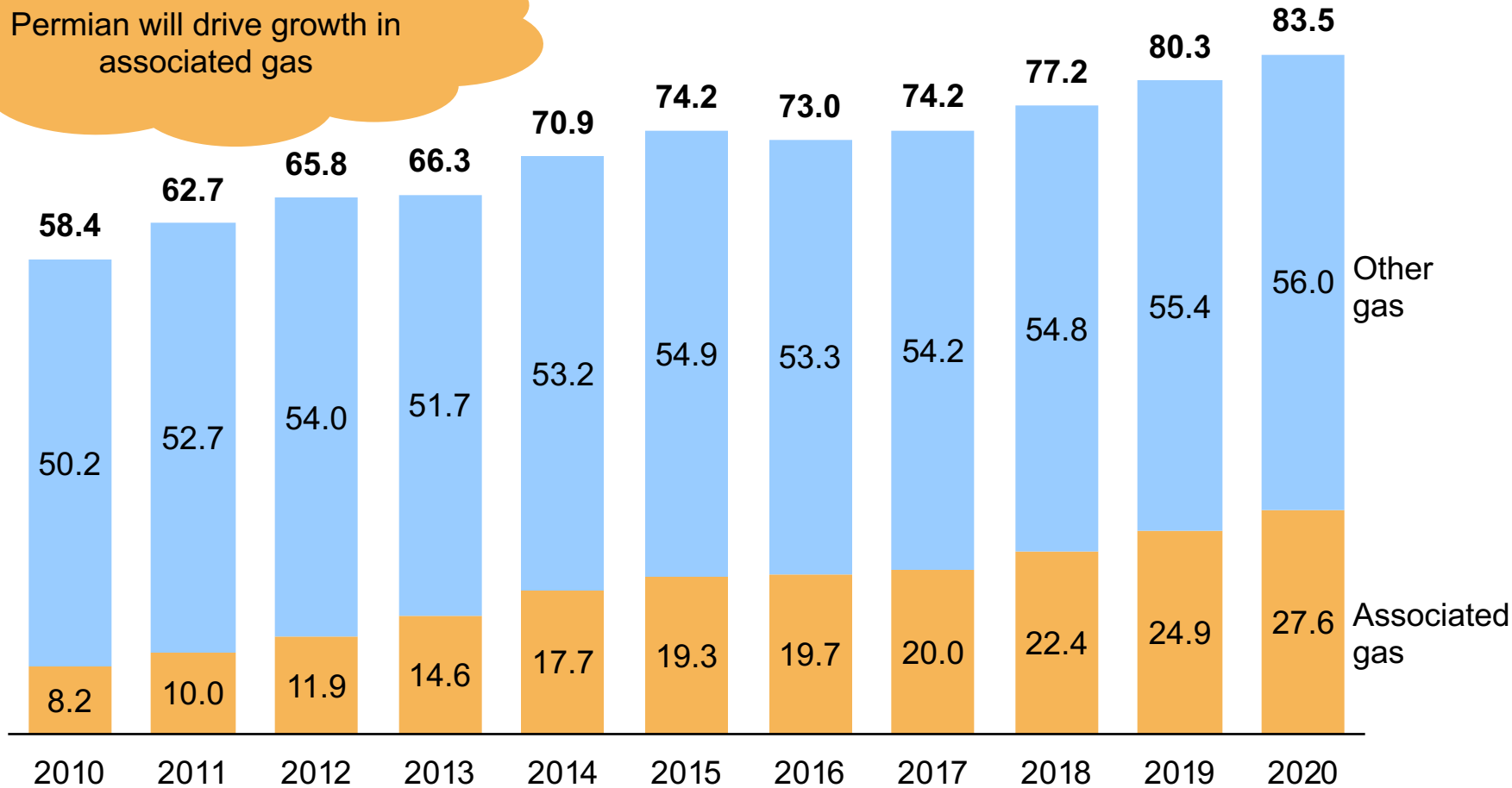
U.S. Dry Shale Production by Basin
(Billion Cubic Feet Per Day)



A significant fraction of natural gas production growth is now coming from associated gas and is linked to oil economics

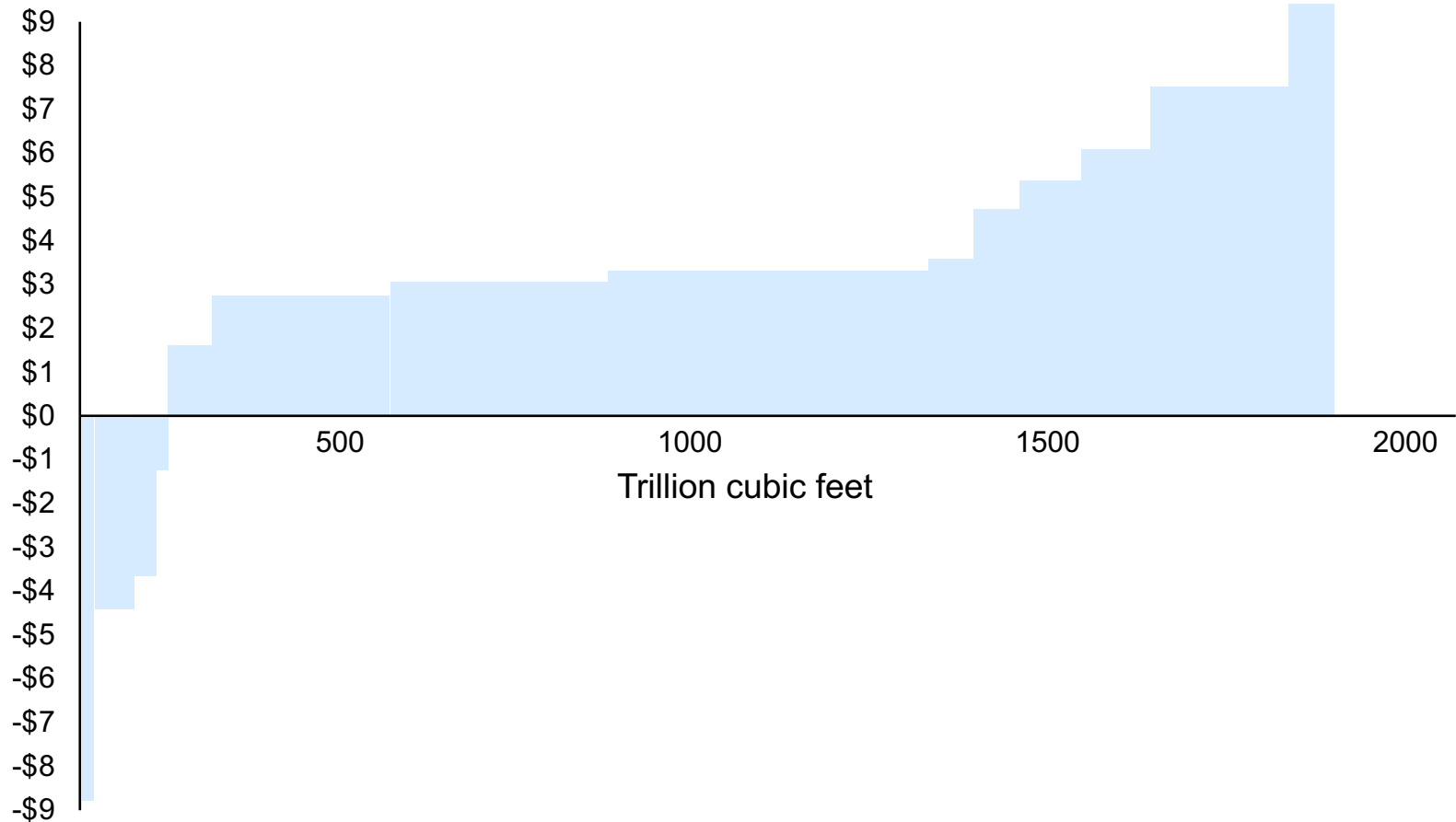
U.S. Total Gas Production
(Billion Cubic Feet Per Day)

Permian will drive growth in associated gas



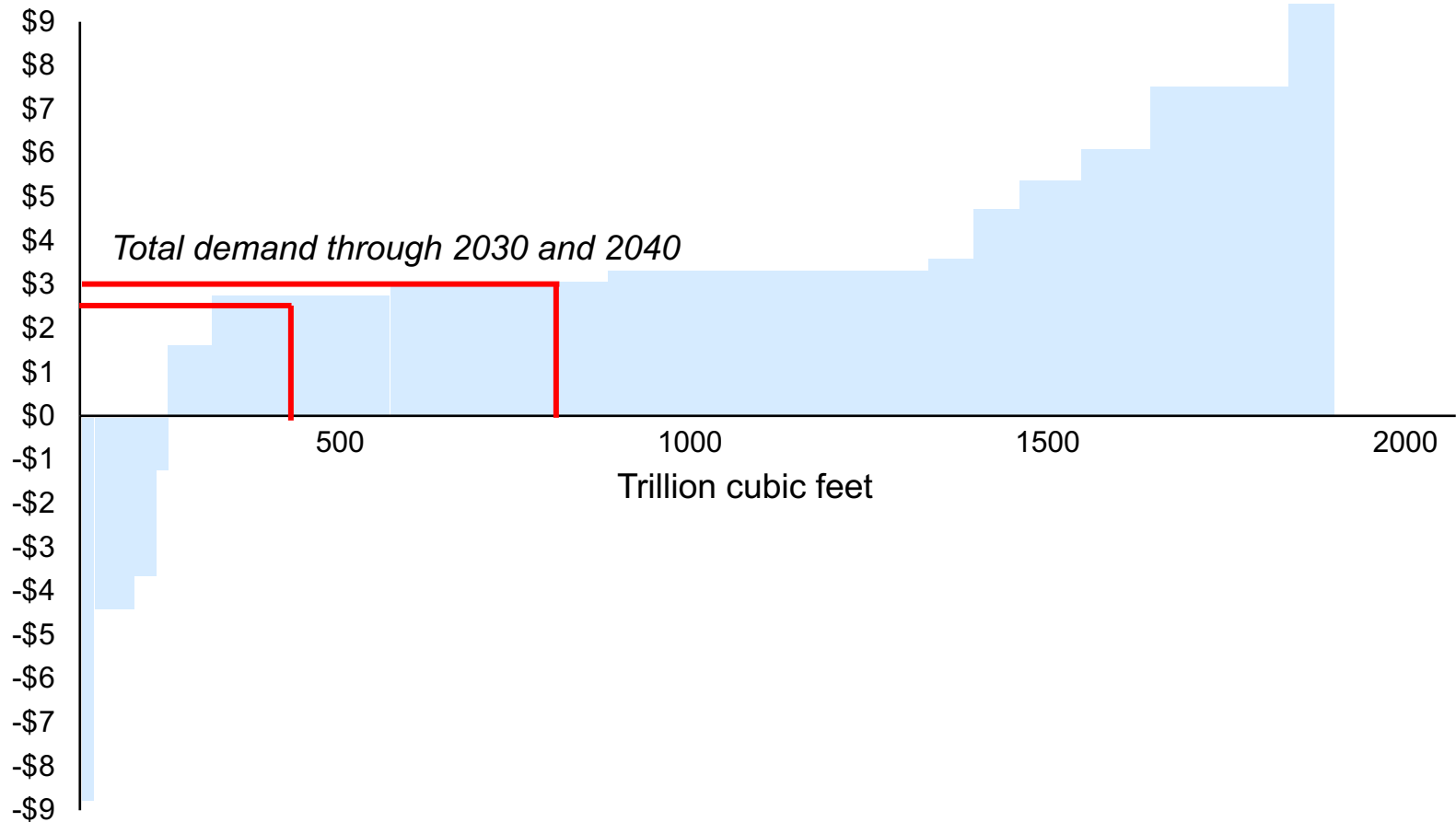
Given this background, we anticipate sustained production and ...

U.S. Natural Gas Supply Curve
(USD Per Million Cubic Feet)

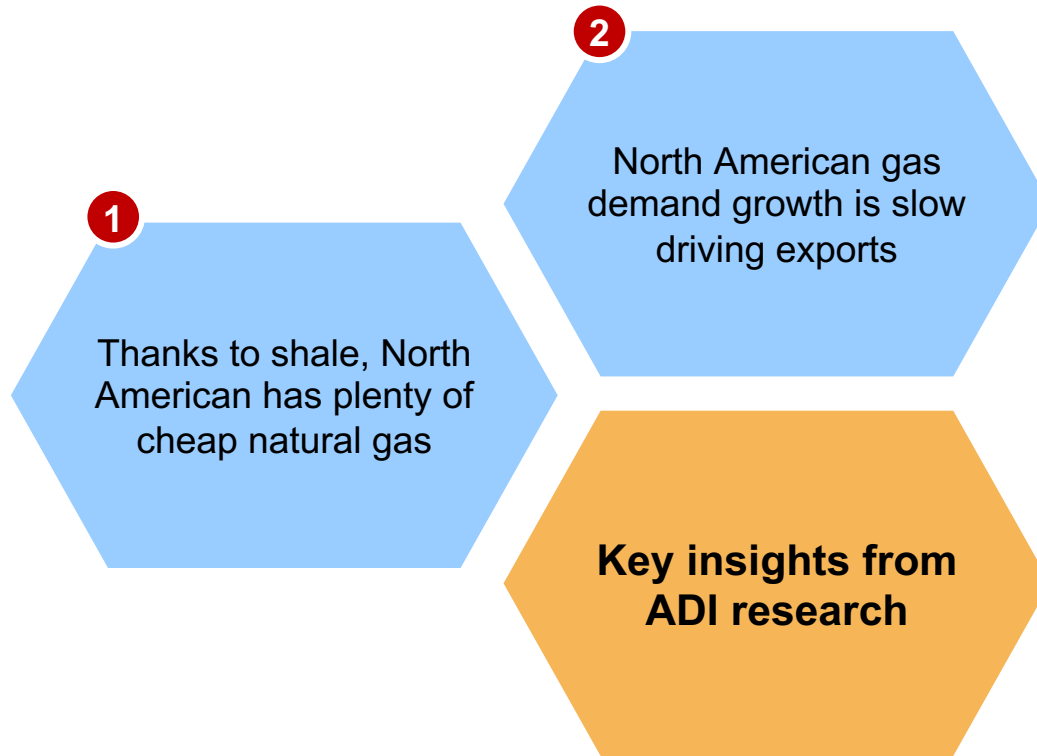


... Supply of cheap natural gas at prices below \$4 per Mcf through the next several years

U.S. Natural Gas Supply Curve
(USD Per Million Cubic Feet)

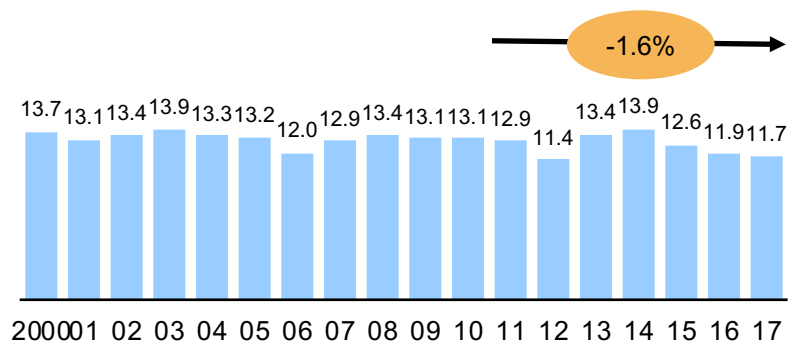


Key messages

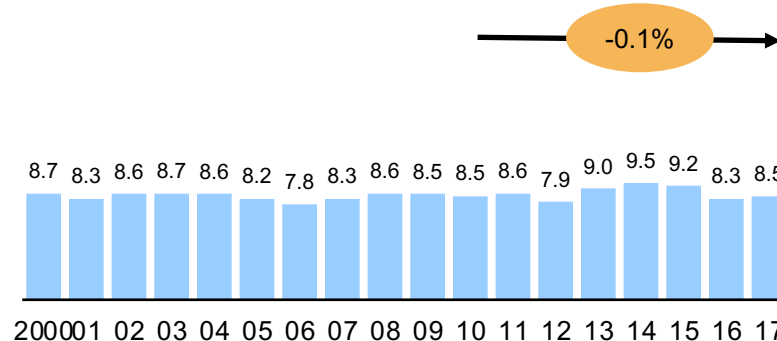


Natural gas demand has grown primarily in the power sector followed by industrials in comparison to other segments

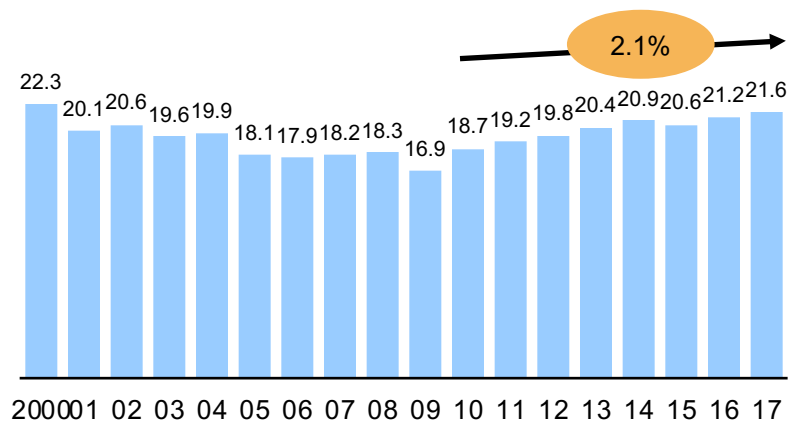
Residential Natural Gas Demand
(Billion Cubic Feet Per Day)



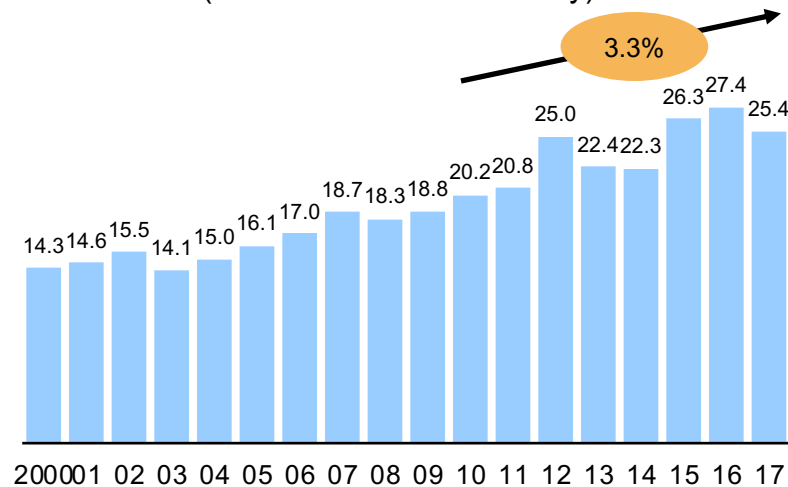
Commercial Natural Gas Demand
(Billion Cubic Feet Per Day)



Industrial Natural Gas Demand
(Billion Cubic Feet Per Day)

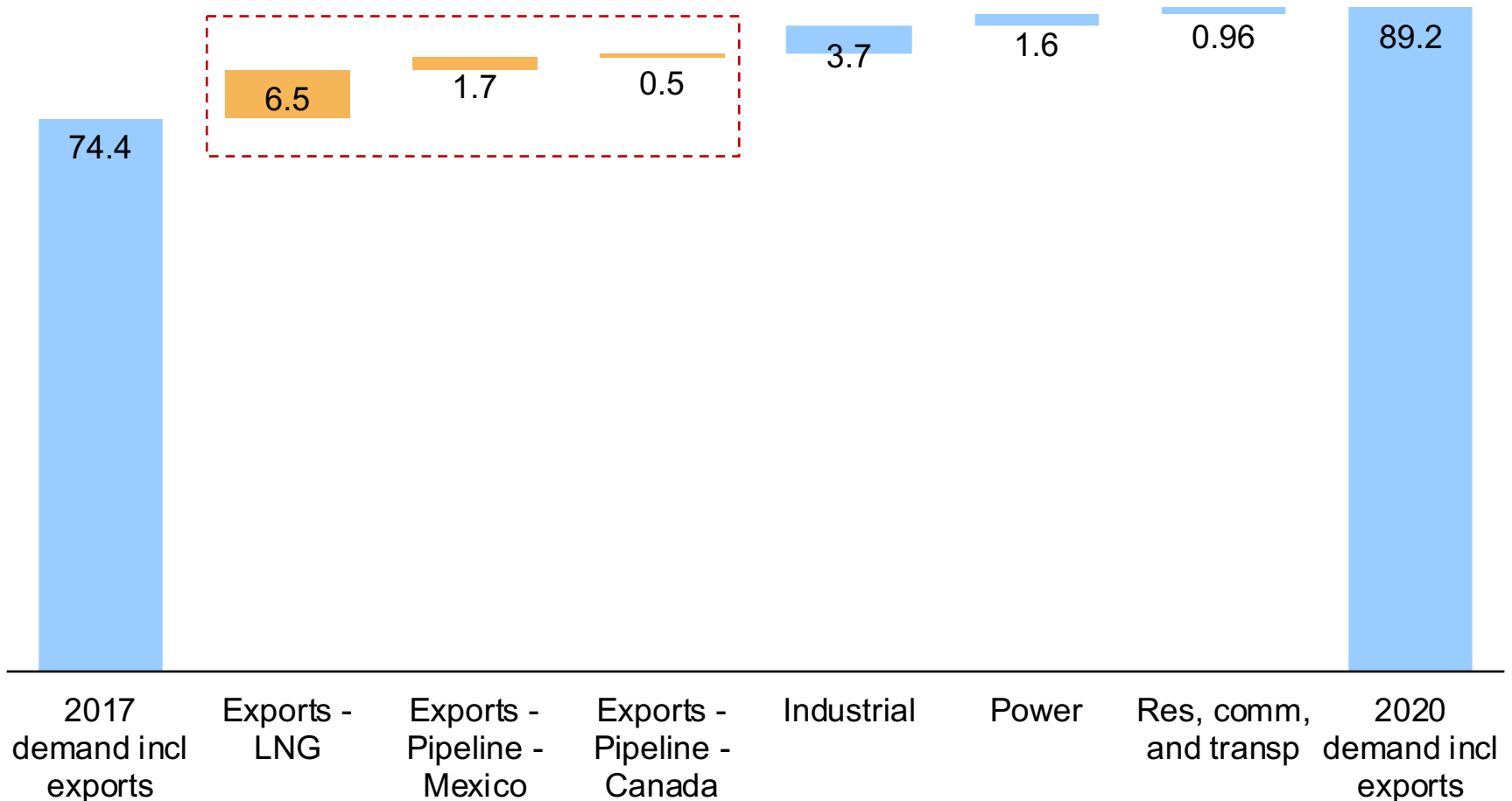


Natural Gas Demand for Power
(Billion Cubic Feet Per Day)

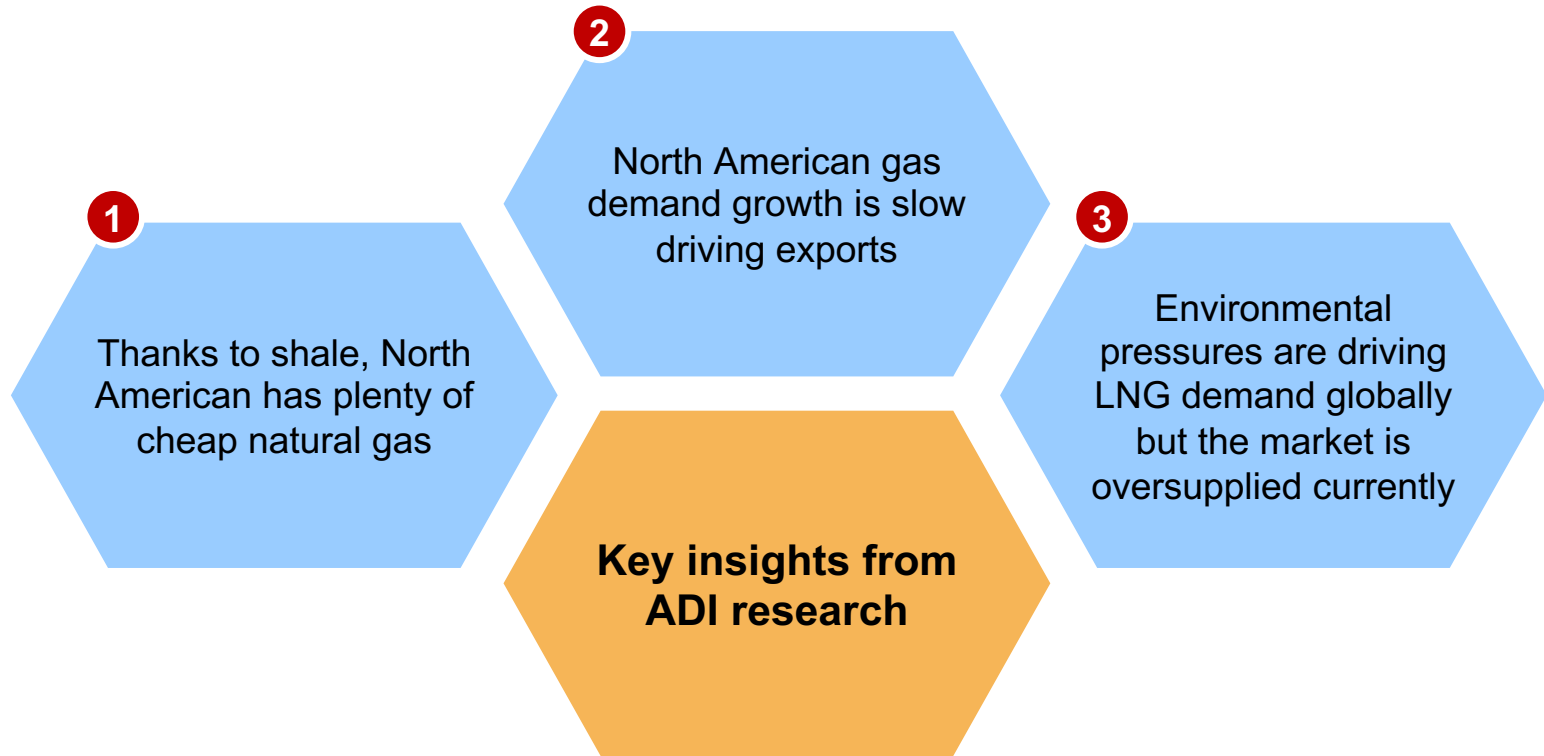


Natural gas exports via pipelines and LNG will after a long time account for the bulk of demand growth until 2025

U.S. Natural Gas Utilization Growth
(Billion Cubic Feet Per Day, 2017-20)



Key messages



More countries are importing LNG either as a primary fuel or to complement or switch away from other fuels

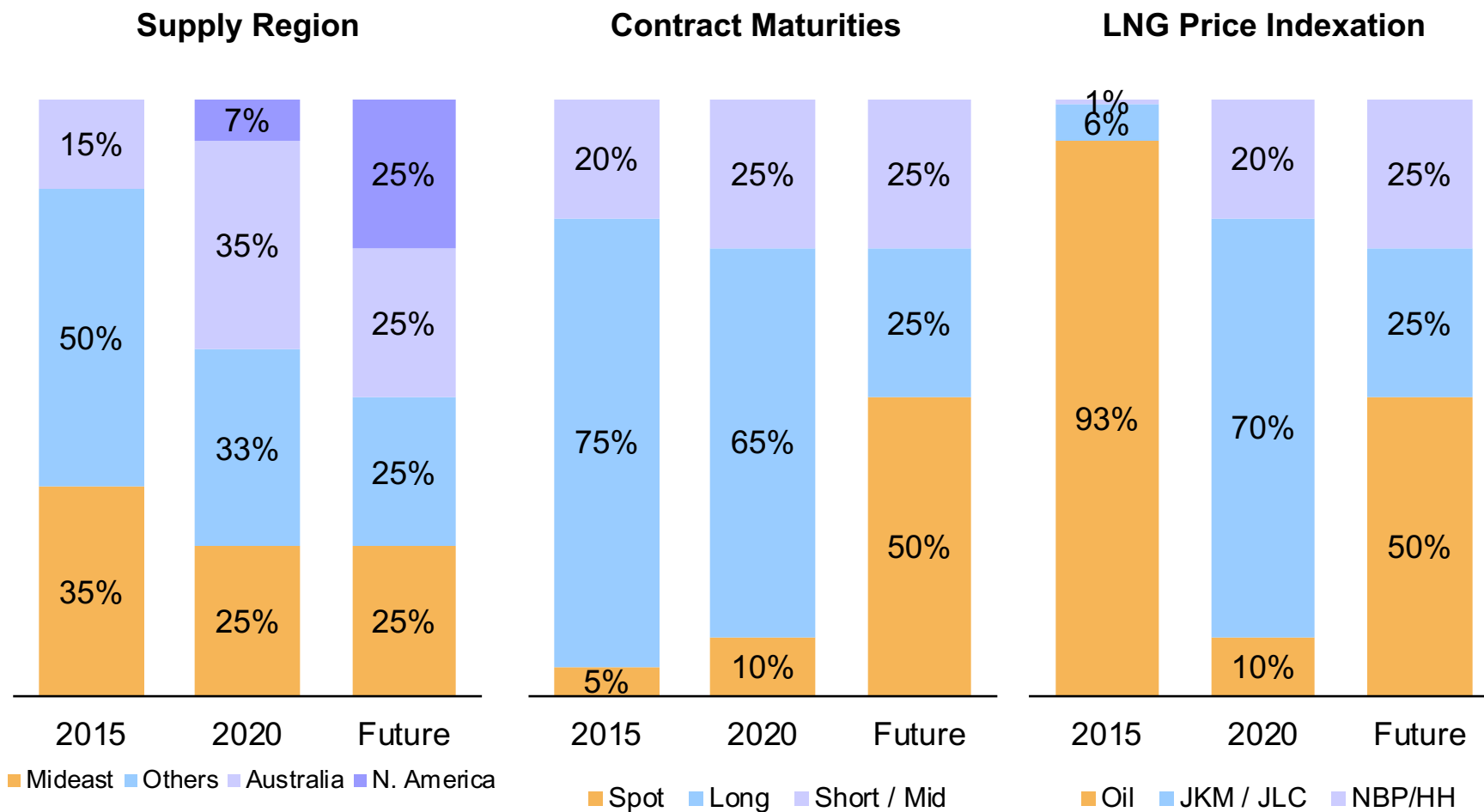
Map of LNG Importing Countries by Primary Use



■ LNG as primary fuel ■ LNG complementing ■ LNG displacing other fuels ■ Bunker fuel

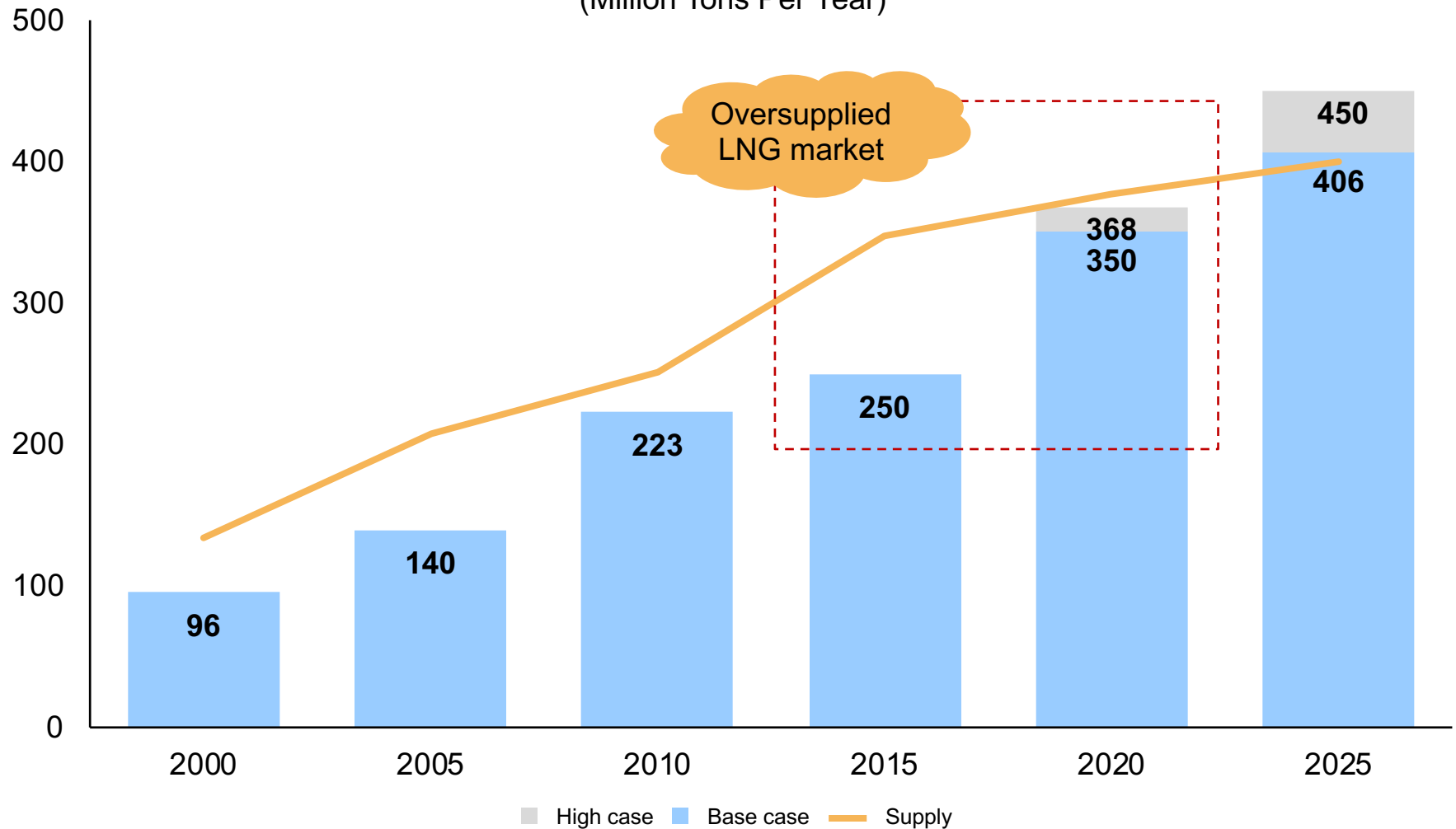
Leading LNG buyers have intensified their efforts to reduce costs and risk via diversification across multiple dimensions

Japanese LNG Importers' Goals

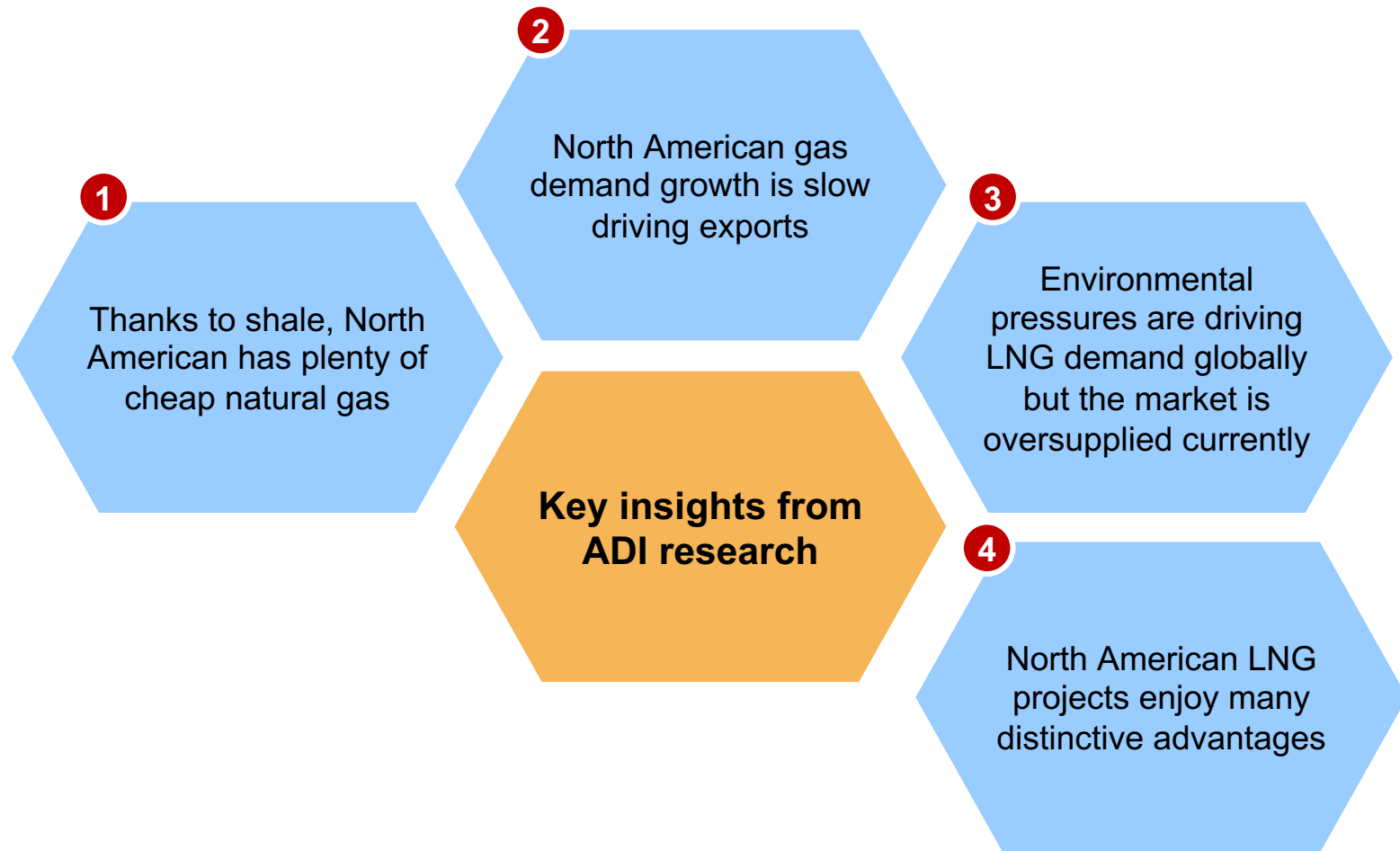


LNG markets are oversupplied although they may balance sooner than expected in early 2020s

Worldwide LNG Demand and Supply
(Million Tons Per Year)

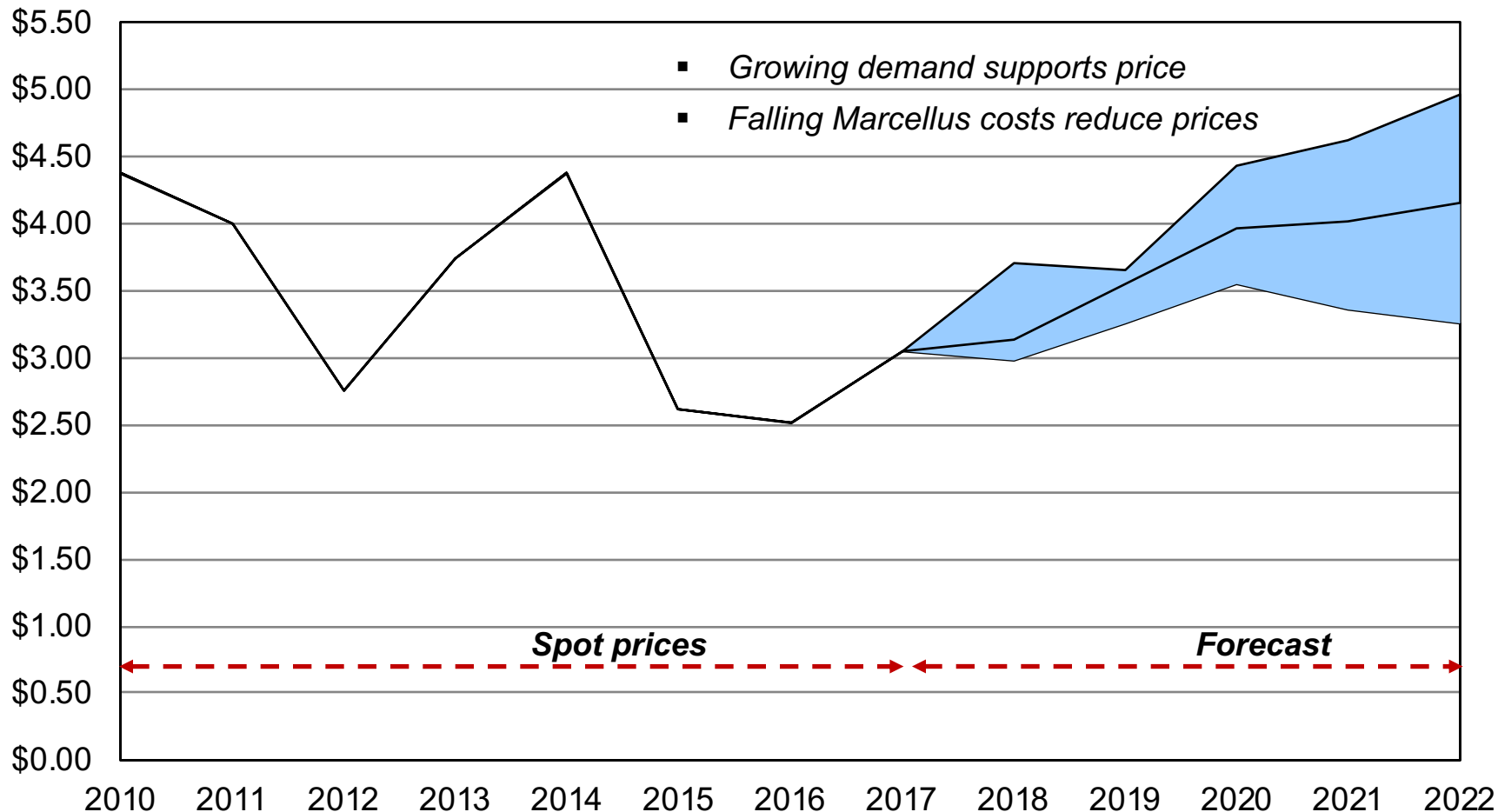


Key messages



Natural gas prices will continue to grow moderately as seen recently but will likely stay below or around \$4 per Mcf

Henry Hub Spot and Forecast Prices
(USD Per Million Btu)



Abundant, liquid supply of natural gas in the U.S. has enabled new LNG business models based on tolling capabilities ...

LNG Value Chain and Business Models



Integrated Model

- ▶ Gas producer builds and owns LNG plant ...
- ▶ ... Owns marketing risk and price upside ...
- ▶ ... Ships LNG under SPA contracts, spot cargoes, and FOB sales

Pure Play

- ▶ Developer builds and owns LNG plant ...
- ▶ ... Buys gas from grid to produce LNG ...
- ▶ ... Sells FOB under long-term SPA with some spot

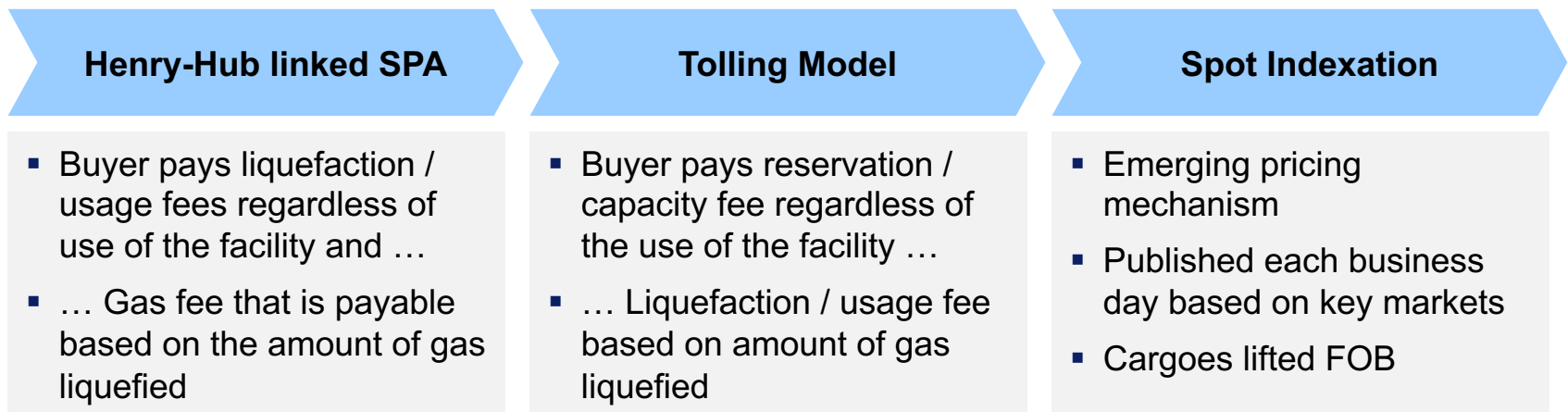
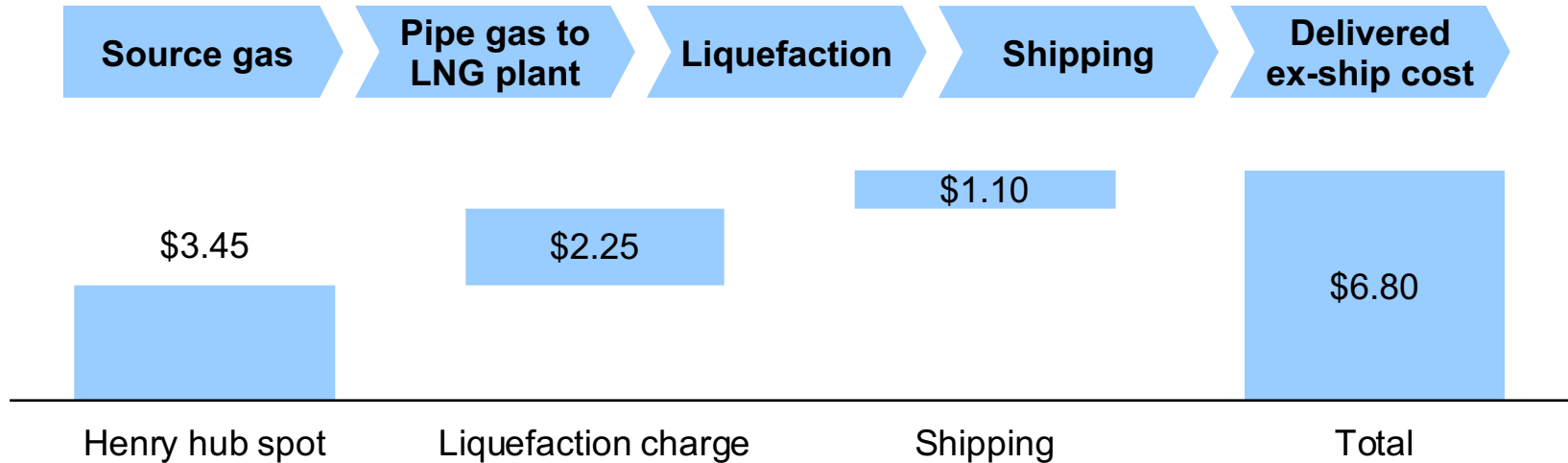
Toll Model

Liquefaction owned by third party

- ▶ Gas producer leases liquefaction plant to "toll" LNG at a fee ...
- ▶ ... Controls shipping and marketing

North American shale gas-based LNG capacity is disrupting pricing mechanisms and expanding spot pricing

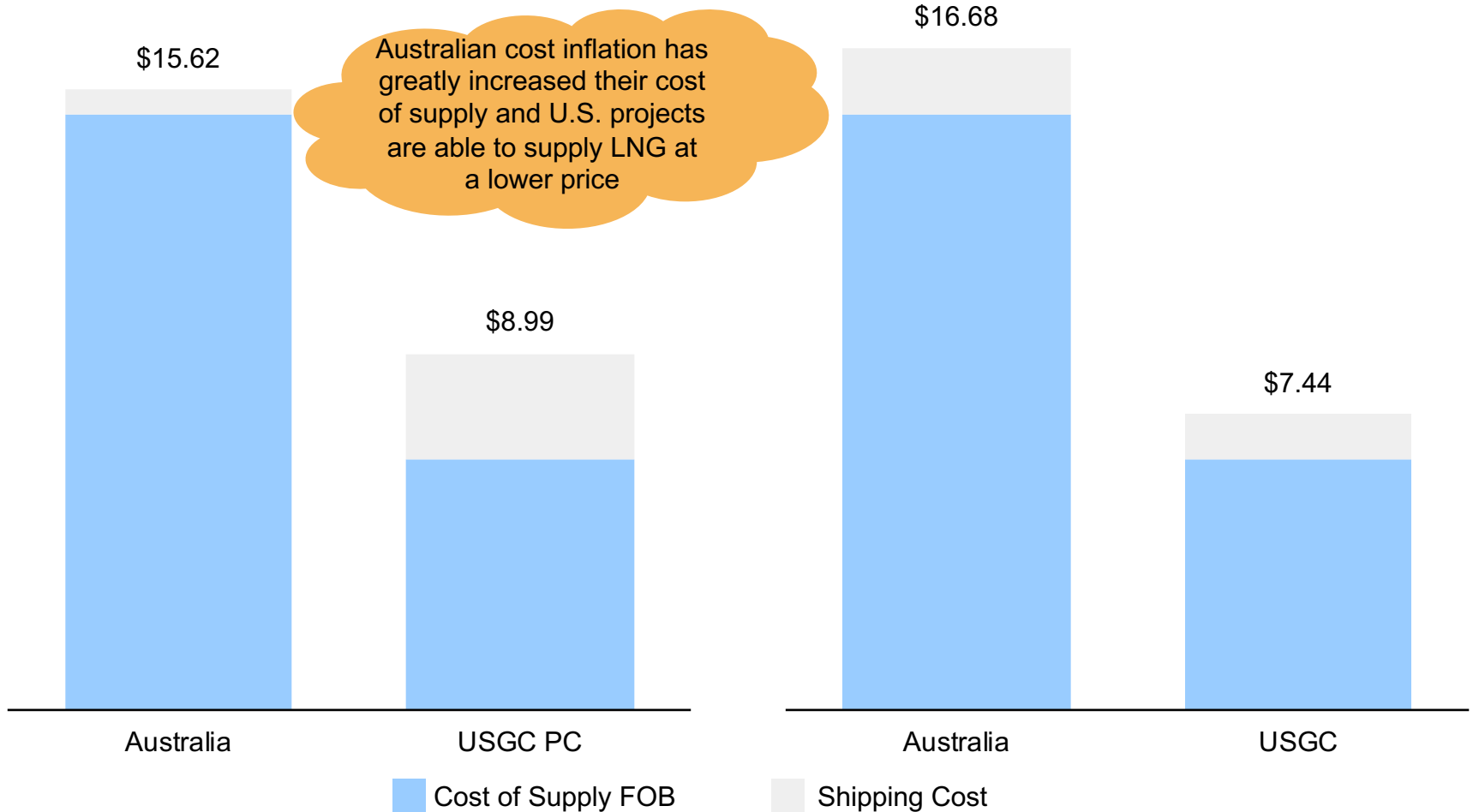
Henry-Hub Linked Sales Purchase Agreement (USD / Million Btu)



... Enabling LNG export projects in the U.S. to supply both Asia and Europe more competitively than Australian projects

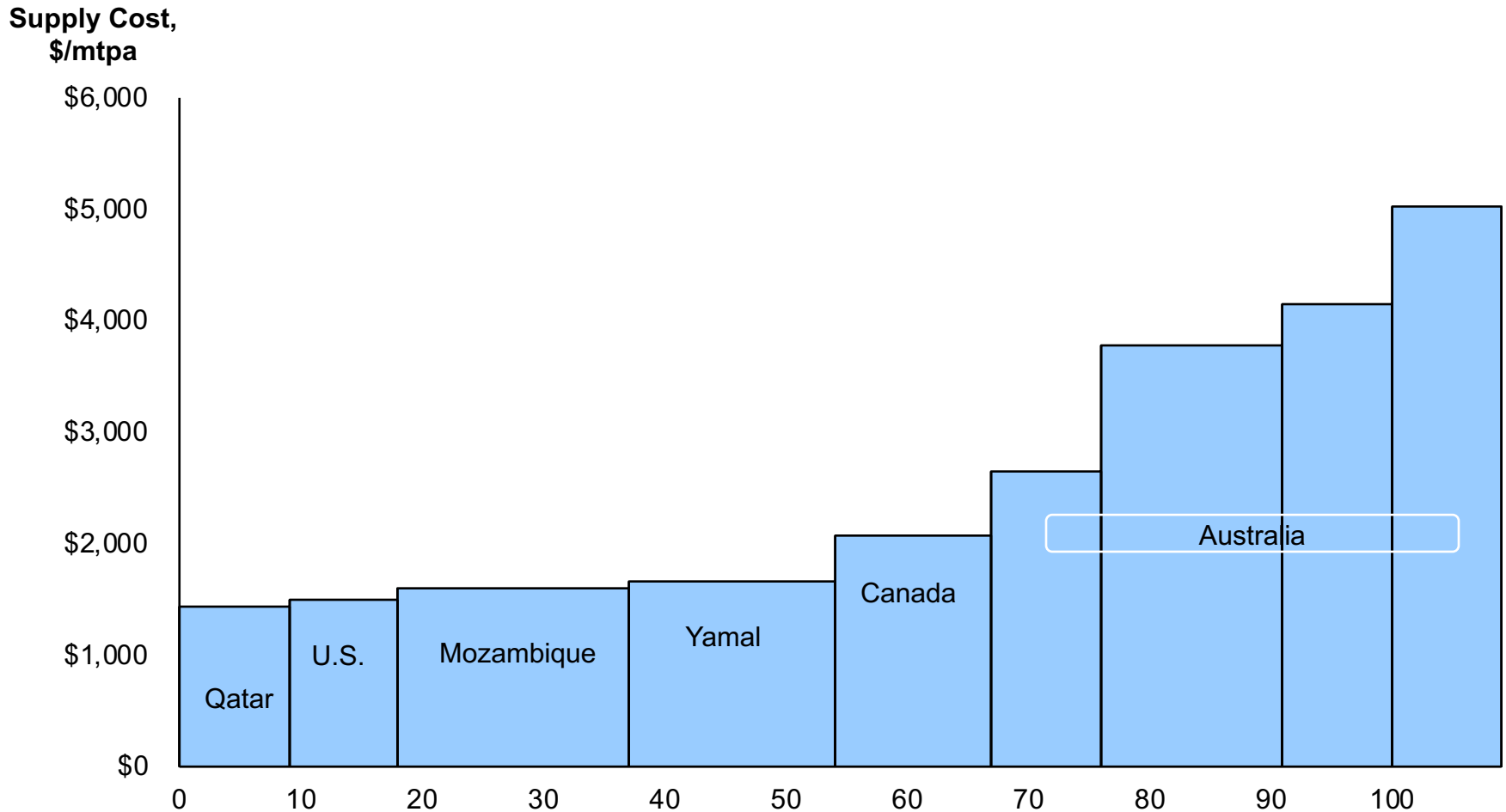
Delivered Ex-Ship (DES) Cost of Supply to Asia
(U.S. Dollar Per Million Btu)

Delivered Ex-Ship (DES) Cost of Supply to Europe
(U.S. Dollar Per Million Btu)

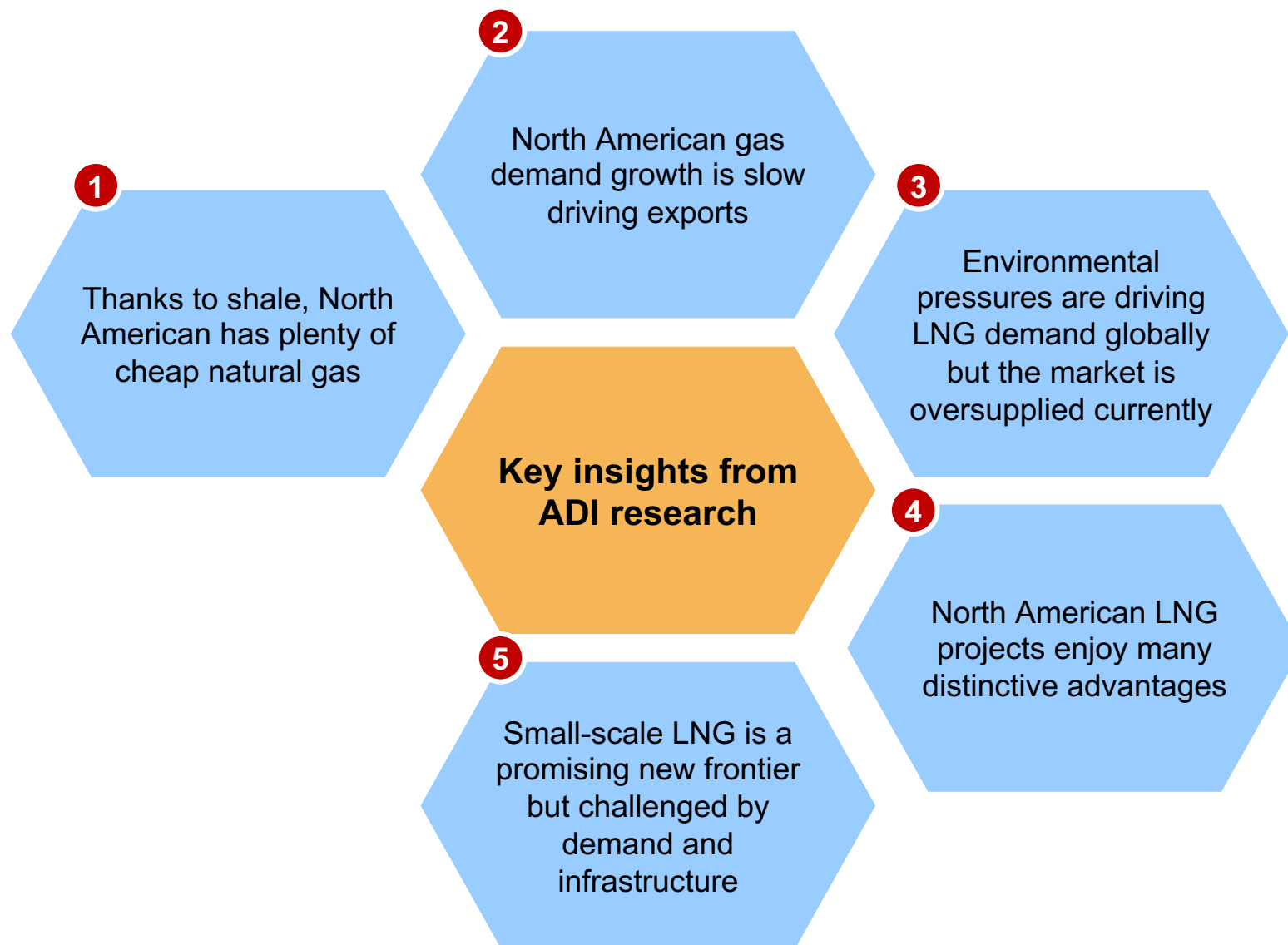


U.S. LNG capacity is very competitively positioned on the supply curve relative to other projects

Capital Cost of LNG Capacity



Key messages



Small- and mid-scale LNG scale is defined in this study to include plants from 20 to 3,000 tons per day of capacity

Large-Scale LNG



Discussion

- Conventional LNG plant is made up of trains...
- ... which can be 3 to 7 million tons per annum in capacity
- Example: RasGas LNG, Qatar

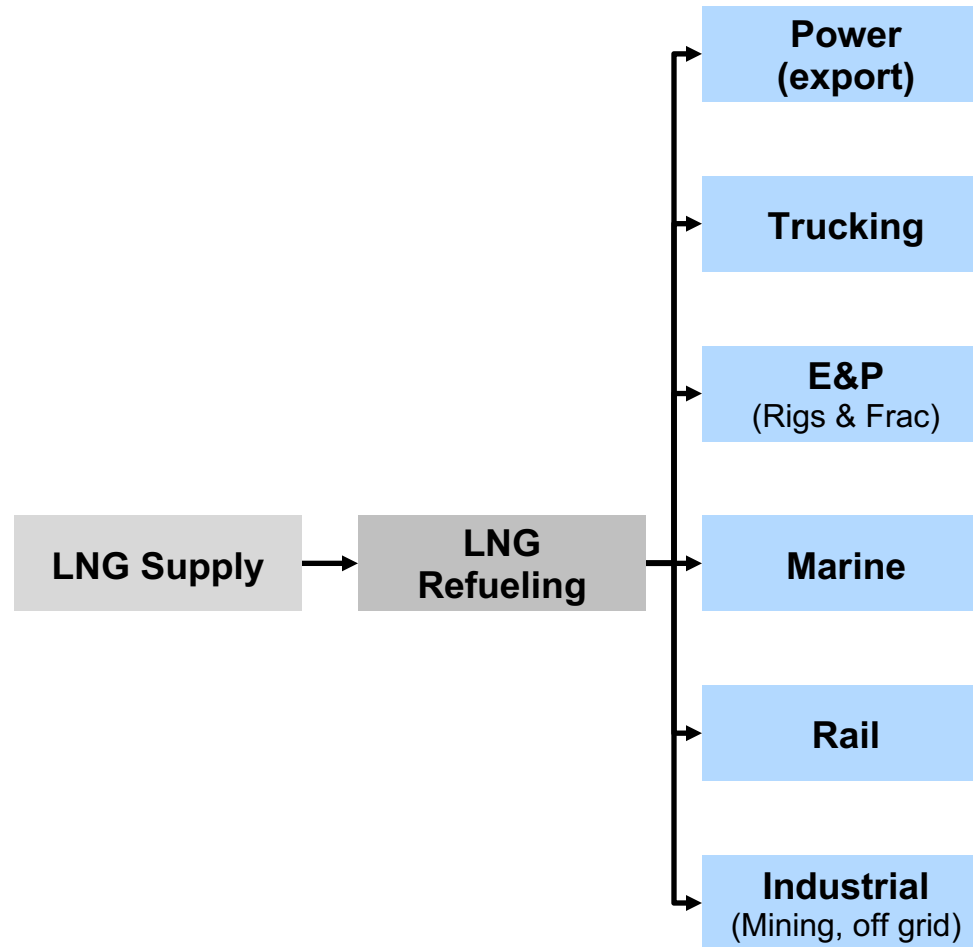
Small- and Mid-Scale LNG



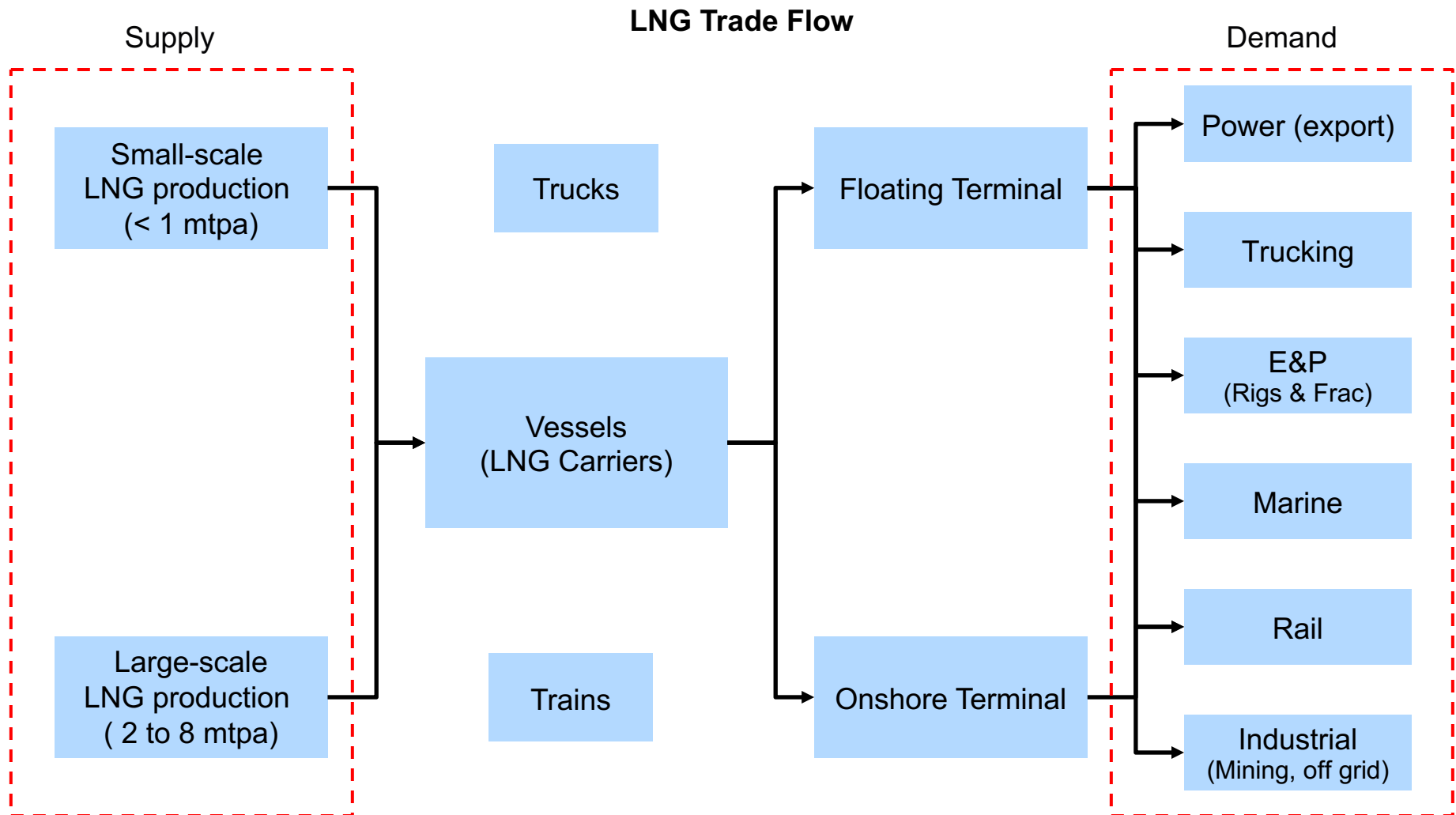
Discussion

- A mini plant's size is 20 to 100 tons per day
- Small plant is 100 to 500 tons per day in capacity and ...
- ... Mid scale is 500 to 3,000 tons per day

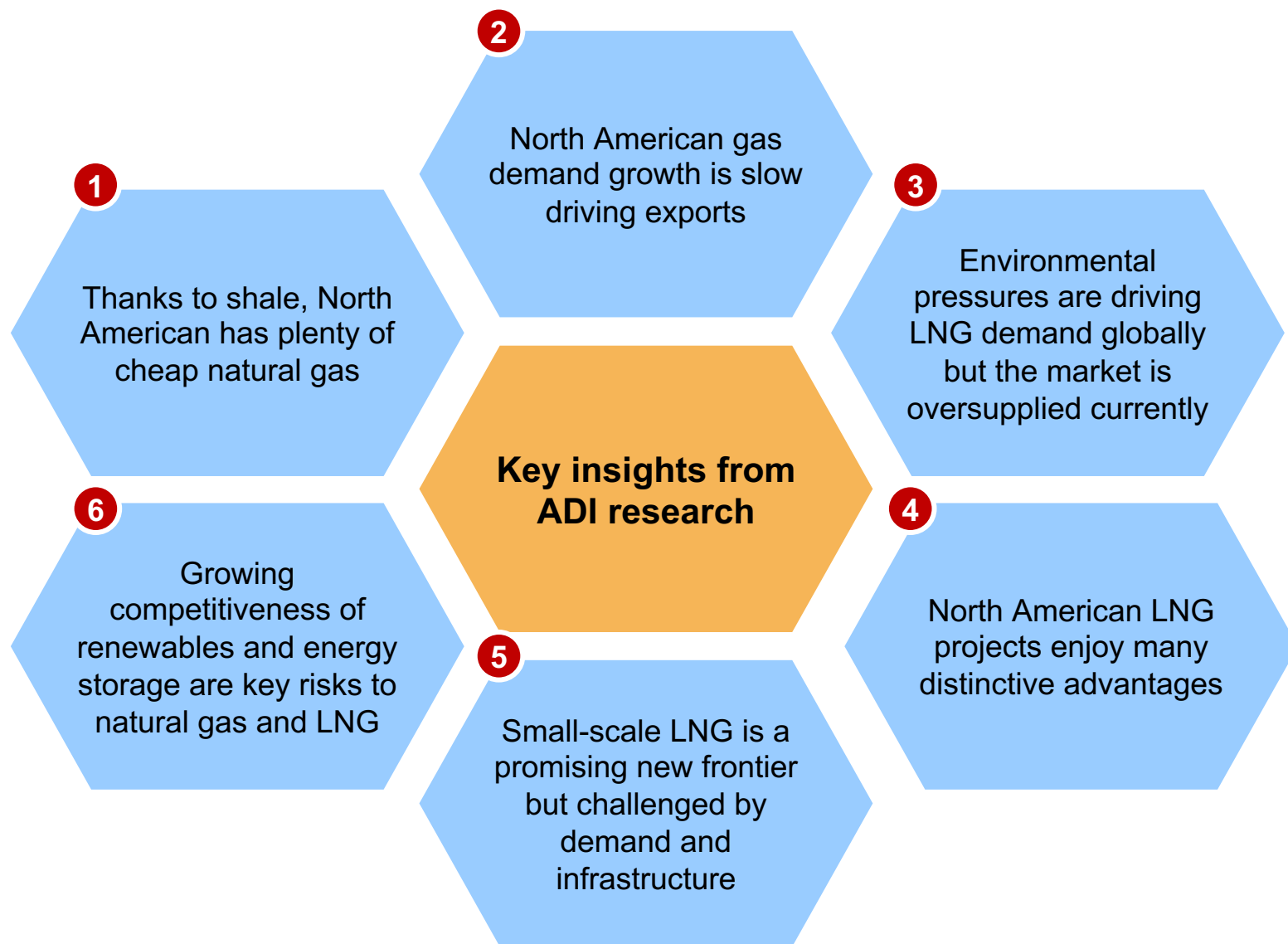
Six segments drive demand for LNG from small- and mid-scale facilities and our study models each of them



Infrastructure is critical to enabling the small-scale LNG market and requires investments across the value chain



Key messages



If fracking was a black swan ...



... So was Fukushima in accelerating demand for gas in Asia



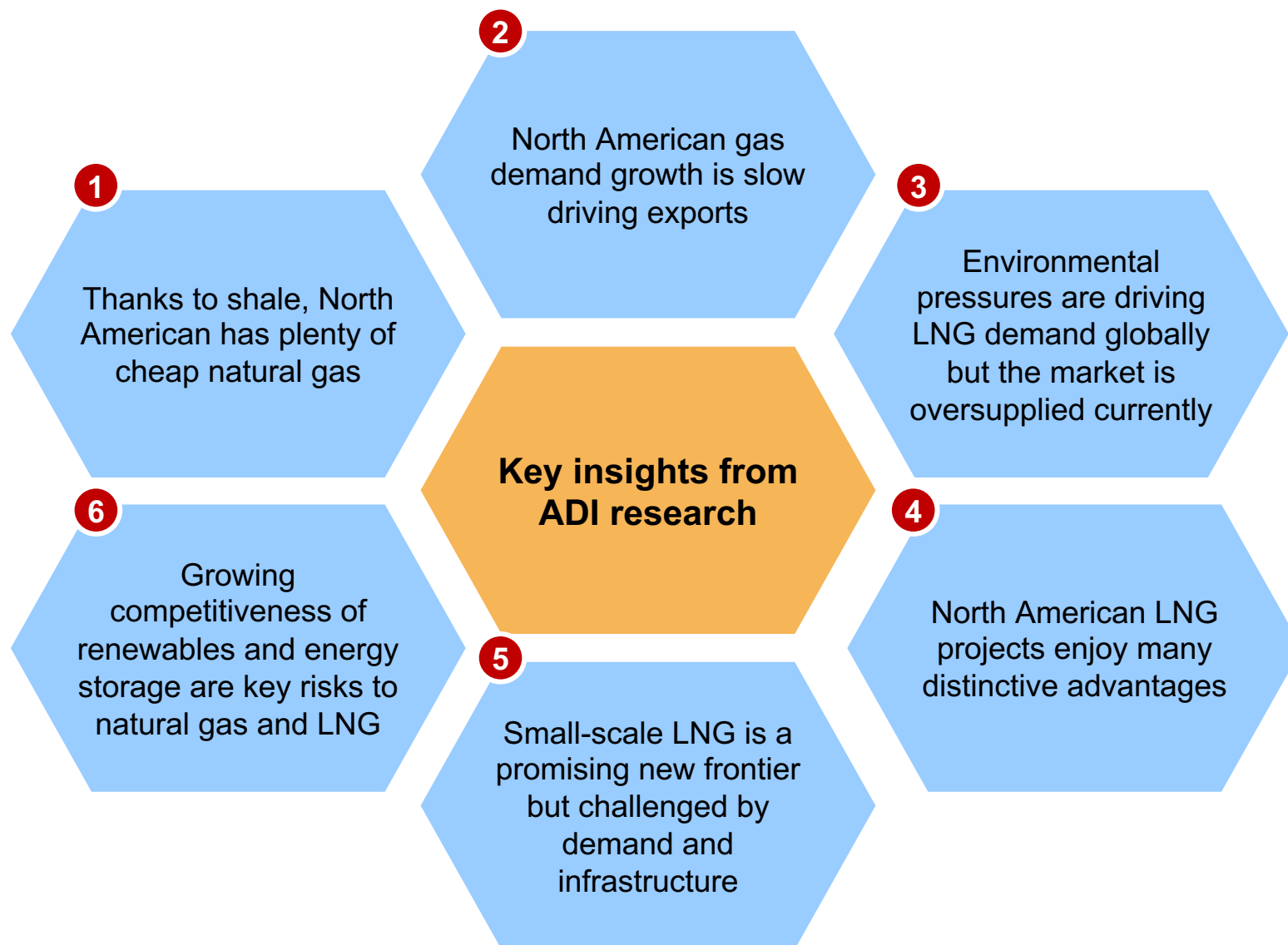
The 70% to 90% decline in solar and wind energy costs were unanticipated and another Black Swan



What will the Black Swans of this decade look like?



Key messages





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