



North American Midstream Infrastructure – A Near Term Update Through 2025

Reflecting on the Current State of Oil and Gas Markets
and Midstream Infrastructure Development

Prepared by ICF for the INGAA Foundation

December 2020



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Joe Ramsey, Steering Committee Chair
Susan Waller, INGAA Foundation Chair
Lauren O'Donnell, Past Chair
Kelly Dunn, TC Energy
Mark Hereth, Blacksmith Group
Craig Meier, Sunland Construction
George Wayne, Kinder Morgan

About the INGAA Foundation: The Interstate Natural Gas Association of America (INGAA) is a trade organization that advocates regulatory and legislative positions of importance to the natural gas pipeline industry in North America. The INGAA Foundation was formed in 1990 by INGAA to advance the use of natural gas for the benefit of the environment and the consuming public. The Foundation, which is composed of over 200 members, works to facilitate the efficient construction and safe, reliable operation of the North American natural gas pipeline system and promotes natural gas infrastructure development worldwide.

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1. Executive Summary

During the past decade, oil and gas infrastructure development in the U.S. has been relatively robust. However, recent market developments—most notably impacts of the COVID-19 pandemic and related declines in economic activity, the recent collapse in oil prices, near-term declines in oil and gas use, and challenges with permitting new pipeline expansion projects—have appeared to slow the pace of infrastructure development. Considering these unprecedented changes, the INGAA Foundation requested ICF Resources LLC (ICF) to evaluate how the paths for markets and infrastructure development will be impacted in the U.S. through 2025.

The main portions of this report were completed in November 2020. Since that time, some sections have been modified, and some comments on recent developments have been placed in the Executive Summary that may not appear in the main body of the report.

The Report Analysis Is Based on Two Forecast Scenarios: Pre- and Post-COVID-19 Pandemic.

To evaluate changes to oil and gas markets and infrastructure development, ICF relied on its market modeling tools to complete two scenarios of North American oil and gas markets through 2025. The

first scenario, labeled ICF Q1 2020, shows market and infrastructure development trends prior to the COVID-19 pandemic and absent extended delays in infrastructure development. The second scenario, labeled INGAA 2020, is a more recent scenario that fully captures impacts of the COVID-19 pandemic and extended delays in infrastructure development. Projected results from the two scenarios were compared to assess how significantly recent events have altered the paths for markets and infrastructure development. Based on that comparison, this study’s findings are summarized as follows.

Potential for infrastructure development is still significant, despite recent events.

The INGAA 2020 scenario shows that almost 33 billion cubic feet per day of capacity is expected to be placed into service through major gas pipeline projects from 2020 through 2025 (Exhibit ES 1). This projected development is lower on a per annum basis than it was in 2018, a banner year for pipeline construction. While projected development is down by almost six billion cubic feet per day, or about 15%, from the level projected in ICF Q1 2020, it still requires a substantial amount of new infrastructure.

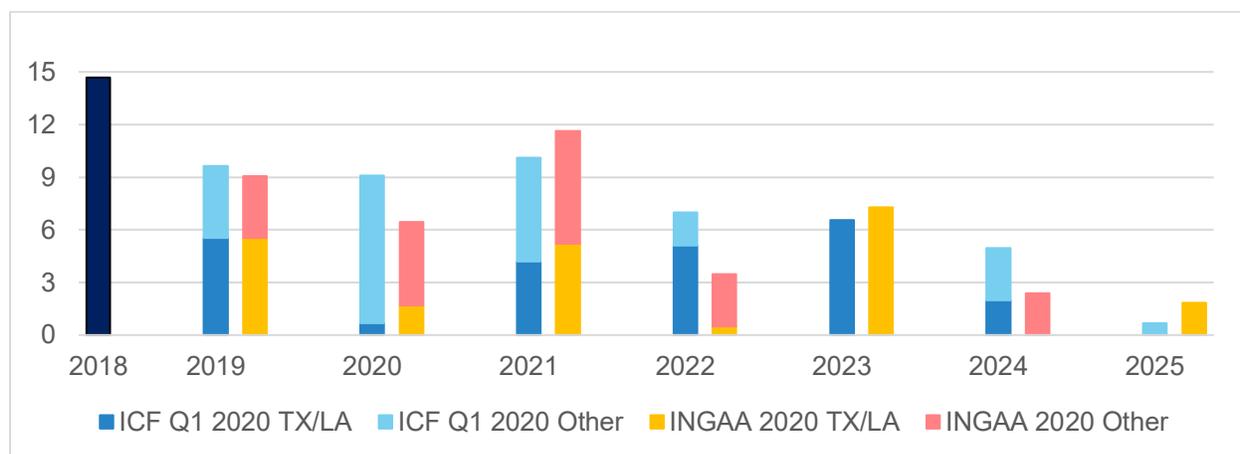
As the impacts of COVID-19 diminish over time, the drivers of new infrastructure return.

New gas infrastructure is needed in many different geographic locations, particularly in Texas and Louisiana, to support continued supply development and continued growth of both domestic gas use and exports (via pipeline and Liquefied Natural Gas (LNG)). LNG exports are a major driver of future demand growth for U.S. natural gas markets. In July



2020, monthly average feed gas deliveries to LNG export facilities dipped below 3.5 billion cubic feet per day for the first time since 2018. However, in November 2020, LNG feed gas deliveries set a record, surpassing 10 billion cubic feet per day. December 2020 feed gas deliveries were higher still, finishing the month at approximately 11 billion cubic feet per day.

Exhibit ES 1: Capacity Additions In-Service for Major Pipeline Projects (Billion Cubic Feet per Day)



Note that this chart shows natural gas pipeline capacity for projects with over 100 miles of new pipe.¹

There is no disagreement that 2020 has been a difficult year for oil and gas producers. While many producers have slashed their budgets in response to significant declines in oil and gas use and collapsing oil and gas prices, the INGAA 2020 scenario shows that exploration and production activity will rebound as markets continue to recover and oil and gas prices firm. A significant amount of economically viable oil and gas resources remain to be developed in the U.S. and Canada; continued productivity improvements in drilling and completion techniques along with unit cost reductions will make it possible for oil and gas production to grow even with lower drilling levels.

Even though the path has been altered by recent events, the INGAA 2020 scenario shows oil and gas production levels continuing to increase in the future. As the impacts of COVID-19 diminish over time, the drivers of new infrastructure return. This result assumes that successful vaccines and more effective treatments for the virus will be developed and deployed in a timely manner, which is an expectation held by many government officials and researchers. After the initial completion of this report, the U.S. Food and Drug Administration approved Pfizer-BioNTech's and Moderna's COVID-19 vaccines for use. While anticipated, the approvals and roll out of the vaccines reduce market risk associated with the COVID-19 pandemic and are expected to accelerate the

¹ Actual historical data is represented by black and or gray bars here and throughout the report.

rebound in economic activity and the need for natural gas infrastructure.

While pipeline project development has become more difficult in recent years, capital still appears to be available for new infrastructure where a project's need is clearly demonstrated. Further, capacity projected in the INGAA 2020 scenario has sufficient market support to justify final investment decisions. While permitting new infrastructure is challenging in today's environment, new capacity is economically justified, even considering the strong headwinds created by COVID-19 and other recent market events.

Gas infrastructure will continue to support power system reliability as renewable power generation expands.

In addition to the new infrastructure discussed above, gas infrastructure is also very important in the power sector. Natural gas has become increasingly essential over the past twenty years as the power sector has moved away from oil and coal to reduce emissions of pollutants and toxic materials. Moreover, the abundance of domestic natural gas supply due to the shale revolution has improved the economics for natural gas dispatch relative to other fuels. As a result, according to the EIA, gas generation in the U.S. has accounted for about 40% of total generation since the beginning of 2019. Natural gas-fired generation in the U.S increased 6% in the first eight months of 2020 compared with the first eight months of 2019 despite a decline in total electricity generation over the same period. The increase in natural gas-fired generation was the result of low natural gas prices and recent natural gas-fired power generation capacity additions. The decrease in electricity sales resulted from reduced business activity as a result of COVID-19 mitigation efforts.

Gas infrastructure will continue to support power system reliability as renewable power generation expands.

While renewable forms of energy, particularly wind and solar resources, have seen significant penetration during the past few years, natural gas generation still holds a prominent role in the sector, and the INGAA 2020 scenario projects that gas generation will continue to hold a relatively steady market share through 2025. Even as decarbonization efforts continue to evolve, the North American Electric Reliability Corporation (NERC) and the nation's Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs) have recognized that natural gas generation is vital to maintaining electric reliability,² as it provides a safety net for uncertainties in renewable generation. Gas infrastructure development continues to support the transition away from coal for power generation.

NERC's December 15, 2020 *Long-Term Reliability Assessment* finds the evolving fuel

² NARUC 2020 Summer Policy Summit, July 2020; ISO/RTO insights

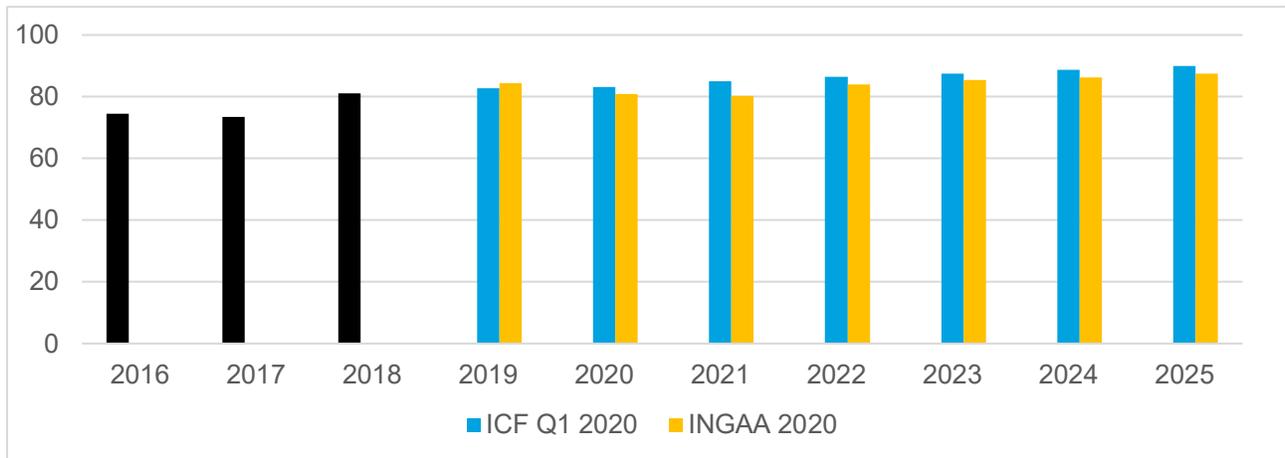
resource mix is changing reliability, security, and resilience landscape. “As more solar and wind generation is added, additional flexible resources are needed to offset these resources’ variability. This is placing more operating pressure on those (typically natural gas) resources and makes them the key to securing Bulk Power System (BPS) reliability. Insufficient flexible resources were a contributing cause to the load shed event in California during the wide-area heat wave in August 2020.”³ Gas infrastructure will continue to support power system reliability as renewable power generation expands.

Natural gas is still a highly desired and cost-effective source of energy for space heating, water heating, cooking, and industrial applications.

Even though domestic natural gas use is down in 2020, it is expected to rebound and increase through 2025 as the market recovers from the pandemic. While the upward trajectory of natural gas use has been dampened by recent events, in the INGAA 2020 scenario it is expected to grow and exceed the 2019 level by 2024. The scenario shows that, in aggregate, total gas consumption will rise to 87.5 billion cubic feet per day by 2025, roughly 3 billion cubic feet per day, or 3.6%, above the 2019 INGAA 2020 scenario level (Exhibit ES 2).

³ https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_LTRA_2020.pdf

Exhibit ES 2: Domestic Gas Use (Billion Cubic Feet per Day)



Sectoral Use (Billion Cubic Feet per Day)

	ICF Q1 2020		INGAA 2020		Change	
	2020-21	2025	2020-21	2025	2020-21	2025
Residential	13.8	14.3	13.9	14.5	0.1	0.2
Commercial	9.3	9.4	8.6	9.3	(0.7)	(0.1)
Industrial	22.4	22.8	20.8	22.8	(1.6)	0.0
Power	31.5	35.7	30.9	33.3	(0.6)	(2.4)
Other	7.0	7.8	6.3	7.6	(0.7)	(0.2)
Total	84.0	90.0	80.5	87.5	(3.5)	(2.5)

The rebound in natural gas use will be most significant in industrial and commercial activities, which were most hurt by the COVID-motivated business closures that occurred during the second quarter of 2020. It is expected to occur across sectors and across the country. As pointed out above, power sector gas use will also continue to grow, albeit at a slightly slower pace than would have otherwise occurred without the COVID pandemic.

The rebound in natural gas use is expected to occur across sectors and across the country.

These trends suggest that natural gas will remain a fuel of choice for many types of consumers across the U.S. Natural gas is still a highly desired and cost-effective fuel for space and water heating, cooking, and many industrial applications. Indeed, it is the most

widely used fuel for space and water heating in the residential and commercial sectors, and it is the fuel of choice for many petrochemical activities where it would be difficult to substitute other fuels or energy sources. It is a key energy source and feedstock for bulk chemical production, petroleum refining, and ammonia and methanol production. While interest is growing to replace gas in several applications as a part of efforts to decarbonize the economy, particularly in space heating through electrification, any significant transition away from natural gas would occur beyond the time frame of this study, particularly in those areas where gas is most cost-effective compared to other alternatives.⁴

Significant increases in exports of oil, gas (LNG and pipeline exports to Mexico), and Natural Gas Liquids (NGL) will provide strong support for oil and gas development.

The focus for U.S. oil and gas development is increasingly pivoting to global markets. While domestic markets will remain important for oil and gas use, much of the incremental production expected in the U.S. will be sought by markets elsewhere. International consumers have growing needs for oil and gas, particularly in Asia where large volumes of natural gas are needed to replace coal generation and support renewables deployment. ICF projects that the global LNG trade will grow by 80 percent by 2040. In addition, international customers value supply diversification and favor oil and gas supplies from the U.S. because of its economic stability and clearly defined and relatively stable laws and regulations.

LNG exports have rebounded and will continue to grow significantly through 2025.

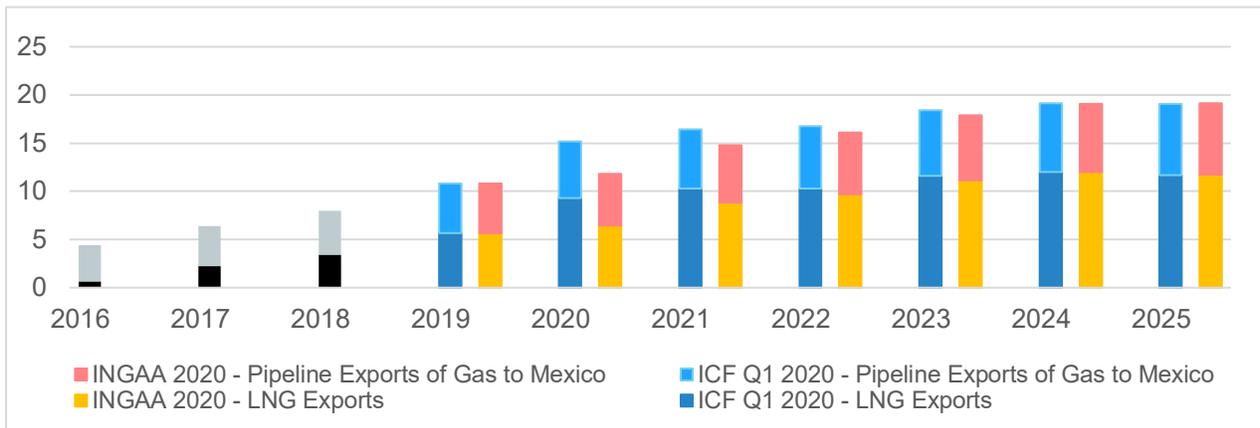
Despite the temporary declines due to the pandemic that occurred during the second quarter of 2020, LNG exports have rebounded and will continue to grow significantly through 2025. The

INGAA 2020 scenario projects that LNG exports will rise from 5.7 billion cubic feet per day in 2019 to 11.7 billion cubic feet per day by 2025, an increase of over 100% (Exhibit ES 3).

⁴ See the 2018 AGA study on residential electrification for an assessment of the cost of electrification of residential natural gas use, https://www.aga.org/globalassets/research--insights/reports/AGA_Study_On_Residential_Electrification

Also see the U.S. Department of Energy's (DOE's) Office of Fossil Energy (FE) October 2020 report: U.S. Oil and Natural Gas: Providing Energy Security and Supporting Our Quality of Life.

Exhibit ES 3: LNG and Mexican Exports (Billion Cubic Feet per Day)



ICF forecasts that global LNG demand, the main driver of international gas trade, will increase 21% between 2020 and 2025. On the supply side, North America is expected to be the largest source of growth, accounting for 70% of the incremental exports between 2020 and 2025. North American exports are expected to more than double from their annual average 2020 levels in the next five years, driven by the wave of recently sanctioned U.S. liquefaction projects, as well as the commissioning of Canada’s first export project by the end of the forecast period.

The INGAA 2020 projection fully catches up with the ICF Q1 trend by 2022. Even so, near-term declines in international gas use due to the pandemic have delayed final investment decisions for several new LNG export terminals until 2021. In addition, projects backed by oil and gas producers are experiencing financing uncertainties as producers continue to rationalize their capital spending plans. These export projections face some clear challenges and risks that should not be overlooked.

Like U.S. LNG exports, pipeline exports to Mexico are robust; they are expected to rise from 5.1 billion cubic feet per day in 2019 to 7.4 billion cubic feet per day in 2020, an increase of about 45%. This trend withstands the impacts of the COVID-19 pandemic because Mexico will continue to have growing needs for natural gas in its power plants. The country is continuing to retire and replace its older oil-fired generation with newer, more efficient, and less expensive gas generation. U.S. natural gas supplies are less expensive than alternatives, including LNG imports, and challenges within Mexico to increase domestic production are expected to persist. Thus, natural gas from the U.S. will continue to be an important source of supply for Mexico’s natural gas needs, reducing energy costs as well as carbon emissions.

Natural gas from the U.S. will continue to be an important source of supply for Mexico’s natural gas needs.

A recent study released by API, conducted by researchers at ICF, examined the

environmental benefits of U.S. natural gas use in China, Germany, and India and showed the importance of natural gas for achieving global emissions reductions. The study found that using U.S. liquefied natural gas (LNG) rather than coal for electricity generation produces on average 50.5 percent fewer greenhouse gas (GHG) emissions in all base case scenarios studied.⁵

Infrastructure development is swinging to the Permian, Haynesville, SCOOP and STACK areas.

As mentioned above, oil and gas production are expected to grow even with the strong headwinds created by recent events. The INGAA 2020 scenario shows that oil production will grow to 14.2 million barrels per day by 2025, roughly 2.5 million barrels per day (+21%) above the 2019 level, and gas production will grow to 103.0 billion cubic feet per day, roughly 10.4 billion cubic feet per day (+11.1%) above the 2019 level (Exhibit ES 4). While these levels are lower than those projected in the ICF Q1 2020 scenario, the rebound and growth in production is still substantial. These trends occur because a significant amount of economically viable resource remains to be produced throughout the U.S.

The rebound and growth in production is still substantial. These trends occur because a vast amount of economically viable resource remains to be produced throughout the United States.

Perhaps the more intriguing result lies in where the production originates. While growth in production is widespread, there are a few notable areas for future development. The Permian Basin is expected to retain its status as the most rapidly growing production area in North America even after the COVID-19 pandemic. It is still the most cost-effective basin in North America. On the other hand, the Marcellus/Utica Basin had been North

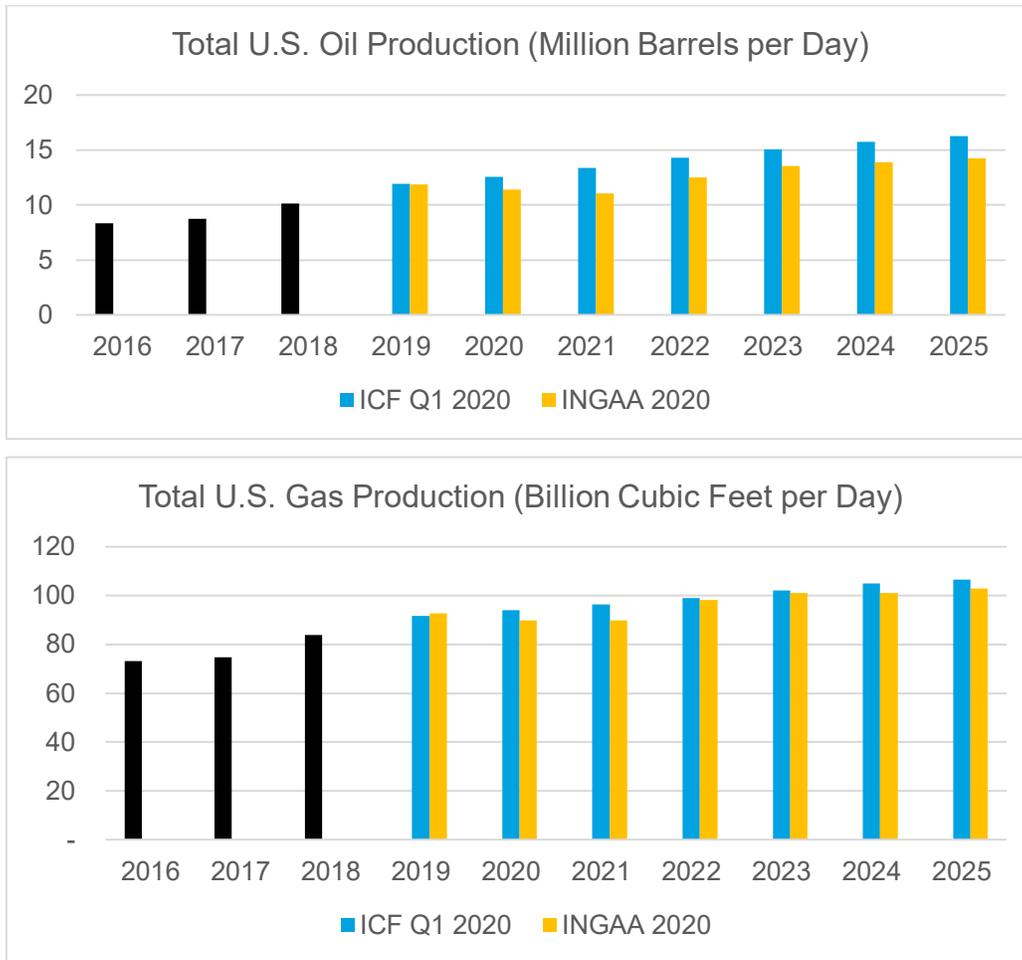
America's most prolific gas play. While it will remain the continent's largest gas play, having experienced an exponential growth in the past decade, its growth rate is projected to slow dramatically during the next few years. While the incremental growth of 4.1 billion cubic feet per day by 2025 shown in the INGAA 2020 scenario seems large, it is merely a 13% increase over the basin's 2019 level, while the Permian growth is up 46%. Dramatic increases will also occur in the Haynesville, SCOOP (South Central Oklahoma Oil Province) and STACK (Sooner Trend Anadarko Canadian and Kingfisher), where 2025 production will be up by over 5 billion cubic feet per day, or by 35% from the 2019 level, with the Haynesville leading the way.

While there is still a significant amount of economically viable resource remaining in the Marcellus/Utica basin, slowing infrastructure development is beginning to take its toll on the basin's activity. During the past few years, several key pipeline projects have been

⁵ <https://www.api.org/news-policy-and-issues/lng-exports/new-lifecycle-analysis-of-us-lng-exports>

delayed or cancelled as they were unable to complete the relevant approvals processes. Opposition to these and other projects has delayed construction and increased their costs, making them very difficult to complete. Thus, new development is generally shifting away from the Marcellus/Utica basin to areas in Texas, Louisiana, and Oklahoma where oil and gas infrastructure development has been less contentious.

Exhibit ES 4: Total U.S. Oil and Gas Production



Pipeline safety investments will continue to be an important focus.

Pipeline safety will continue to be an important focus for pipeline companies as they continue to respond to the new Pipeline and Hazardous Materials Safety Administration (PHMSA) rules. These rules are expected to drive continued investment in safety programs for pipelines over the next 15 years. They generally increase the mileage of gathering lines subject to PHMSA federal regulations, require reconfirmation of established operating pressures (MAOPs), and expand in-line inspection and pipeline maintenance requirements (e.g., anomaly repair and corrosion control). In addition,

PHMSA has proposed rules that will likely become effective within the next three years, including valve automation, rupture detection, and the use of integrity management in lieu of pipe replacement for Class Location Changes.

The PIPES Act directs PHMSA to update its regulations to embrace the latest safety technologies and aid in the further reduction of methane emissions

Finally, new pipeline safety legislation—the PIPES Act of 2020—was included in the 2021 omnibus spending and pandemic aid package that Congress passed and the President signed late December 2020. The PIPES Act directs PHMSA to update its regulations to embrace the latest safety technologies and aid in the further reduction of methane emissions. New PHMSA rules have intensified pipeline safety efforts, and all pipeline companies deem pipeline safety measures as critical to maintaining social license to operate and provide services to customers.

2. Introduction

2.1. Objectives of the Study

This study is intended to identify the opportunities and challenges that will result from the continued evolution of the economic and political environments that pipeline operators, contractors, and service providers will face over the next five years. The purpose of the report is to provide information that can be used by pipeline operators, contractors, and service providers to adapt to anticipated changes over the study time horizon. The study is focused on how natural gas and natural gas infrastructure are likely to evolve through 2025, considering shifts in domestic and global markets mainly due to the pandemic and collapse of oil prices, political and public policy drivers, economic factors, and the global demand for natural gas, which drives U.S. exports of natural gas.

In the prior decade, market growth was relatively consistent for oil and gas production, domestic gas use, oil consumption, and NGL and LNG exports. But the future of the market has become less predictable. In early 2020, markets were disrupted by the oil price war between Russia and Saudi Arabia. The market turmoil increased as COVID-19 slowed economic activity significantly, which impacted oil and gas markets further. At the same time, an increase in opposition to oil and gas use is making future growth less certain. Also, extended permitting delays for new infrastructure are delaying infrastructure development and increasing costs. Capital expenditures of exploration and production (E&P) companies are also at risk with this market uncertainty. Hence, a review of current markets is necessary to understand changes to projected natural gas infrastructure development.

ICF has historically conducted infrastructure studies for the INGAA Foundation with a long-term view, typically looking out two decades, and has updated the analysis on approximately a three-year cycle. Given recent developments, the INGAA Foundation hired ICF to conduct an out-of-cycle evaluation over a shorter time horizon, through 2025.

2.2. Methodology

To evaluate changes to oil and gas markets and infrastructure development, ICF relied on its market modeling tools to complete two scenarios of U.S. oil and gas markets through 2025.

The first scenario, labeled ICF Q1 2020, shows market and infrastructure development trends *prior* to the impacts of the COVID-19 pandemic and absent extended delays in

infrastructure development.

The second scenario, labeled INGAA 2020, is a more recent scenario that fully captures impacts of the COVID-19 pandemic and extended delays in infrastructure development.

Projected results from the two scenarios were compared to assess how significantly recent market events have altered the paths for markets and infrastructure development.

For each of these scenarios, this report discussed the following notable market drivers:

- Gross domestic product
- Global oil use
- Oil prices
- Global LNG trade
- Change in electric sales
- Penetration of renewable generation

This report also compares market projections for the following parameters across the two scenarios:

- Drilling activity
- Oil production
- Gas production
- Disposition (consumption plus exports)
- Total gas consumption
- Residential gas consumption
- Commercial gas consumption
- Industrial gas consumption
- Power generation gas consumption
- LNG exports
- Gas pipeline exports to Mexico
- Gas pipeline development

Projected results from the two scenarios were compared to assess how significantly recent market events have altered the paths for markets and infrastructure development.

3. Natural Gas Market Outlook

A very mild winter (2019-20) combined with record-level natural gas production led to low natural gas prices at the beginning of 2020 even before the collapse of oil prices and the COVID-19 pandemic. However, the collapse of oil prices and COVID-19 pandemic led to a sharp reduction in economic activity, influencing natural gas markets.

The collapse of oil prices and COVID-19 pandemic led to a sharp reduction in economic activity, influencing natural gas markets.

This section discusses the key drivers and natural gas market outlook through 2025 and compares the INGAA 2020 scenario with the ICF Q1 2020 scenario.

3.1. Key Drivers

The INGAA 2020 infrastructure study fully captures impacts of COVID-19 and extended delays in infrastructure development. The major market drivers—gross domestic product, global oil use and oil prices, global LNG trade, electric sales, and the penetration of renewable generation—are discussed in detail below.

3.1.1. Gross Domestic Product

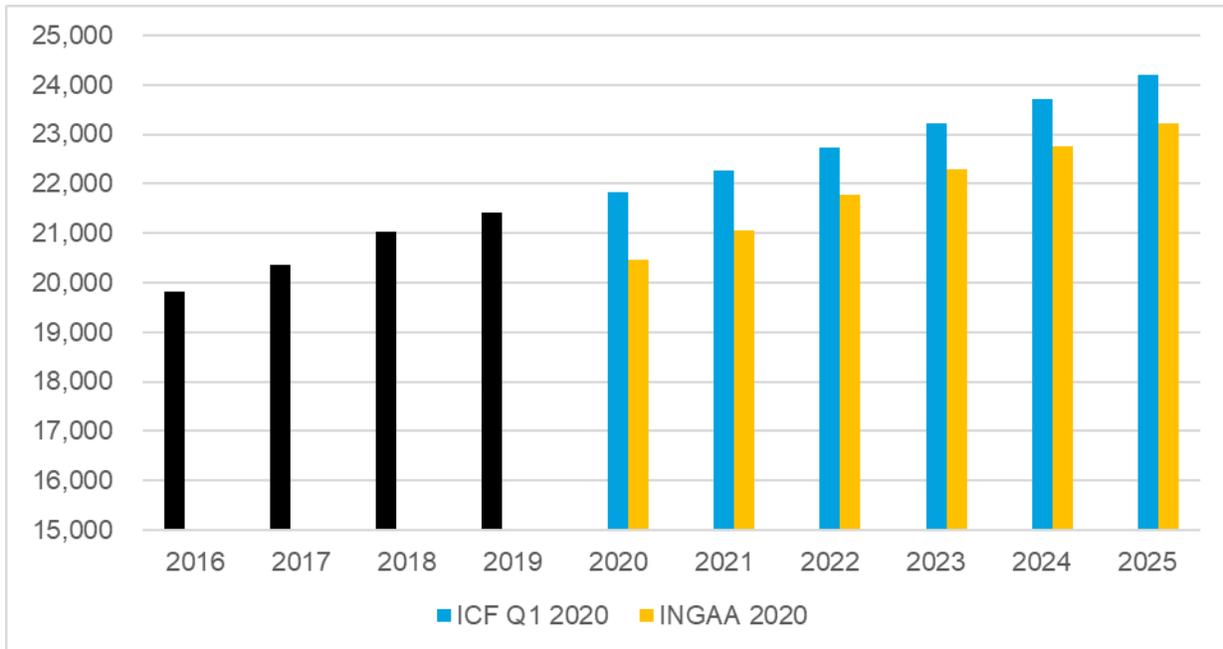
Economic activity is one of the more important drivers of oil and gas markets and infrastructure development as it determines market growth. Gross domestic product (GDP) is used as a proxy to measure economic activity. The INGAA 2020 scenario assumes a V-shaped economic recovery with a sharp rebound in activity following the closure of many businesses during the second quarter of 2020. Historical U.S. GDP growth is based on data from the Bureau of Economic Analysis (BEA); growth assumptions from Q3 2020 to Q4 2022 are based on the Wall Street Journal's (WSJ) August 2020 Survey of Economists. The real GDP decreased by 5% in Q1 2020 and 31.4% in Q2 2020 on an annualized basis according to BEA's September release. The average GDP is estimated to grow by 18.3% for Q3 2020 and 5.9% for Q4 2020 on an annualized basis. The GDP is expected to grow by 2.8% in 2021 and 3.5% in 2022 as the global markets recover from the recent events. From Q1 2023 forward, ICF assumes U.S. GDP grows at 2.1% per year.

Many organizations revised their economic growth projections and are forecasting a quick rebound starting Q3 2020 when economic activities start to grow again.⁶

⁶ WSJ Economic Forecasting Survey, September 2020

The supply and demand fundamentals of natural gas markets will be influenced by how quickly and by how much the domestic and global economies rebound, combined with the rebound in oil prices.

Figure 1: U.S Real GDP Actual Projected Levels (Billion 2019\$)



Source: Historical GDP Estimates from Bureau of Economic Analysis – Vintage History of Quarterly Gross Domestic Product (GDP) and Gross Domestic Income (GDI) Estimates

In 2020, U.S. GDP is estimated to be down by 4.4% from 2019. As seen from Figure 1, the U.S. Economy will recover from the pandemic but will be at least 4% smaller through 2025 than it would have otherwise been. Because economies are highly correlated, many countries have been impacted in similar ways by COVID-19.

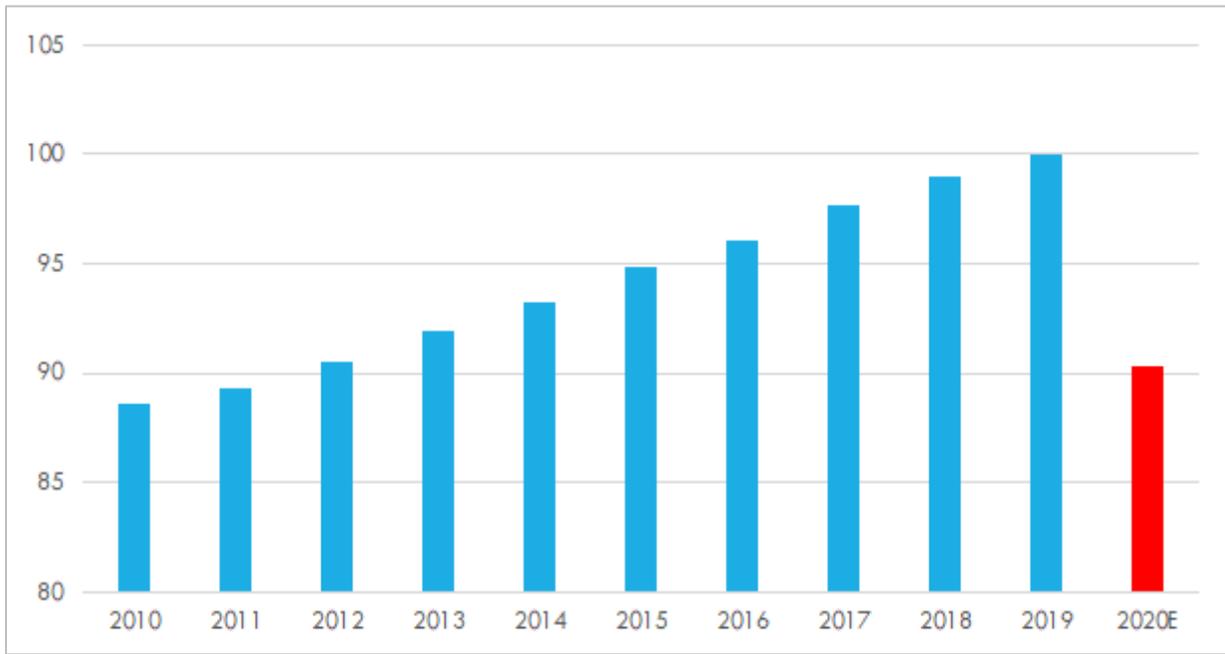
The expectation of a V-shaped economic recovery hinges on the release and widespread distribution of effective vaccines by early 2021. If effective vaccine distribution is delayed well beyond that, the economic rebound would be less certain.

3.1.2. Global Oil Use

Based on estimates of year-to-date values through August 2020 for oil consumption, global oil consumption in 2020 is expected to be 10% below its 2019 level, as shown in Figure 2. This has led to a collapse in oil prices and created additional uncertainty for oil development. Based on the recently released World

Energy Outlook 2020 report, the International Energy Agency (IEA) projects that the global oil demand will not reach 2019 level until 2023 in the Stated Policies Scenario.⁷

Figure 2: Global Oil Demand (Million Barrels per Day)



Source: BP Statistical Review of World Energy 2020, U.S. EIA Short-Term Energy Outlook, September 2020

Global oil use is a key parameter, as recovery in oil demand would boost crude oil exports and petroleum products from the U.S. This would help in the recovery of oil prices, which is again a key driver that affects natural gas production and thus infrastructure development in the U.S.

3.1.3. Oil Price

The price of oil is an important driver of oil and gas markets, and recent weakness in oil prices is expected to hold down drilling activity and infrastructure development in oil-prone plays. ICF's crude oil price forecast uses futures prices for 2020 and a blend of futures and ICF's fundamental forecast for 2021-2024. For the long-term, ICF assumes oil prices (U.S. Refiners' Acquisition Cost of Crude oil) rise steadily to an equilibrium marginal production cost of \$60 per barrel (in real 2019\$) by 2035, which is lower than the \$70 per barrel by 2035 in the ICF Q1 2020 scenario. The reduction in long-term view of oil price assumption in the INGAA

⁷ IEA (2020), World Energy Outlook 2020, IEA, Paris <https://www.iea.org/reports/world-energy-outlook-2020>

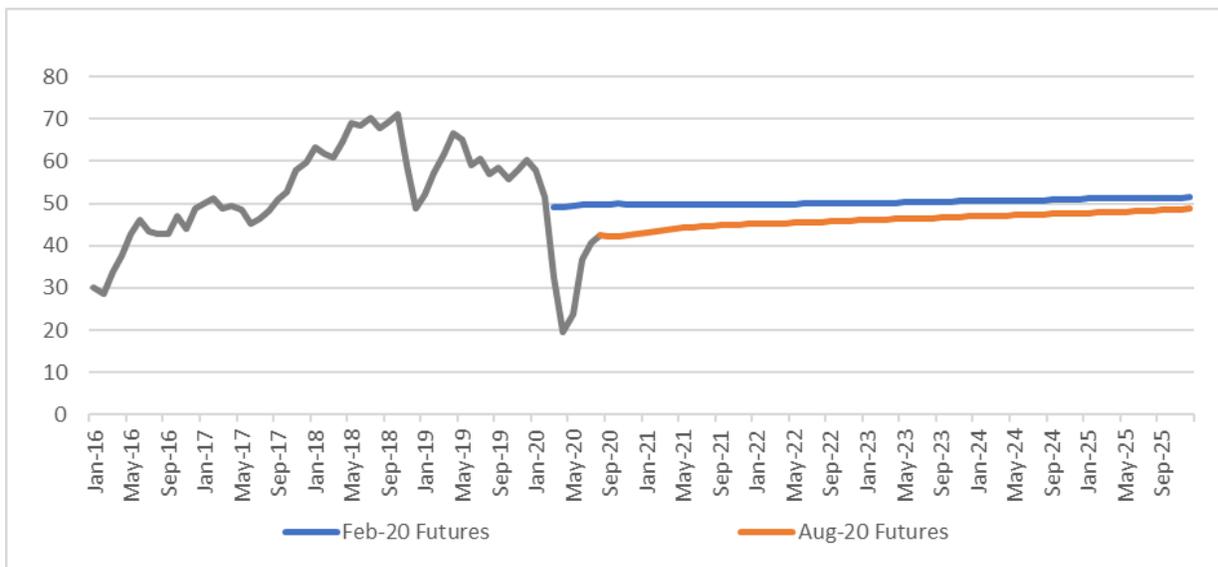
2020 scenario is mainly due to expectation of lower long-term global oil demand due to slower economic growth, greater use of renewables/electricity, more energy conservation (Btu/\$GDP) on the demand side and sustained improvements in supply-side productivity and lower OPEC discipline on the supply side.

On November 25, 2020 the price of U.S. oil jumped to an eight-month high on optimism about a vaccine for the coronavirus.

The current oil prices and futures have recovered slightly since the second quarter of 2020 due to production cuts and recovering demand. As a result of COVID-19, West Texas Intermediate (WTI) oil prices have recently averaged close to \$40 per barrel (Jan-Aug 2020), well below the average of nearly \$60 per barrel in 2019.

Figure 3 shows a comparison in the futures price strip for oil used; ICF Q1 2020 utilized the futures from February 2020 while the INGAA 2020 scenario uses the futures from August 2020. The uncertainty of oil futures has increased significantly which makes E&P development less certain in oil-prone plays.

Figure 3: WTI Futures in Nominal Dollars per Barrel



Source: Historical from EIA and futures from barchart.com

Most of the oil and gas producers are hedged in the near-term, which limits their risk to a sudden drop in commodity prices. However, a steep drop in oil prices and a persistent low commodity price environment might result in cash-strapped producers with significant impacts on the exploration and production (E&P) activity for further development of resources. Oil prices have rebounded from post-COVID

lows. On November 25, 2020 the price of U.S. oil jumped to an eight-month high on optimism about a vaccine for the coronavirus.

3.1.4. Global LNG Trade

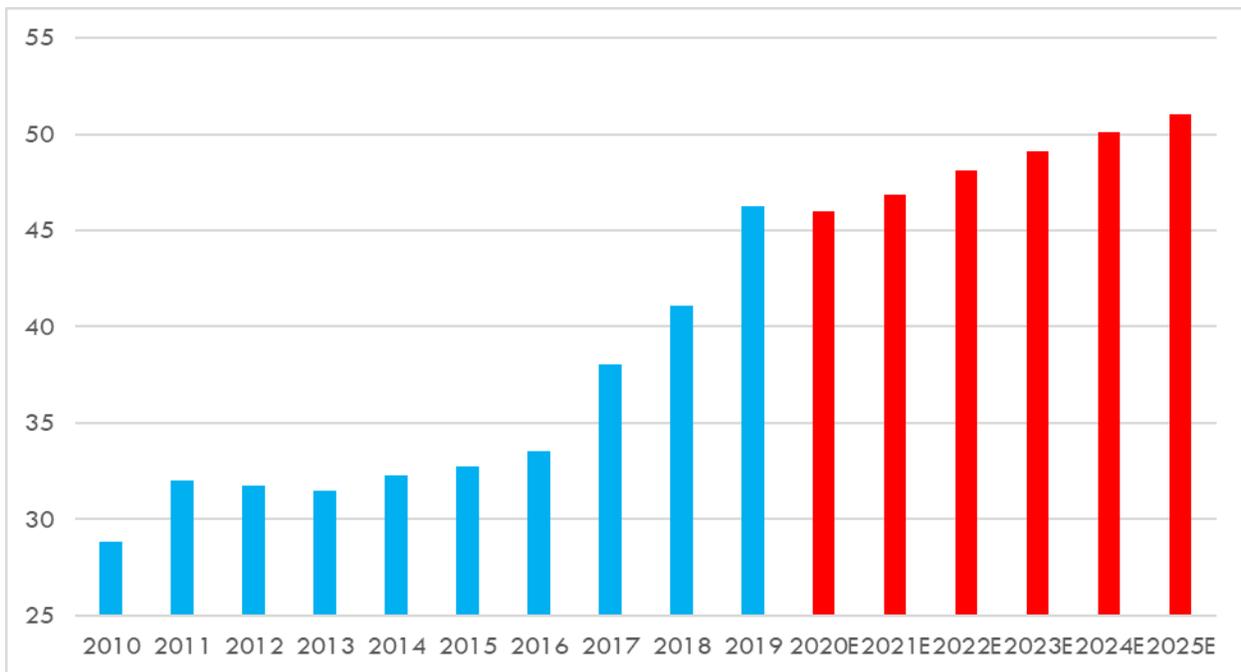
ICF projects a need for more liquefaction capacity development by 2024 when the global demand could exceed global supply.

The global historical LNG demand is sourced from the BP Statistical report 2020 while the forecast starting 2020 has been estimated by ICF based on available LNG forecasts from Bloomberg and the Oxford Institute of Energy

Studies. ICF projects the global LNG trade to be 5% lower in 2020 as compared to the 2019 levels of 46 billion cubic feet per day. Figure 4 shows the changing global LNG trade between 2010 to 2025.

While global trade is expected to rebound along with economic activity, it may take a couple of years for markets to fully return to pre-COVID trends. ICF projects a need for more liquefaction capacity development by 2024 when the global demand could exceed global supply.

Figure 4: Global LNG Trade (Billion Cubic Feet per Day)



Source: Historical – BP Statistical Report 2020

3.1.5. Power Markets

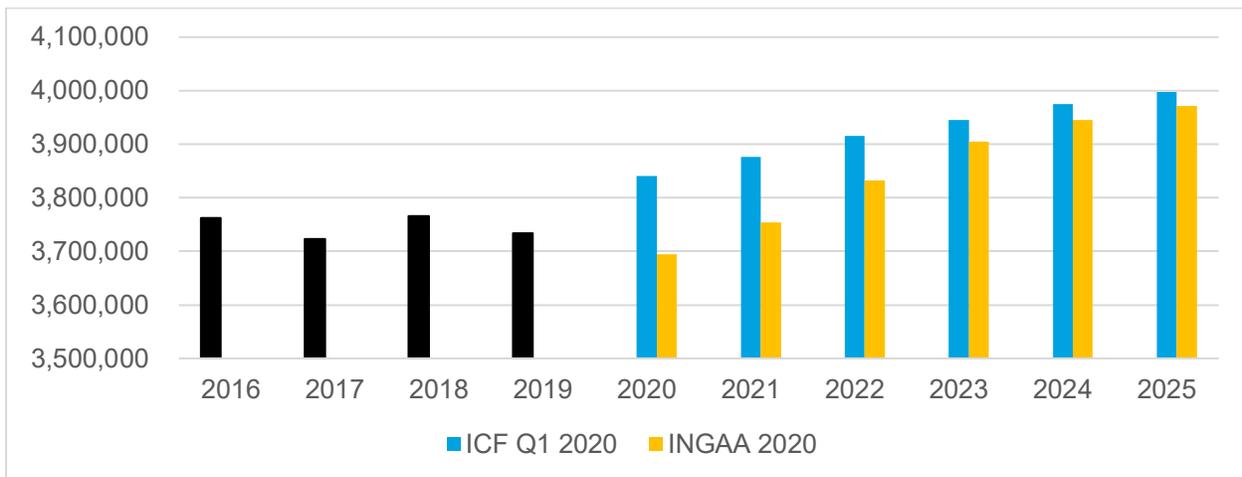
The abundance of domestic natural gas supply due to the shale revolution made gas cheaper and improved the economics for natural gas dispatch in the power sector. In addition, over the past twenty years as the power sector has moved away from oil and coal to reduce emissions of pollutants and toxic materials, it has increasingly relied on natural gas. As a result, and according to EIA, gas generation in the U.S. has accounted for about 40% of total generation since the beginning of 2019.

ICF's projections for natural gas consumption from the power sector are a function of electricity demand, state and regional policies, and other factors. Electricity sales are a measure for the size of the power sector and as the electric sales increase, generation increases, and natural gas use from the power sector is expected to grow. Electric sales are lower in the INGAA 2020 scenario as compared to the ICF Q1 2020 scenario due to the slowdown in the economic activity relating to COVID-19.

Increasing coal retirements and low natural gas prices are paving the way to an increase in natural gas generation capacity additions. ICF projects an increase in electric sales with lower coal generation giving an advantage to natural gas in the near-term through 2025. Figure 5 compares the electric sales between the scenarios and shows that the INGAA 2020 scenario remains below the ICF Q1 2020 scenario through 2025.

ICF projects an increase in electric sales with lower coal generation giving an advantage to natural gas in the near-term through 2025.

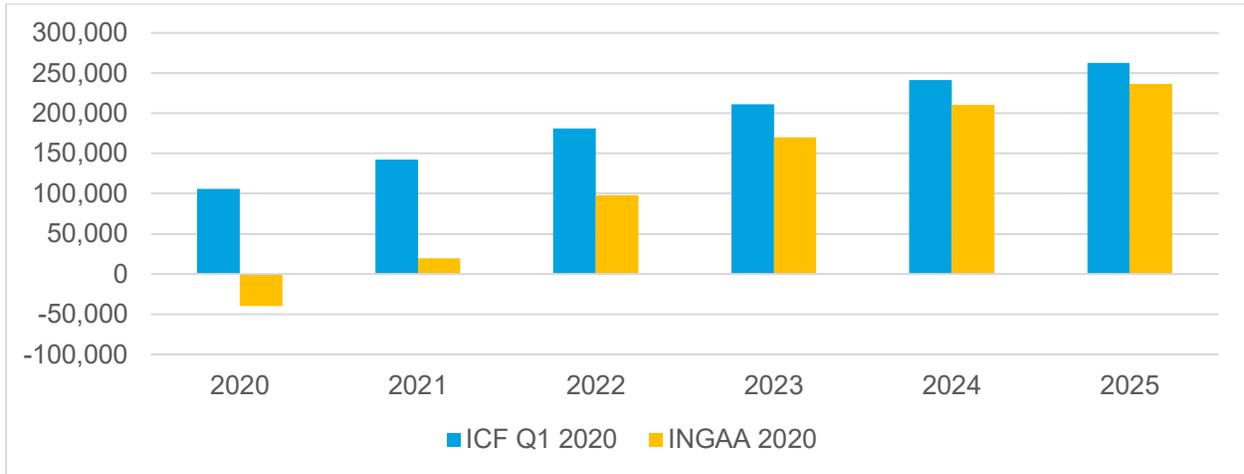
Figure 5: Electric Sales (Million kWh)



As seen in Figure 6, the INGAA 2020 scenario shows a modest decline of about

40 GWh in 2020 as compared to the 2019 levels. Though the market rebounds in 2021, it will take several years to return to the pre-pandemic projections. The growth in electric sales implies that the growth in gas generation will not be impaired post-2022.

Figure 6: Change in Electric Sales from 2019 (Million kWh)



3.1.6. Penetration of Renewable Generation

With increasing renewable generation, there will be a need for additional fast-start, and in some instances, extended duration capacity, which can be provided by natural gas.

Renewable generation, both utility-scale and end-use (e.g., rooftop solar), decrease the need for generation from other sources, including natural gas. As compared to ICF Q1 2020, 2025 renewable generation in the INGAA 2020 scenario will be 12% higher (roughly 97 Terawatt-hours). Renewables

are capturing a much greater market share. State renewable standards, federal tax incentives, and sharply declining costs are the primary drivers of the increased renewable penetration. With increasing renewable generation, there will be a need for additional fast-start, and in some instances, extended duration capacity, which can be provided by natural gas.

Natural gas fired generators accounted for 43% of operating U.S. electricity generating capacity and 39% of overall electricity generation in 2019.⁸ With continuing coal plant retirements and natural gas being more cost-effective and

⁸ EIA, <https://www.eia.gov/todayinenergy/detail.php?id=45496>

cleaner than the other fossil fuels, natural gas is expected to play a continuing role in complementing growing renewable generation.

3.2. Overall Market Projections

This section discusses how projections for U.S. oil and gas markets have been altered by recent events. Market projections in the ICF Q1 2020 scenario are compared to those in the INGAA 2020 scenario. Projections for drilling activity, oil and gas production, gas use and exports, and pipeline development are reviewed.

3.2.1. Drilling Activity

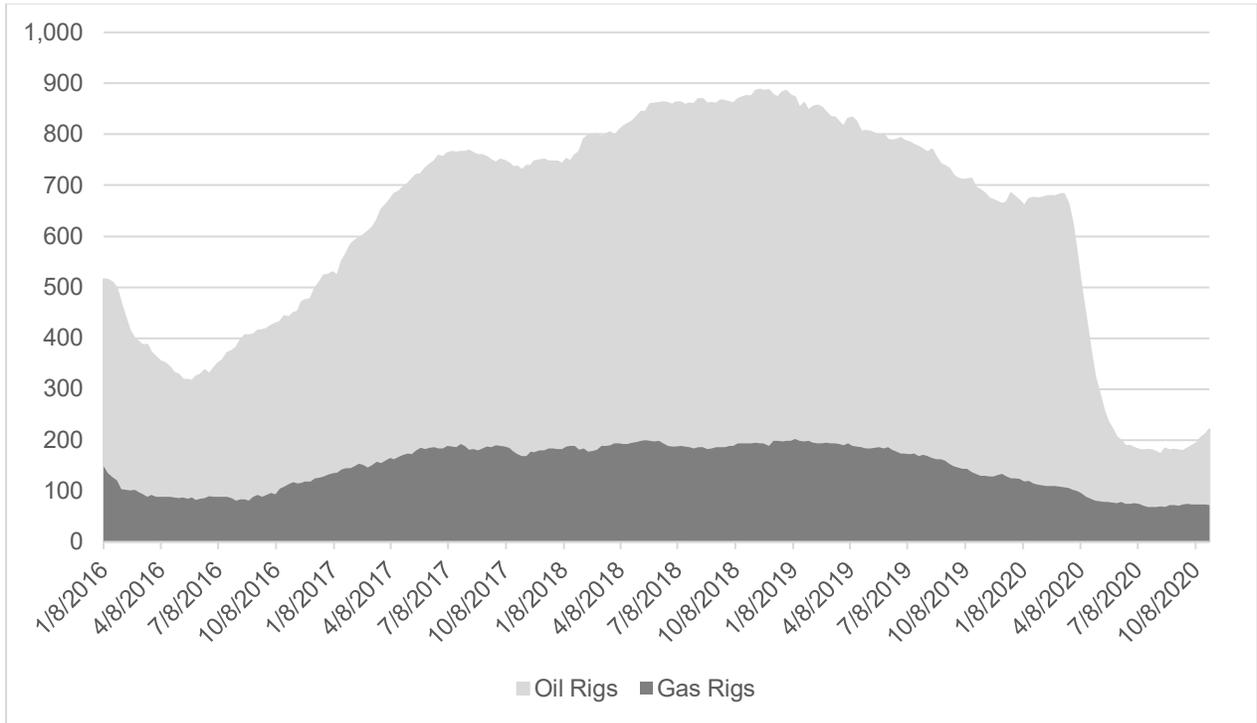
U.S. drilling activity for both oil and natural gas has declined significantly since the beginning of the year, primarily due to the collapse in oil prices and global demand reduction due to the COVID-19 pandemic. The oil price war brought oil prices to all-time lows, and COVID-19 created a further demand reduction. This has led to a decline in oil and natural gas production from all oil plays in the U.S., particularly from the Permian basin.

Oil price volatility has gone up, raising uncertainty for the price of oil in the future. This, in turn has led to increased project discount rates (i.e., applied rates of return). With reduced oil prices, E&P budgets are likely to continue to be constrained and drilling activity will remain below pre-COVID levels. Less capital is being deployed for upstream development and several E&P majors have announced intentions to diversify to cleaner sources of energy. Many of the big oil companies like Shell, BP, Eni SpA, Total, and Equinor are inclined towards investments into renewable energy sources. Capital spending of E&P companies is at risk and many companies in the U.S. have announced deep cuts in capital expenditures (CAPEX) for 2020 and 2021. This will keep exploration and drilling activities constrained in 2020 and 2021.

The U.S. active oil and gas rig count was 293 rigs as reported by Baker Hughes at the end of October 2020, 64% lower than the prior year and 27% lower than the May 2016 count. As shown in Figure 7, oil rigs have accounted for most of the decrease in rig count. Baker Hughes data shows a decrease of 68% in oil rigs and 45% in gas rigs over the past year. For most of 2020, when the COVID-19 pandemic was at its peak, oil and gas exploration activities across the major plays came down significantly, especially in oil-directed plays like the Permian, Bakken, and Denver-Julesburg (DJ) basin. This has resulted in a decline in near-term production capacity. As the economy continues to recover and the energy industry

tries to move past this major setback, ICF expects drilling activity to ramp up as upstream companies strive to meet the guidance targets promised to their shareholders. Despite this incentive, ICF expects that rig count will not reach pre-pandemic levels in the next five years.

Figure 7: U.S. Active Rig Count Historical

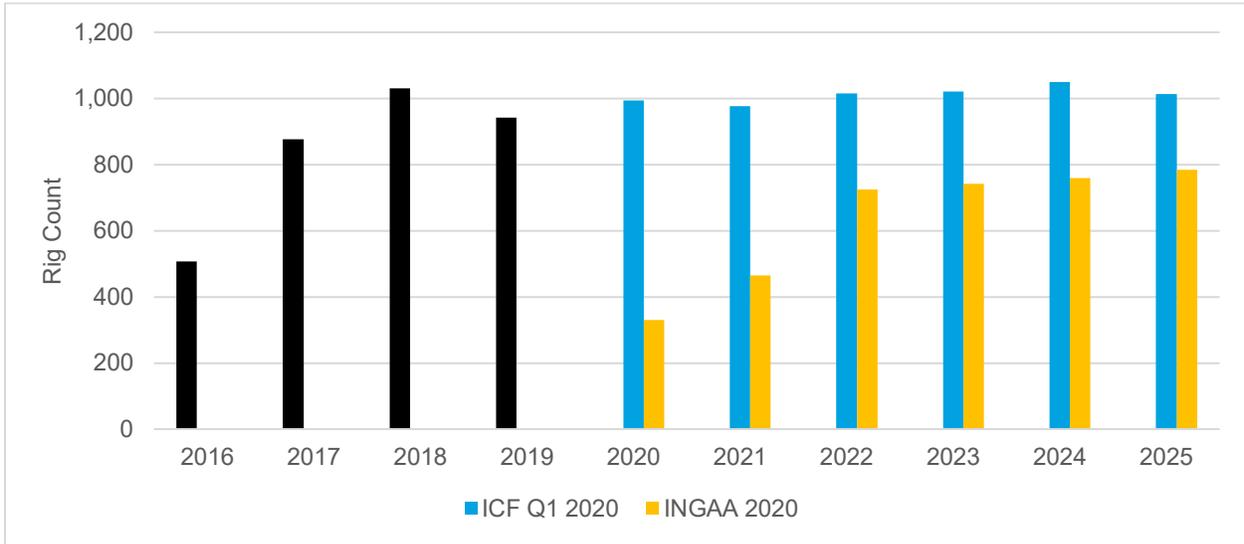


Source: Baker Hughes; North American Rig Count

The INGAA 2020 scenario expects that the sharp downturn in rig activity will be partly offset starting early 2021 due to increased productivity (higher output per well completion) and high inventory of previously drilled-but-uncompleted wells. The INGAA 2020 scenario projects U.S. rig count to remain between 600 and 800 on an average annual basis until 2025.

Current U.S. drilling activity is much lower than Pre-COVID levels. As depicted in Figure 8, drilling activity for 2021-22 is estimated to be down by 31% in ICF's Detailed Production Report (DPR) for the new INGAA 2020 scenario compared to the DPR from ICF's Q1 2020 scenario. Similarly, drilling activity in 2025 is expected to be down by 21% in the INGAA 2020 scenario compared to the ICF Q1 2020 scenario.

Figure 8: U.S. Rig Activity Outlook



Source: Baker Hughes (Historical)

3.2.2. Oil and Gas Production

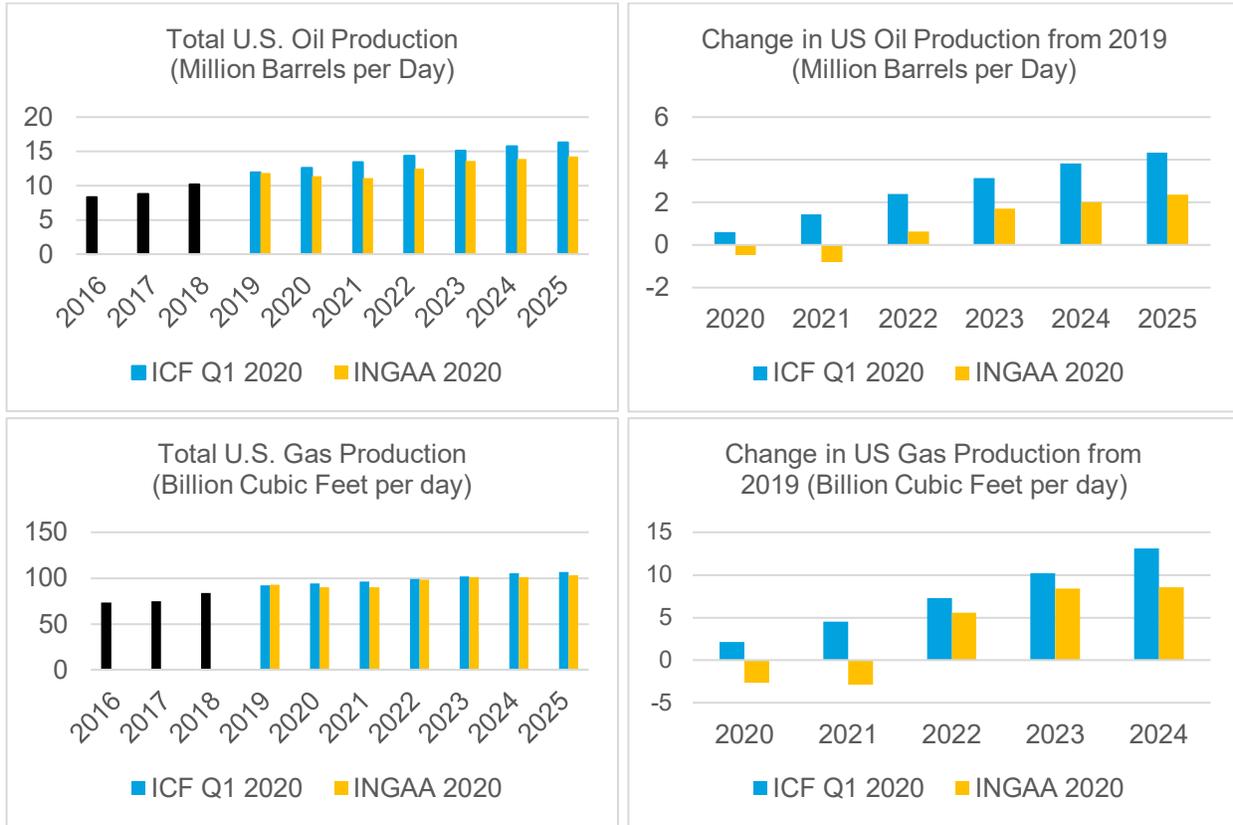
With reduced drilling activity, U.S. oil and gas producers are continuing to focus on improving well productivity and drilling efficiency to reduce production costs. Oil and gas production are expected to grow even with the strong headwinds created by recent events. The INGAA 2020 scenario shows oil production growing to 14.2

Oil and gas production are expected to grow even with the strong headwinds created by recent events.

million barrels per day by 2025, roughly 2.5 million barrels per day (+21%) above the 2019 level, and gas production growing to 103.0 billion cubic feet per day, roughly 10.4 billion cubic feet per day (+11.1%) above the

2019 level (Figure 9). While these levels are lower than the ICF Q1 2020 scenario projections, the rebound and growth in production is still substantial. These trends occur because a significant amount of economically viable resource remains to be produced throughout the U.S. The focus for U.S. oil and gas development is increasingly pivoting to global markets.

Figure 9: Total U.S. Oil and Gas Production



Since the beginning of the year, oil production from the Permian basin has seen the largest drop, as shown in Figure 10, compared to ICF Q1 2020, as many producers in the region announced CAPEX cuts and well shut-ins.

Figure 10: Permian Basin Oil Production (Million Barrels per Day)



U.S. dry natural gas production continued to grow in 2019, averaging a record 92.6 billion cubic feet per day, which is 10% higher than the 2018 annual average,

mainly driven by growth in natural gas production from the Permian, Appalachia, and Haynesville regions. ICF projects that the average annual natural gas production in U.S. will be down year-over-year in both 2020 and 2021 but will rebound starting 2022 based on the announced producer CAPEX plans. However, many oil and gas producers are at risk of being constrained by capital if sustained low oil prices persist.

U.S. natural gas production from gas wells (non-associated gas), as shown in Figure 11, is expected to be about the same as the ICF Q1 2020 scenario by 2025 in the INGAA 2020 scenario, while the U.S. natural gas production from oil wells (associated gas production) is down versus the ICF Q1 2020 scenario. As the markets collapsed and the oil prices reached new lows, many producers cut back their spending on drilling activities and hence the gas production from oil wells is projected to be growing at a slower pace in the INGAA 2020 scenario compared to ICF Q1 2020 scenario as shown in Figure 12. The INGAA 2020 scenario projects that much of the incremental non-associated gas production will come from gas wells particularly in the Haynesville region.

Figure 11: U.S. Non- Associated and Associated Natural Gas Production (Billion Cubic Feet per Day)

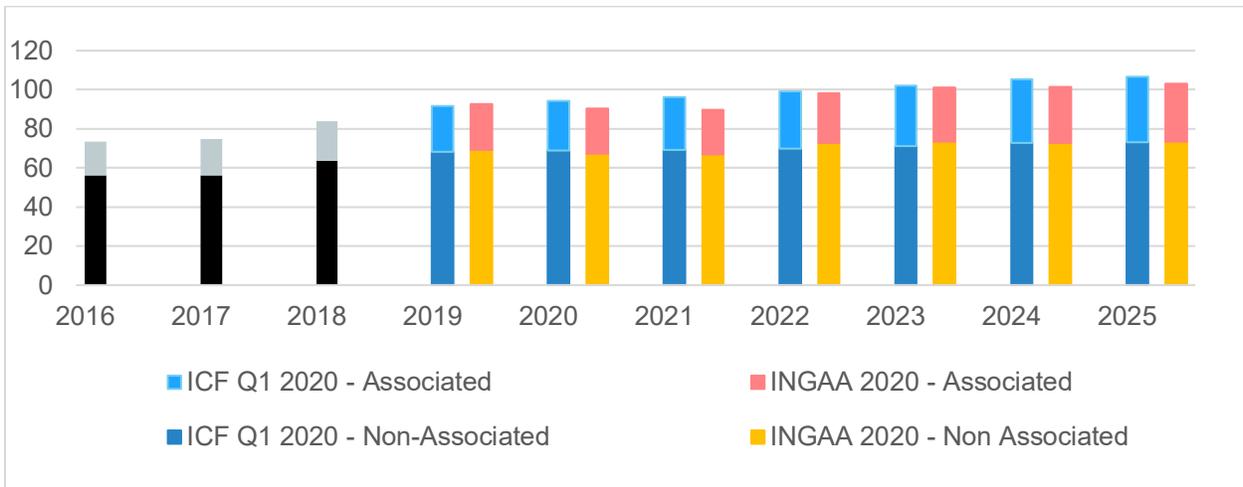
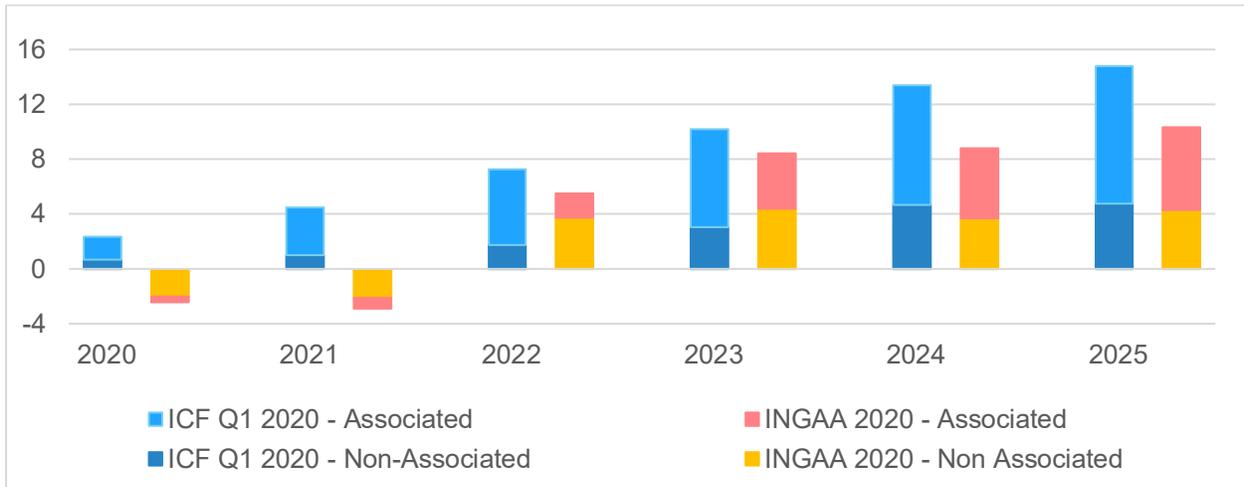


Figure 12: Change in U.S. Natural Gas Production from 2019 (Billion Cubic Feet per Day)



The INGAA 2020 scenario assumes permitting delays for new infrastructure and cancellations of ongoing projects in the Marcellus/Utica, which will restrict gas resource development in that area. Therefore, as shown in Figure 14, the INGAA 2020 scenario projects that future gas-based resource development will shift away from the Marcellus/Utica to the southern states that are more receptive to oil and gas development. The Permian, Haynesville, SCOOP and STACK will replace much, but not all, of the new production from the Marcellus/Utica that would be developed absent infrastructure constraints. Also, with production activity shifting from oil-prone plays to gas-prone plays compared to ICF Q1 2020 scenario, the gas prices are projected to rise from current levels. The gas price volatility may increase as the price sensitive supplies will make up a bigger portion of supply.

In aggregate, however, future natural gas production will grow at a slower pace versus the ICF Q1 2020 scenario.

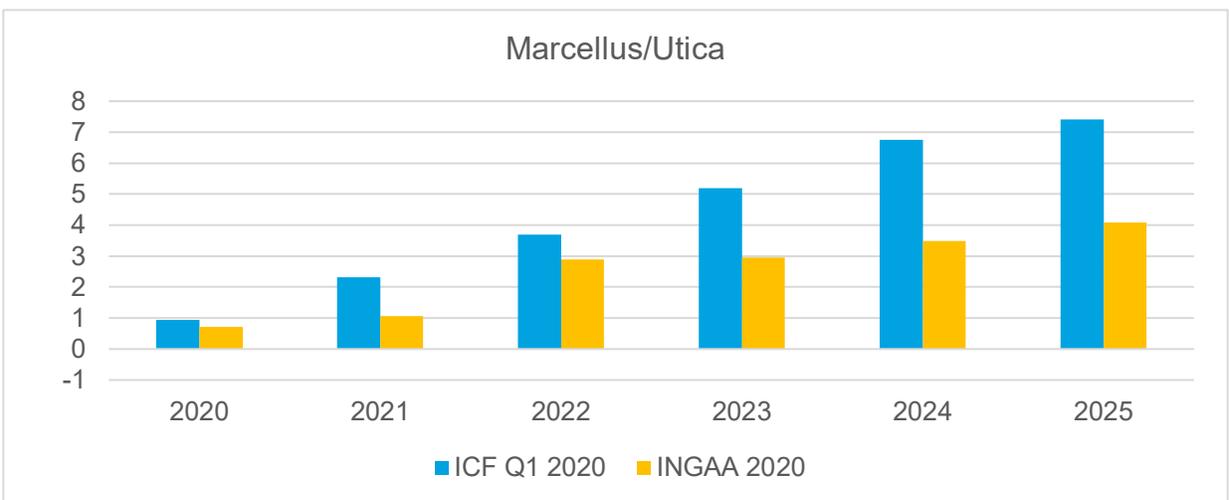
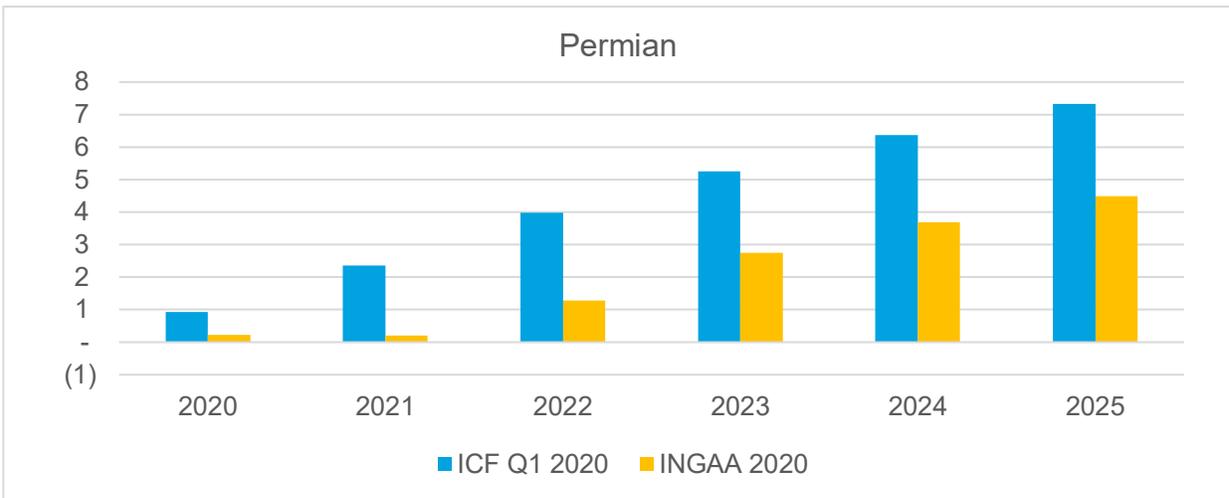
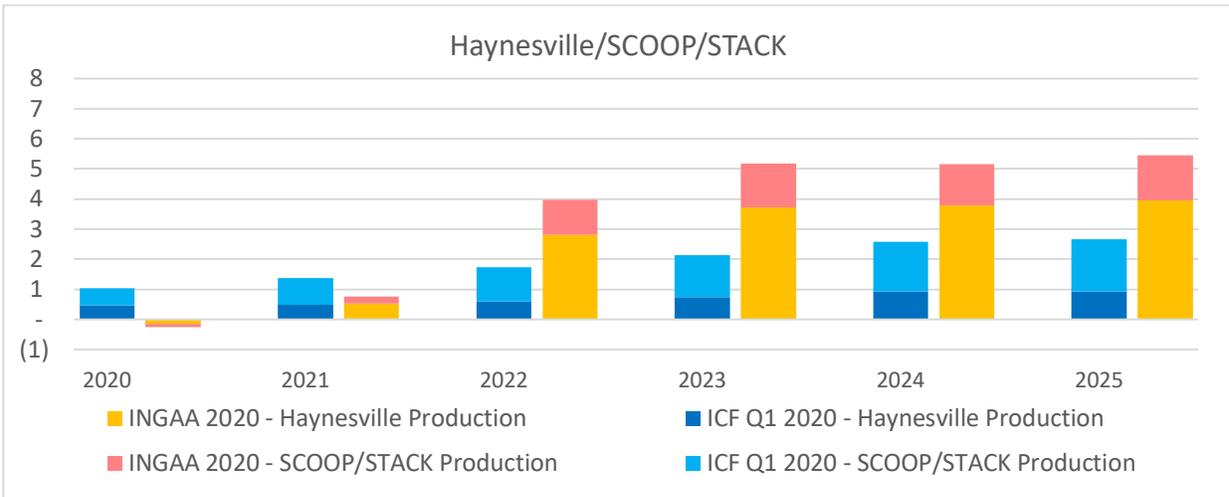
While growth in production is widespread, there are a few notable areas for future development. The Permian Basin had been the most rapidly growing production area in North America before the COVID-19 pandemic, and it is expected to remain such even after the pandemic. It is still the most cost-effective basin in North America. On the other hand, the Marcellus/Utica Basin had been North America's most prolific gas play. While it will remain the continent's largest gas play, its growth rate is projected to slow dramatically during the next few years.

The Permian Basin had been the most rapidly growing production area in North America before the COVID-19 pandemic, and it is expected to remain such even after the pandemic.

While the incremental growth of 4.1 billion cubic feet per day by 2025 shown in the INGAA 2020 scenario seems large (Figure 13), it is merely a 13% increase over the basin's 2019 level, while the Permian growth is up 46%. Even more dramatic increases will occur in the Haynesville, SCOOP and STACK, where 2025 production will be up by over 5 billion cubic feet per day or by 35% from the 2019 level.

Thus, production growth is swinging away from the Marcellus/Utica to other plays located in the southern U.S. While there is still a significant amount of economically viable resource remaining in the Marcellus/Utica basin, slowing infrastructure development is beginning to take its toll on the basin's activity. During the past few years, several key pipeline projects have been cancelled as they were unable to complete the approvals process. Opposition to these projects and others has delayed construction and increased their costs, making the area's projects difficult to complete. Future development of the area is becoming hindered by this problem, which is likely to get worse absent changes to the permitting process. This is generally shifting development away from the area to areas in Texas, Louisiana, and Oklahoma where oil and gas infrastructure has been better received.

Figure 13: Change in Gas Production from 2019 (Billion Cubic Feet per Day)



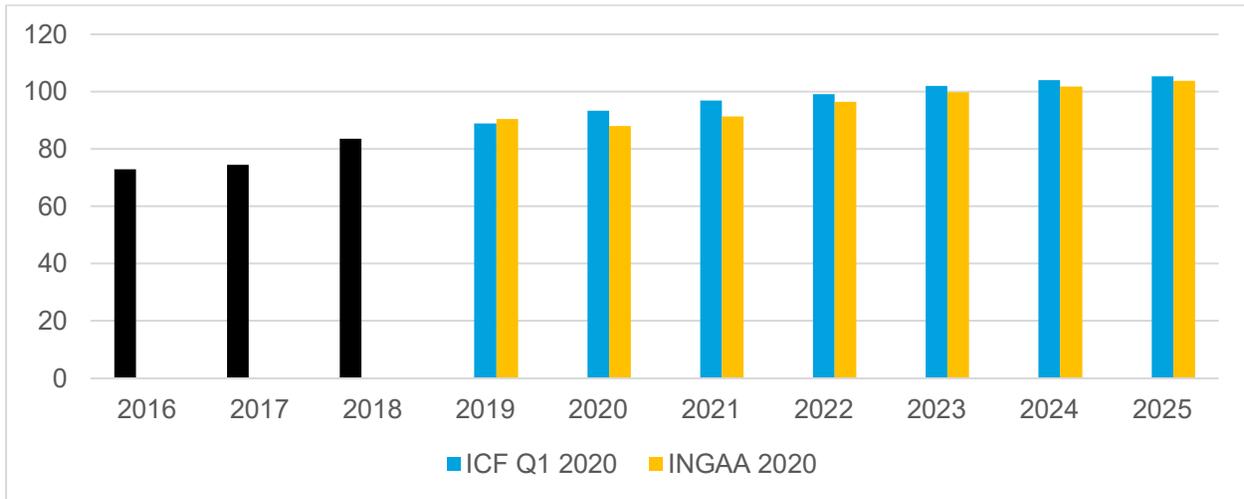
Sustained low oil prices as well as potential changes in the political environment pose a risk for infrastructure development through 2025.

Regulations or restrictions around potential leasing of federal land for exploration and production activities or for construction of greenfield pipelines may affect the projected growth in oil and gas production. The federal government may also increase the number of environmental restrictions on oil and gas production activities and on pipeline construction activities and change the corporate tax structure or end certain tax incentives like Intangible Drilling Costs (IDCs) for oil and gas companies. All these issues will increase the budget of ongoing exploration and production activities and delay the pipeline projects that are underway.

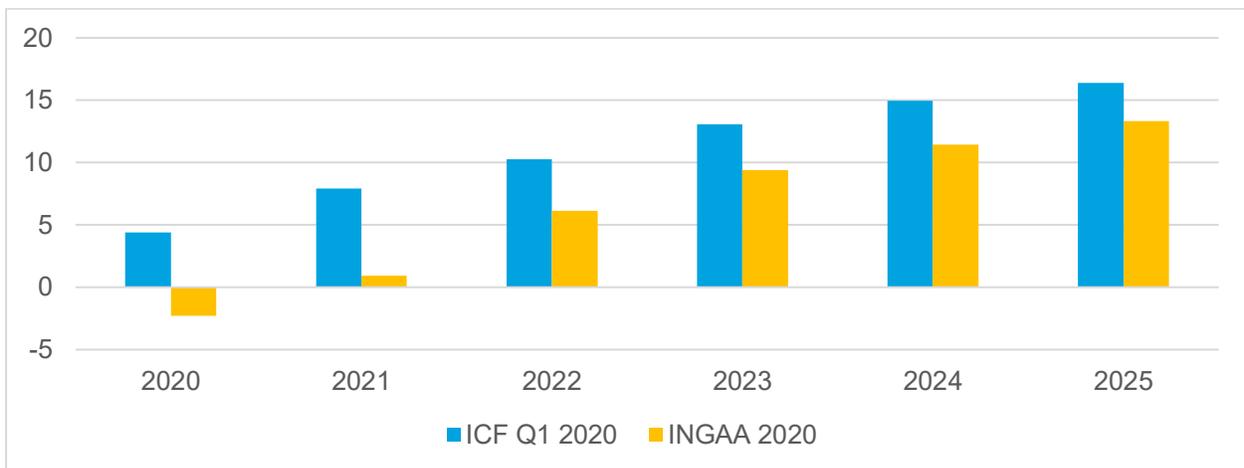
3.2.3. Natural Gas Disposition

The total U.S. natural gas disposition that includes domestic consumption and net exports has been impacted by lockdown restrictions due to COVID-19 in U.S. as well as in several countries across the world. As shown in Figure 14, the total gas disposition will be down in 2020 compared to 2019 primarily due to reduced demand in domestic gas use as well as LNG exports.

Figure 14: Total U.S. Gas Disposition (Consumption + Net Exports (Billion Cubic Feet per Day))



Change in U.S. Gas Disposition from 2019



Even with the pandemic, gas disposition in 2025 is projected to be up by over 13 billion cubic feet per day, or close to 15% versus the 2019 level in the INGAA 2020 scenario, mostly a result of growing exports.

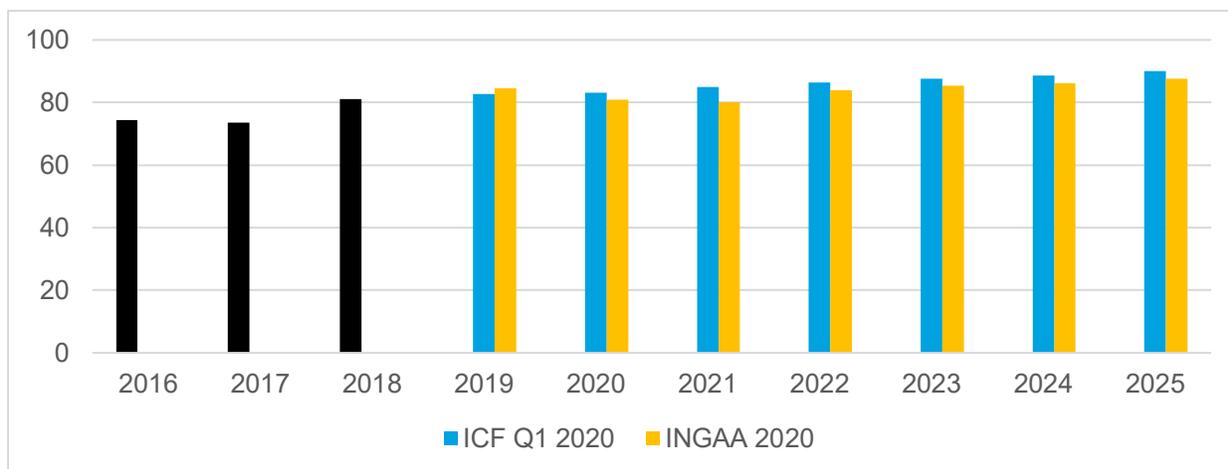
The natural gas disposition in 2020 is down by over 5 billion cubic feet per day or by roughly 6% in the INGAA 2020 scenario compared to the ICF Q1 2020 scenario as shown in Figure 14.

The natural gas disposition in 2025 is down by almost 2 billion cubic feet per day or by 1.6% in INGAA 2020 scenario compared to the ICF Q1 2020 scenario. Even with the pandemic, gas disposition in 2025 is projected to be up by over 13 billion cubic feet per day, or close to 15% versus the 2019 level in the INGAA 2020 scenario, mostly a result of growing exports.

3.2.3.1 Domestic Gas Consumption

Even though domestic natural gas use is down in 2020, it is expected to rebound and increase through 2025 as the market recovers from the pandemic. While the upward trajectory of gas use has been dampened by recent events, the INGAA 2020 scenario shows that gas use is expected to grow and exceed the 2019 level by 2024. The scenario also shows that, in aggregate, total gas consumption will rise to well over 87 billion cubic feet per day by 2025, roughly 3 billion cubic feet per day, or 3.6% above the 2019 INGAA 2020 scenario level (Figure 15).

Figure 15: Domestic Gas Use (Billion Cubic Feet per Day)



Sectoral Use (Billion Cubic Feet per Day)

	ICF Q1 2020		INGAA 2020		Change	
	2020-21	2025	2020-21	2025	2020-21	2025
Residential	13.8	14.3	13.9	14.5	0.1	0.2
Commercial	9.3	9.4	8.6	9.3	(0.7)	(0.1)
Industrial	22.4	22.8	20.8	22.8	(1.6)	0.0
Power	31.5	35.7	30.9	33.3	(0.6)	(2.4)
Other	7.0	7.8	6.3	7.6	(0.7)	(0.2)
Total	84.0	90.0	80.5	87.5	(3.5)	(2.5)

The rebound in natural gas use will be most significant in industrial and

commercial activities, which were most hurt by the COVID-motivated business closures that occurred during the second quarter of 2020. It is expected to occur across sectors and across the country. In addition, power sector gas use will continue to grow, albeit at a slightly slower pace than would have otherwise occurred without the COVID pandemic.

Residential and Commercial Gas Use

With warmer than normal winter weather between January through March 2020, residential and commercial gas consumption in the U.S. was down in 2020 versus the pre-pandemic levels. Residential and commercial gas use in April 2020 showed a significant drop on a weather normalized year-on-year basis, according to the EIA. As per the latest data published by EIA, residential consumption in U.S. for July 2020 was 6% above the July 2019 consumption while commercial was down by 9%. This is based on the actual data and not weather-normalized data.

The INGAA 2020 scenario shows an average increase of 1.2% in the residential demand year-over-year based on the Q1 2020 scenario starting July 2020 to December 2020 and 1% between January 2021 and December 2025. Gas use in the residential sector is expected to be higher in future years as compared to Q1 2020 as many businesses are increasingly opting for working from home.

A combination of factors, including lasting changes to work-from-home policies, the use of commercial floor space, and the way students are educated, will yield lower growth rates for commercial gas use than those in ICF Q1 2020 scenario. The demand from the commercial sector is projected to be down, with many schools, offices, restaurants, and retail outlets closed in several states. ICF also projects that there will also be a permanent loss of demand in the commercial space.

In October 2020 the EIA forecasted that residential natural gas consumption for the 2020–21 winter season (October–March) will average 21.1 billion cubic feet per day (Bcf/d), 5% more than last winter. EIA expects more residential natural gas consumption because of forecasts for colder temperatures this winter and changes in consumer behavior due to COVID-19.

The INGAA 2020 scenario projects an average decrease of about 12% in the commercial demand year-over-year compared to Q1 2020 for the second half of 2020. With effective vaccines against COVID-19 expected early in 2021, the scenario assumes that the markets will start to recover, and the total residential and commercial demand will be slightly higher by end of 2025 in the INGAA 2020 scenario compared to the ICF Q1 2020 scenario.

Industrial Gas Use

Industrial gas consumption in U.S. is primarily focused on industrial heating processes, on-site power generation, and feedstock for chemical processes, accounting for approximately 27% of the U.S. natural gas consumption in 2019. Lower natural gas prices reduce the cost to manufacture plastics and chemicals, which makes the U.S. petrochemical industry more competitive in the international marketplace. This, in turn, makes the industrial sector a sustainable source of demand growth and a continued user of gas transmission services.

U.S. industrial demand is down in 2020 due to lower demand (in addition to milder weather) from chemical and petroleum facilities in the Gulf-coast. Recovery will depend on how quickly the economy can rebound over the next few months. The INGAA 2020 projection for industrial gas use relies on industrial production growth rates recently forecasted by the American Chemistry Council.⁹ Declines in industrial gas use due to the pandemic vary by industry, with primary metals, petroleum, coal products, paper, and the chemicals industries affected more than other industrial processes that use natural gas.¹⁰

The INGAA 2020 scenario forecasts that U.S. industrial consumption will average 20.0 billion cubic feet per day in 2020, down 2.8 billion cubic feet per day from 2019 because of reduced manufacturing activity. This is equivalent to a drop of 12.8%, while demand does not change much between 2019 and 2020 in the ICF Q1 2020 scenario. As the economy recovers, industrial gas use in U.S. is expected to rebound to 2019 levels by 2024.

Power Sector Gas Use

Amid the low gas prices, the year-to-date natural gas-fired power generation grew in 2020 compared to year-ago levels for the same time period, supported by recent coal retirements and changes to the generation stack with more combined cycle plants that came online last year. This growth occurred despite a warmer-than-average winter that reduced electric heating demand and the reduction in electricity demand due to COVID-19.

In 2020, natural gas consumption in the U.S. is expected to be 32.7 billion cubic feet per day, about 1.7 billion cubic feet per day higher than 2019 and 1.6 billion cubic feet per day higher than projected in the ICF Q1 2020 scenario. However,

⁹ American Chemistry Council, [Mid-Year 2020 Situation & Outlook, June 2020](#)

¹⁰ EIA, <https://www.eia.gov/todayinenergy/detail.php?id=45196>

growth in gas demand from generation is somewhat slower in the INGAA 2020 scenario relative to the ICF Q1 2020 scenario. By 2025, the INGAA 2020 scenario projects power sector gas use in the U.S. will reach 33.3 billion cubic feet per day, lower than the ICF Q1 2020 scenario by 2.3 billion cubic feet per day.

Power sector gas use is projected to be lower on an average annual basis in 2021 compared to 2020 in INGAA 2020 scenario as tightening gas supply results in an increase in the natural gas prices

The share of natural gas fired power is expected to have risen to above 40% of the U.S. electric generation mix in 2020.

and thus makes coal-to-gas switching somewhat less attractive. Power sector gas use is projected to rebound starting in 2022. Power generation gas use is expected to grow over the next five years despite a long-term push towards renewables and policies emphasizing clean (not emitting carbon dioxide) energy adoption by some states. ICF considered the impact of uncertainty in the impact of gas use from the power sector over the next five years based on the net-increase in gas-fired capacity that is expected to come online and the expected reduction in coal and nuclear-fired generation capacity.

Despite an expected rebound in electric sales, growth of gas generation is below growth levels in ICF Q1 2020 because of increased renewable penetration.

However, this trend is impacted by natural gas prices; the change from relatively high gas use in 2020 to relatively depressed gas use in 2021 in the INGAA 2020 scenario is due to gas price changes. The relatively low gas prices in 2020 encouraged coal-to-gas switching while 2021's projected gas price rebound reduces the level of switching. The share of natural gas fired power is expected to have risen to above 40% of the U.S. electric generation mix in 2020.

Figure 16 depicts the projected change in power generation from 2019 in all the NERC regions for the INGAA 2020 scenario. It shows that generation from renewables and gas are further displacing the coal generation in the near-term across most of the country. Some states, like California, have already phased out, or are in the process of phasing out, coal generation to reduce carbon emissions.

Figure 17 shows the change in gas use from 2019 across all NERC regions for INGAA 2020 scenario. ICF projects that gas use will decline further in 2021 relative to 2020 in most regions due to the projected increase in natural gas prices in 2021.

Figure 16: Annual Change in Power Generation from 2019 (TWh)

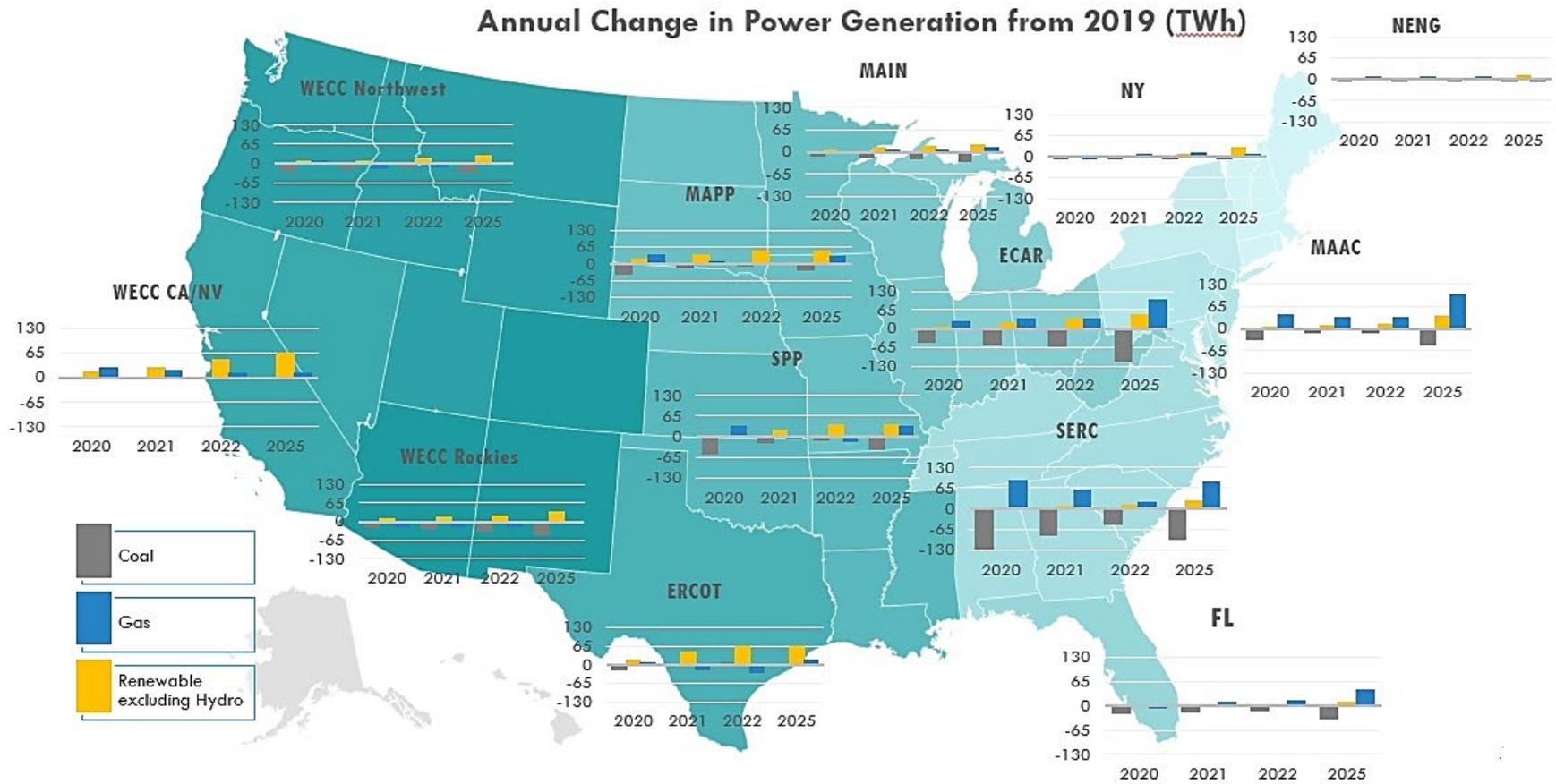
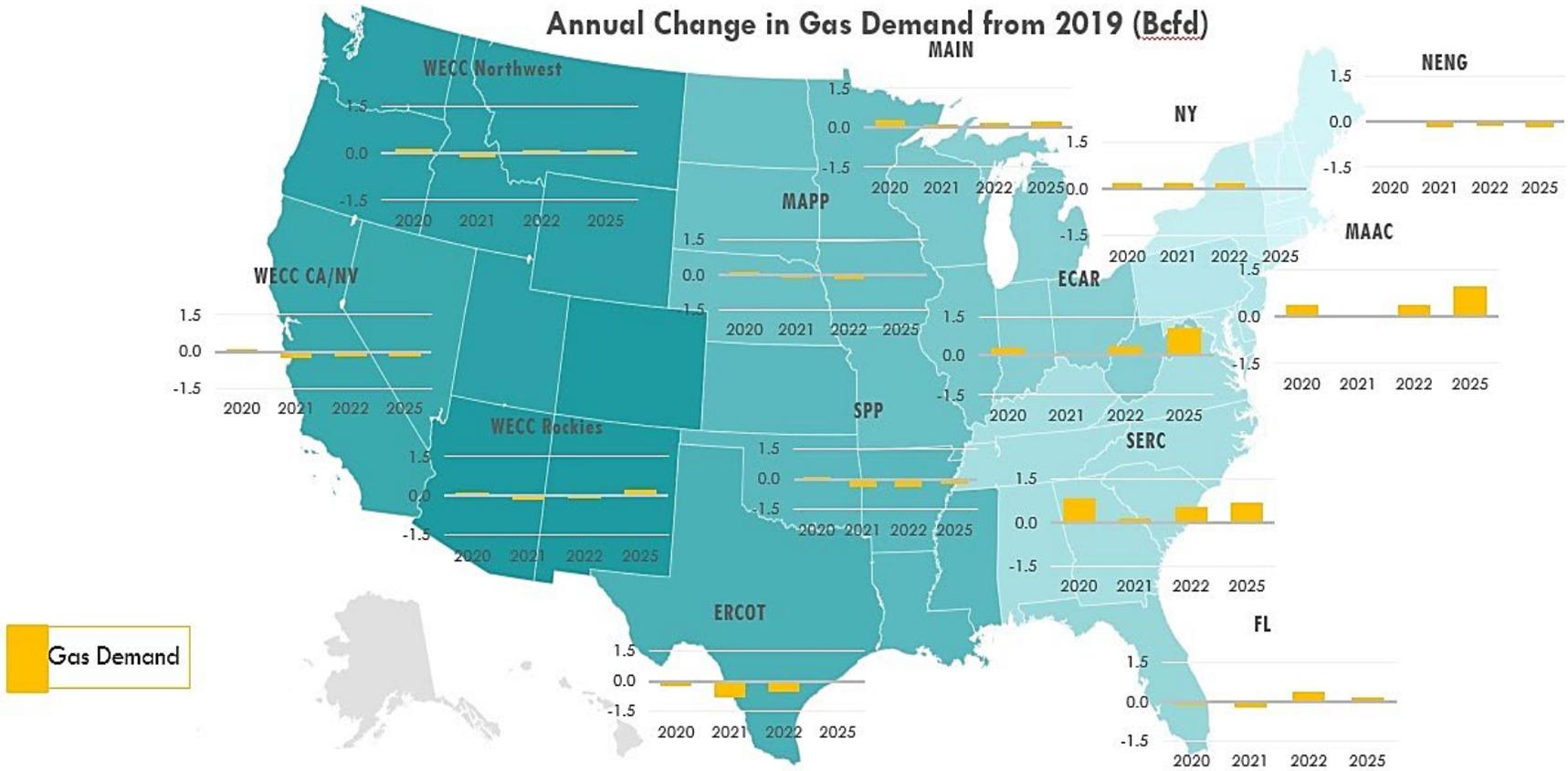


Figure 17: Annual Change in Gas Demand from 2019 (Billion Cubic Feet per Day)



These trends indicate that natural gas will remain a fuel of choice for many types of consumers across the U.S. Natural gas will continue to be a highly desired and cost-effective fuel for space and water heating, cooking, and many industrial applications. Indeed, it is the most widely used fuel for space and water heating in the residential and commercial sectors, and it is by far the most efficient and fuel of choice for many petrochemical activities where it would be difficult to cost-effectively substitute other fuels or energy sources. It is a key energy source and feedstock for bulk chemical production, refining, and ammonia and methanol production. While interest is growing to replace gas in several applications as a part of efforts to decarbonize the economy, particularly in space heating through electrification, any significant transition away from natural gas would occur beyond the time frame of this study, particularly in those areas where gas is most cost-effective compared to other alternatives.

These trends indicate that natural gas will remain a fuel of choice for many types of consumers across the U.S.

3.2.3.2 LNG Exports and Pipeline Exports to Mexico

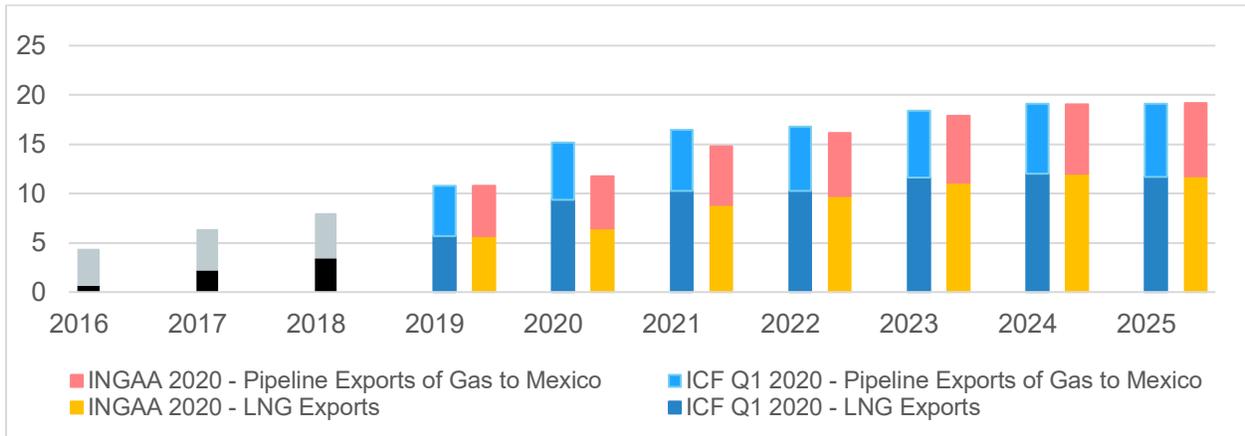
The focus for U.S. oil and gas development is increasingly pivoting to global markets. While domestic markets will remain important for oil and gas use, much of the incremental production expected in the U.S. will serve international markets. This occurs, in part, because international consumers, particularly those in Asia, have significantly growing needs for oil and gas. Significant volumes of gas are needed to replace coal generation and to support renewables deployment in that region. In addition, international customers are expected to value supply diversification and favor oil and gas supplies from the U.S. because of the stability of its economy and its clearly defined and relatively stable laws and regulations.

LNG exports have rebounded and will continue to grow significantly through 2025.

Despite the temporary declines that occurred during the second quarter of 2020, LNG exports have rebounded and will continue to grow significantly through

2025. The INGAA 2020 scenario projects that LNG exports will rise from 5.7 billion cubic feet per day in 2019 to 11.7 billion cubic feet per day by 2025, an increase of over 100% (Figure 18).

Figure 18: LNG and Mexican Exports (Billion Cubic Feet per Day)



While the 2020 level is noticeably lower than the level it otherwise would have been absent the market changes since the beginning of the year, LNG exports in the INGAA 2020 scenario fully catch up with exports in the ICF Q1 scenario by 2022. Even so, near-term declines in international gas use have delayed final investment decisions for several new LNG export terminals. In addition, projects backed by oil and gas producers are experiencing financing uncertainties as producers continue to rationalize their capital spending plans. As a result, these projections reflect challenges and risks that should not be overlooked.

Like U.S. LNG exports, growth in pipeline exports to Mexico have been robust. Exports of pipeline gas to Mexico are expected to rise from 5.1 billion cubic feet per day in 2019 to 7.4 billion cubic feet per day in 2025, an increase of about 45%. This trend has been little altered by the COVID-19 pandemic. Mexico is expected to continue to have robustly growing needs for natural gas in its power plants. The country is continuing to retire and replace its older oil-fired generation with newer, more efficient, and less expensive gas generation. U.S. gas supplies are less expensive than other alternatives for Mexico including LNG imports, and challenges within Mexico to increase domestic production are expected to persist. Thus, natural gas from the U.S. will continue to be an important source of supply for Mexico's gas needs.

LNG Exports

LNG supply in 2019 showed a record growth as several U.S. liquefaction projects came online. So, even before the pandemic, the LNG market was set for oversupply in 2020 and 2021 as new projects continued to grow liquefaction

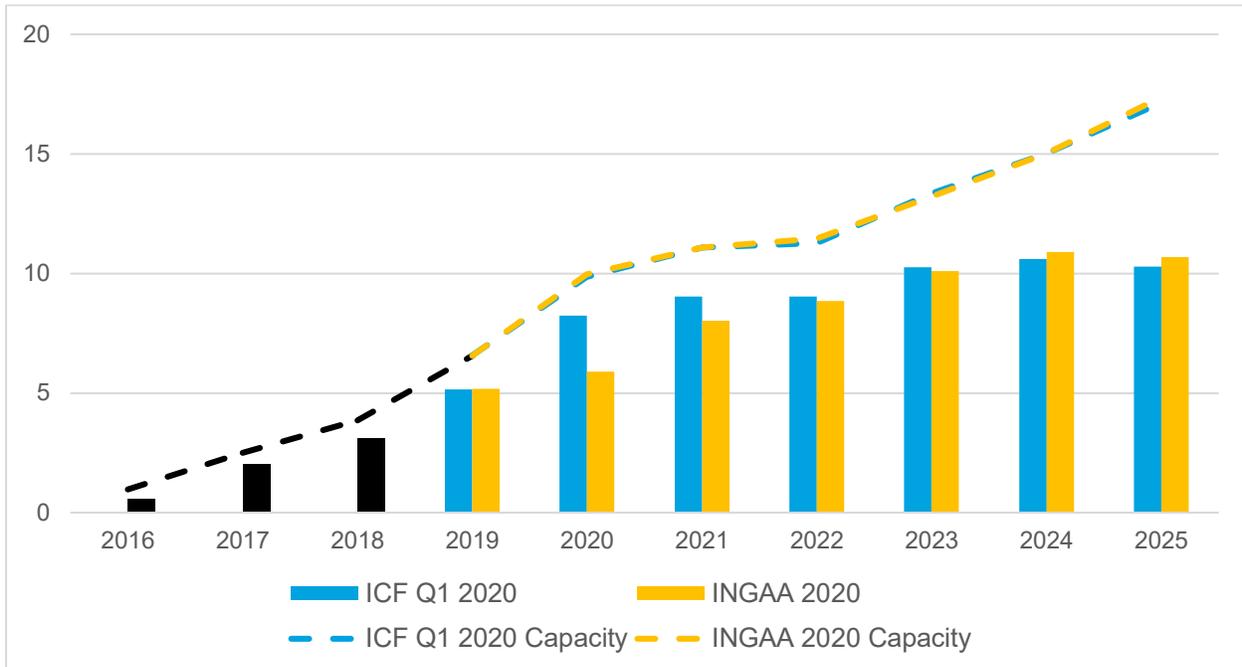
capacity. With the reduced natural gas demand in 2020 due to the COVID-19 pandemic and lockdown of major global economies, global LNG demand is projected to decline in 2020 compared to 2019. After six consecutive years of growth, the INGAA 2020 scenario projects the global LNG demand to drop from 46 billion cubic feet per day in 2019 to 44 billion cubic feet per day in 2020. A quick rebound in LNG demand is seen in 2021 and growth continues thereafter.

The number of LNG liquefaction facilities that may eventually enter the market will depend on the ability of the developers to sign long-term supply contracts with international buyers and to secure project financing and regulatory approvals. Based on our assessment of global LNG demand and supply, the INGAA 2020 scenario assumes that 9 U.S. LNG export terminals will be built and/or expanded: Sabine Pass, Freeport, Cove Point, Cameron, Corpus Christi, Elba Island, Golden Pass, Port Arthur, and Calcasieu Pass. By 2025, the U.S. LNG annual average export capacity is projected to grow from 11.1 billion cubic feet per day in 2021 to 17.4 billion cubic feet per day in 2025.

With the collapse of global energy demand, several oil and gas companies have pushed back decisions on building new LNG terminals. For example, the Final Investment Decision (FID) for NextDecade's Rio Grande LNG project has been delayed until 2021 due to challenging market conditions.¹¹ U.S. LNG export terminal capacity utilization is projected to average about 72% from 2021 through 2025 in the INGAA 2020 scenario versus 74% in the ICF Q1 2020 base scenario.

¹¹ <https://www.reuters.com/article/us-usa-nextdecade-lng/nextdecade-delays-texas-lng-export-project-investment-decision-to-2021-idUSKBN22U2ZU>

Figure 19: Annual average U.S. LNG Exports and Capacity (Billion Cubic Feet per Day)



As shown in Figure 19, U.S. export volumes are projected to be 8.0 billion cubic feet per day in 2021 in the INGAA 2020 scenario, down from 9.0 billion cubic feet per day in the ICF Q1 2020 scenario. This decrease is attributed to the loss in global LNG demand and increased global competition among LNG suppliers. The LNG exports may be higher than our expected volumes if global gas demand recovers more quickly than expected from the COVID-19 pandemic.

The price spread between Asia’s Japan Korea Marker (JKM) and the U.S.’ Henry Hub (HH) has increased from \$0.913/MMBtu on February 19th, 2020 to \$2.878/MMBtu on October 14th, 2020. The firming up of JKM is expected to make U.S. LNG more competitive on a global scale and the feed gas LNG deliveries to U.S. terminals had at least temporarily rebounded to pre-COVID levels by the end of October 2020 exceeding ICF’s expected rebound in LNG exports in Q4 2020.

Pipeline Exports to Mexico

Gas trade with Mexico has not been impacted much by COVID-19, as Mexico continues to retire and replace its older oil-fired generation with newer, more efficient, and less expensive gas generation. As U.S. gas supplies are relatively less expensive than other alternatives for Mexico, the INGAA 2020

scenario is forecasting U.S. pipeline exports to Mexico to average 5.3 billion cubic feet per day in 2020 (Figure 20). This will continue to grow as Mexico’s demand for natural gas continues to rise, while its domestic production has been declining. INGAA 2020 projects pipeline exports to Mexico to be lower than the Q1 2020 levels between 2020 to 2023 due to COVID-19 demand reductions and delays in pipeline and power generation infrastructure development in Mexico. With Mexico continuing to add gas-fired generation and sponsor new pipelines from the U.S., exports are projected to grow to 7.4 billion cubic feet per day by 2025, at par with the 2025 exports in the ICF Q1 2020 scenario (Figure 21).

Figure 20: Pipeline exports to Mexico (Billion Cubic Feet per Day)

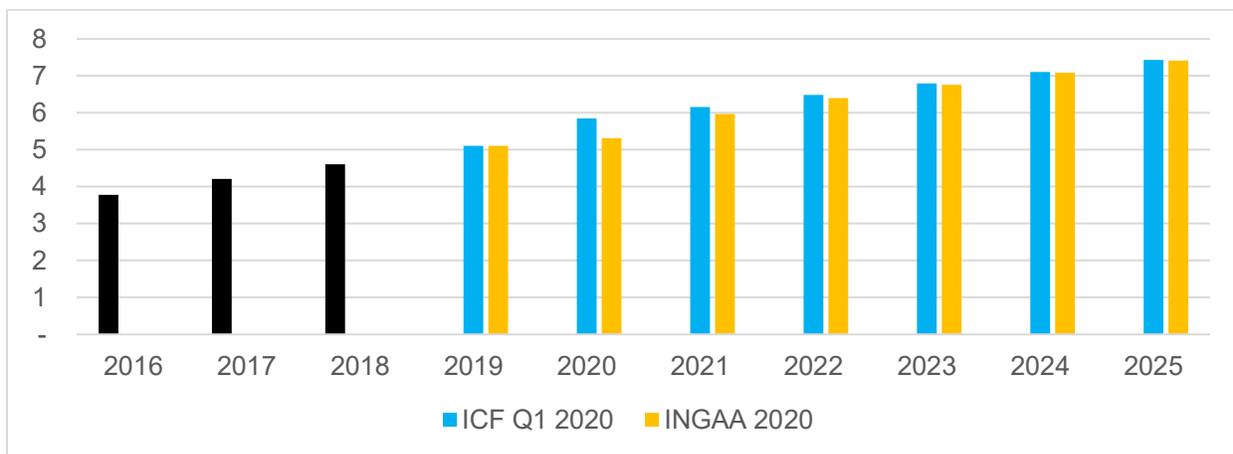
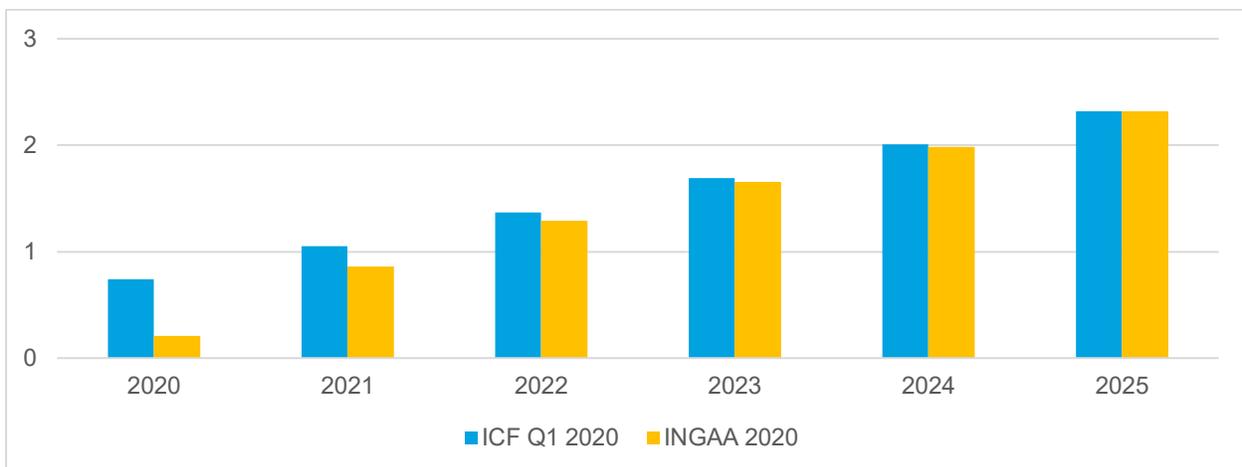


Figure 21: Change in Pipeline exports to Mexico from 2019 (Billion Cubic Feet per Day)



The projections of pipeline exports to Mexico in the two scenarios assume that the current challenges within Mexico to increase domestic production persist.

ICF does not assume any LNG export terminals will be built in Mexico. However, there is upside potential for pipeline exports to Mexico if one or more LNG export facilities are built. Sempra has recently announced that it reached an FID for Energía Costa Azul LNG (ECA LNG) project on November 17, 2020 and LNG production from ECA LNG Phase 1 is expected to start in late 2024.¹² This will provide an additional outlet for U.S. gas production.

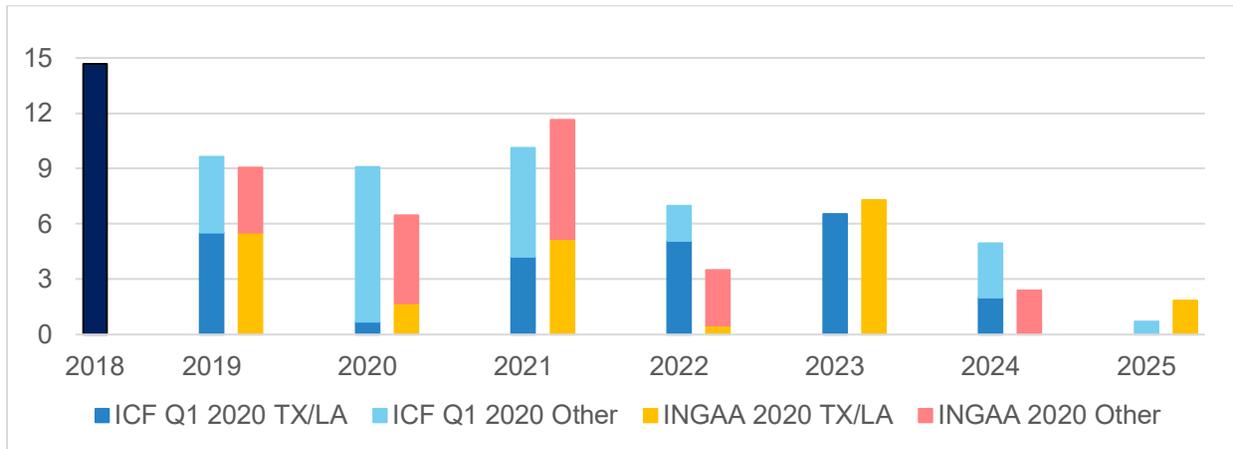
The recently published 2020-2024 Sistrangas expansion plan by Mexico's Energy Ministry SENER on November 5, 2020 aims to expand the Sistrangas pipeline system to improve the interconnectivity of the system to better serve the gas needs of Southeast and Southern parts of the country. This is expected to likely increase the U.S. natural gas exports to Mexico to meet the growing demand of the Mexican power and industrial sectors than projected in INGAA 2020 scenario.

3.2.4. Implications for Infrastructure Activity

During the period of recovery from the pandemic, infrastructure will need to address market growth from increased demand, including LNG exports from both current and new liquefaction plants and expansions. Many of the new pipeline projects that have yet to be completed focus on transporting Permian, Haynesville, SCOOP and STACK gas to export facilities. The level of expected pipeline development from 2020 through 2025 in the latest INGAA 2020 projection is lower, however, due to major pipeline projects that have been delayed or cancelled. The ICF Q1 2020 outlook expected 38 billion cubic feet per day of pipeline capacity to be completed between 2020 and 2025, whereas the INGAA 2020 outlook expects 33 billion cubic feet per day to be completed during the same time period. Expected new capacity in Texas and the Marcellus is down by over 6 billion cubic feet per day relative to the ICF Q1 2020 scenario, and new capacity in the Haynesville in Louisiana is up by 2 billion cubic feet per day (Figure 22).

¹² <https://www.sempra.com/sempra-energy-announces-fid-landmark-energia-costa-azul-lng-export-project>

Figure 22: Capacity In-Service for Major Natural Gas Pipeline Projects (Billion Cubic Feet per Day)



Note: Chart shows capacity only for those projects with greater than 100 miles of new pipe.

3.3. Certification and Permitting Uncertainties, Infrastructure Construction Delays, and Legal Challenges

Infrastructure development has been impacted by challenges in obtaining Federal, state and local permits and certifications, as well as increasing opposition from environmental advocacy groups. Difficulty receiving the necessary certifications and permits to begin construction and legal challenges from groups opposing the construction of new pipelines have resulted in project delays, increased costs and, in some cases, their cancellation. Major pipeline projects with total capacity of 2.6 billion cubic feet per day that were expected to be completed in 2020 and about 5.3 billion cubic feet per day with expected in-service dates between 2020 and 2025 have been delayed or cancelled since the beginning of 2020.

Pipeline projects have been delayed due to opposition from local and national environmental groups, landowners and indigenous groups on the issuance of pipeline environmental permits and certificates. This has included legal challenges to the use of the general Nationwide Permit 12 (NWP 12), which is used for utility projects with limited impacts on waters of the U.S. that have caused construction delays and uncertainty.

Separately, some projects have had difficulty obtaining a water quality certification from specific states. Clean Water Act Section 401 provides a federal framework through which states can exercise authority to certify that discharges from projects requiring federal authorization will comply with applicable federal water quality

standards. States can exercise authority to certify that discharges from projects requiring federal authorization will comply with applicable federal water quality standards and in doing so can condition the activity to ensure that the discharge will comply with applicable water quality standards. However, the Clean Water Act provides that states must make a decision on such requests within a reasonable period of time, not to exceed one year. Several pipeline projects have endured years of litigation to confirm the timeframe within which the state must act and the scope of the state's review.

In July 2020, U.S. EPA issued final regulations intended to clarify the shared responsibilities between states and federal agencies under Clean Water Act Section 401, including the time period for a state's review, who determines the reasonable period of time, whether the state has waived its opportunity for review, and when federal agencies may proceed with processing reviews and authorization if waiver has occurred.

These challenges increase the need for Pipeline companies to engage with communities well before permits and certification requests are sought and then continue such engagement throughout the development, construction, and restoration process to reduce the risk of opposition to permits and certification requests.

3.4. Pipeline Safety Programs

Recent market changes have little impact on pipeline safety programs. Pipeline safety is of paramount importance and critical to a pipeline company's ability to construct and their social license to operate. Despite recent market changes, pipeline safety efforts have intensified, in part because of new PHMSA rules that:

- Increase mileage of gas gathering pipelines subject to PHMSA federal regulations
- Require reconfirmation of established operating pressures (MAOPs)
- Expand in-line inspection and pipeline maintenance requirements (e.g., anomaly repair, corrosion control)

PHMSA has proposed rules that will likely become effective within the next three years, including Valve Automation and Rupture Detection and Use of Integrity Management in lieu of Pipe Replacement for Class Location Changes. Pipeline safety programs will continue to be significant areas of focus for pipeline companies during next five years, with new rules described above implemented over the next 15 years.

4. Dynamics for Infrastructure Development

This section summarizes the impacts of the key drivers and the overall market projections on infrastructure development. Although recent market events slowed down the pace of infrastructure development, the natural gas market is still projected to grow over the next five years, mainly driven by power sector and export markets.

4.1. What Has Not Changed Since the Beginning of 2020?

Natural gas is still a highly desired and cost-effective source of energy for space heating, water heating, and cooking. It is still a cost-effective fuel and feedstock for many industrial applications. Being cheaper and cleaner than the other fossil fuels, it is still a foundational fuel supporting renewables. With the share of renewable generation in the U.S. projected to increase in the future, natural gas generation has an opportunity to improve the reliability and resiliency of the electric grid as it is flexible and dispatchable when needed.

Gasoline and diesel are still the most dominant fuels for transportation; oil products are key to many manufacturing applications. New supplies of oil and gas continue to foster development of new midstream infrastructure. Most U.S. oil and gas supplies are still cost-effective to develop, even with lower oil and gas prices. To keep its recently achieved energy independence, the U.S. must maintain and, in some areas, increase its oil and gas production. Even though domestic energy use may lag, export markets will continue to provide an outlet for oil and gas products. The natural gas sector in the U.S. is becoming more dependent on growth in export markets compared to domestic markets.

Pipeline safety investments will continue to be an important focus for the foreseeable future following the recent adoption of extensive new PHMSA regulations and the PIPES Act of 2020.

4.2. What Has Changed in 2020?

COVID-19 has caused a global recession, significantly reducing oil and gas use. Oil consumption has been hit hard and oil prices have collapsed. The current futures price strip for oil is much lower than it was in early 2018 and the International Energy Agency (IEA) recently stated that oil markets will not

Being cheaper and cleaner than the other fossil fuels, it is still a foundational fuel supporting renewables.

rebound to pre-COVID levels until 2023.¹³

In response to reduced consumption and prices, U.S. energy companies have slashed their budgets, reducing their drilling activity by 40% to 70% of pre-COVID levels. Oil-prone plays such as the Permian Basin have been hit the most. In April through June 2020, supply shut-ins occurred across the U.S. to curtail production. Exports of oil products, natural gas liquids (NGLs), and LNG have been hit hard by reduced demand in global markets. However, exports have already begun rebounding from the lows set in Q2 2020.¹⁴ Industrial gas use has declined, most notably in refineries and petrochemical applications. Commercial gas use has declined due to closures of businesses and schools and idled commercial floor space as many organizations have implemented work-from-home policies. Growth in power sector gas use is slowing due to increased penetration of renewable resources.

However, natural gas infrastructure requirements will not decline proportionally since natural gas complements renewables.

Opposition to oil and gas development is continuing to strengthen as concerns about climate change become more prominent. Permitting delays have impaired infrastructure development and have significantly increased project costs.

4.3. Which Impacts May Linger Until 2025?

With the COVID-19 pandemic expected to continue well into 2021, it may take several years before economies fully recover. Even though an economic recovery is expected, the overall size of the economy is expected to still be smaller than it otherwise would have been without COVID-19.

Oil price volatility has gone up, raising uncertainty for the price of oil in the future. This in turn has led to increased project discount rates (i.e., applied rates of return). With reduced oil prices, E&P budgets are likely to continue to be constrained and drilling activity will remain below pre-COVID levels. Less capital is being deployed for upstream development and several E&P majors have announced intentions to diversify to cleaner sources of energy. Many of the big oil companies like Shell, BP, Eni SpA, Total, and Equinor are inclined towards investments into renewable energy sources. In the near term, exports of oil products and LNG in the INGAA 2020 scenario are lower than projected prior to COVID-19 in the ICF Q1 2020. FIDs for

¹³ IEA (2020), World Energy Outlook 2020, IEA, Paris <https://www.iea.org/reports/world-energy-outlook-2020>

¹⁴ EIA, <https://www.eia.gov/totalenergy/data/browser/index.php?tbl=T01.04B>

several LNG projects have been delayed. Use of some oil products like jet fuel may take a longer time to return to pre-COVID levels, thus the industrial gas use from some sectors like the refining sector will also lag.

Commercial gas use may continue to lag as some businesses adopt permanent work-from-home strategies and some schools or universities change the way they educate students. Growth in power sector gas use is likely to continue at a slower pace as renewable generation continues to become more cost effective. However, natural gas infrastructure requirements will not decline proportionally because of the need for flexible natural gas generation to complement that renewable generation. Opposition to oil and gas development, which is causing permitting delays are increasing the costs of infrastructure development. If this trend continues, infrastructure development will be delayed or altogether cancelled as projects are priced out of the market.

5. Key Uncertainties

There is significant uncertainty regarding market growth and infrastructure development. While some factors create upside potential for oil and gas markets, there are also significant downside risks (Figure 25).

Figure 25: Upside Potential and Downside Risks for Oil and Gas Markets through 2025

Upside Potential	Downside Risks
1) Rules requiring dispatchable thermal generation for grid reliability which favor gas	1) Capital constraints on oil & gas activity
2) Accelerated deployment of effective vaccine and more robust rebound in economic activity	2) Delayed or ineffective vaccines for COVID-19
3) Well productivity better than expected	3) Drilling bans on federal lands
4) Uncertainty in Persian Gulf Oil Production	4) Continued oversupply of oil
5) Reduced trade restrictions and tariffs	5) Accelerated trade war
6) Additional substitution of gas for coal in the power sector	6) Restrictions on incremental gas use

As mentioned in Section 3, collapsing oil markets and prices have been responsible for this year's decline in oil and gas production, which is a major driver of slowing infrastructure development.

“The pandemic affected energy prices for products ranging from crude oil to various refined petroleum products, such as heating oil, jet fuel, diesel fuel, retail gasoline, and gasoline at the pump. The onset of the pandemic led to an initial drop in prices for petroleum-based products, and then, just as abruptly, prices rose sharply as producers limited production and demand increased.”¹⁵ However, oil prices face great uncertainty, and price volatility is relatively high. Oil production from the Middle East plays a major role in determining oil prices, and uncertainty around these prices generally bolsters price volatility. While the current oversupply of oil has been exacerbated by a slow return of demand for some oil products, such as jet fuel, the picture for oil prices remains unclear, with many factors in play.

Another significant risk for oil and gas markets and infrastructure development is the

¹⁵ <https://www.bls.gov/opub/mlr/2020/article/from-the-barrel-to-the-pump.htm>, U.S. Bureau of Labor Statistics, October 2020

economy. The INGAA 2020 scenario assumes a V-shaped economic recovery with a sharp rebound in activity following the closure of many businesses during the second quarter of 2020. The economic recovery is not certain, and many economists believe it could be uneven as countries around the world endure waves of COVID infections until effective vaccines are deployed. Even then, some economists think a full rebound of economic activity may not occur until months after vaccine deployment. On the flip side, productivity improvements and cost reductions in the oil and gas business could increase production even at drilling levels well below pre-pandemic levels, spurring infrastructure development and offsetting some of the negative impacts of lagging economic activity.

A negative factor that is even more obvious than those already discussed would be significantly delayed or ineffective COVID-19 vaccines. The expectation of a V-shaped economic recovery hinges on the release of effective vaccines by early-2021. Delay beyond that throws the certainty of an economic rebound into question.

The 2020 election will likely have a significant impact on federal policies that affect the midstream infrastructure industry. The Biden administration should be expected to attempt to unwind many of the regulatory changes made by the Trump administration and return to Obama-era regulations. The Biden administration is also expected to promote additional regulations, in particular, regulations related to climate change.

President-elect Joe Biden has vowed to make the climate crisis and environmental justice guiding principles of his administration from day one of his presidency. In addition, the pipeline industry should expect an immediate rejoining in the Paris Climate Accord and reinstatement of methane regulations that were rolled back or slated for rollback under the Trump administration. Reinstatement of the methane regulations will take some time and will provide an opportunity for further industry input.

The Biden platform calls for elimination of new drilling on Federal lands, and the new administration can also be expected to roll back Trump administration efforts to open additional formerly protected areas for exploration. These changes will influence where infrastructure development occurs because it will likely increase production costs as drilling on federal lands moves to private lands.

The Biden administration is also expected to roll back changes to slow increases in vehicle fuel efficiency standards and to proceed with the implementation of higher appliance energy efficiency standards. However, the larger environmental issue for the oil and gas industries is the secondary effects of policies to address climate change. The Biden platform includes:

- A requirement for 100% zero-emitting electric generation by 2035
- Economy-wide net-zero emissions by 2050
- Significant funding for building energy efficiency

- Extensive support for electrification of buildings and transportation

These goals are unlikely to have significant impacts on energy demand in the next five years. However, the Biden administration's direction is clear and will affect funding and planning for oil and gas industry investment.

Among the most likely policy changes would be limits on electric power generation emissions. Achieving the 100% goal by 2035 in the power sector seems challenging, but there could be movement in that direction. With a closely divided Congress, it will be difficult to achieve through legislation, especially in the next two years. A power sector carbon tax might also be considered. However, even in the absence of formal legislation, market economics are expected to put pressure on coal generation. Near-term coal plant retirements could put additional upward pressure on gas generation in the medium-term, but without long-term certainty on policy, financing new baseload generation would be difficult.

Increased support for emissions limits at the state-level can also be expected. Continued support for these policies in future administrations would be needed to carry this through, but many states are adopting similar policies; a consistent national policy may be preferable to many different state policies.

Electric reliability rules could have positive impacts on the natural gas business and natural gas infrastructure development.

Meanwhile, rapid growth of renewable generation with or without specific climate-related policies will likely increase the need for peaking and intermediate load gas generation. However, federal action to address issues associated with payment for the natural gas infrastructure required

by the power sector would be less likely under the Biden administration. FERC, NERC, ISOs, and RTOs have investigated reliability rules for natural gas support of renewables over the past few years, but nothing significant has yet happened on that front. Electric reliability rules could have positive impacts on the natural gas business and natural gas infrastructure development.

There is a significant interest in hydrogen fuel to reduce carbon emissions. Hydrogen could be produced from natural gas combined with Carbon Capture and Sequestration (CCS). Alternatively, hydrogen could be produced from renewables or nuclear power displacing natural gas. The development of a hydrogen economy will provide opportunities for massive investments in the production and transportation of gaseous fuels that the pipeline industry is well-positioned to take advantage of.

All these trends suggest declining natural gas demand for power generation in the long-term (post-2025) with limited impacts in the near-term. Natural gas will continue to be a foundational fuel, enabling penetration of renewables and energy storage, and ensuring electric generation reliability. A push towards electrification of the building sector is

already visible in certain cities and states. The Biden platform includes strong support for this trend along with large investments in building energy efficiency. Both would decrease residential and commercial gas demand in existing buildings and slow down gas demand growth in new buildings. However, achieving substantive goals in this area will be very challenging, almost certainly more challenging than the transition on the power generation side due to the much larger numbers of buildings involved.

Natural gas will continue to be a foundational fuel, enabling penetration of renewables and energy storage, and ensuring electric generation reliability.

Local moratoriums on new gas hook-ups would be easier to achieve but would also have smaller effects on gas demand. Part of the gas LDC response to these pressures will be a shift toward the use of renewable natural gas (RNG), which could involve some pipeline investment to tap available or new resources. While the timing is unclear and likely slower than suggested by the policy recommendations, residential and commercial gas load is likely to decline in the long-term post 2025 due to national, state, and local policies. The changes in demand are also likely to exacerbate the “peakiness” of electric load, as electric heat’s response to cold snaps is layered on to potential intermittency of renewable generation.

The Biden platform also includes aggressive plans for decarbonization of the transportation sector. California has gone even farther, announcing a moratorium on new gasoline and diesel vehicles by 2035. Again, achieving these goals on these timetables will be difficult, but the trend is clear. The policies will likely be clarified at about the same time as the economic recovery is realized and could affect the appetite for renewed investment in the oil and gas sector.

A closely divided Congress is expected to moderate the scope of the legislative agenda that could be implemented in the first two years of the Biden presidency, potentially leading to a focus on executive actions. The composition of the Senate may change again in 2022, making the 2022 election important in determining the longer-term effectiveness of the Biden legislative agenda.

Certain changes to tax laws could offset negative impacts. While it is possible that the U.S. would consider such changes to reduce a growing federal budget deficit, it is also less likely with the Biden administration. If anything, new tax policies at the federal level are likely to favor energy-efficient and “greener” forms of energy. As well, expedited approvals for oil and gas infrastructure, another positive factor for oil and gas markets, now also appear less likely. While it is currently unknown whether the Biden administration would propose drilling bans on federal lands, such measures could have pronounced negative impacts on oil and gas activity.

Finally, trade policies will have significant bearing on oil and gas markets. The environment for global trade has become more contentious with President Trump’s

policies during the past few years. Even though President-elect Joe Biden has signaled that his administration is likely to continue along a similar path, the direction is not entirely clear. Nevertheless, the prevailing view among oil and gas industry representatives is that reduced trade restrictions and tariffs would be net positives for oil and gas activity, while an amplified trade war would have negative implications.

Environmental regulations, energy policies, and market and consumer sentiment are likely to continue to put pressure on coal power plants, and gas generation is expected to continue to substitute for coal generation in the future. However, a growing movement by some states and municipalities to restrict, and in some cases ban, new gas use could dampen future growth of gas. For example, moratoria on incremental gas use were introduced in parts of New York and Massachusetts between 2014 and 2019. Also, more recently, San Jose, California became the largest city in U.S. to ban natural gas use in new commercial buildings.¹⁶

There are now 37 cities and counties in California that have banned new natural gas hookups.

¹⁶ <https://sanjosespotlight.com/san-jose-bans-natural-gas-in-new-commercial-buildings/>

6. Conclusions

As the COVID-19 pandemic eases, markets are expected to rebound.

The COVID-19 pandemic and related declines in economic activity, the recent collapse in oil prices, near-term declines in oil and gas use, continued opposition to oil and gas infrastructure development, and increasing uncertainties about the role of hydrocarbons as the world continues to strengthen its efforts to fight climate change—have appeared to slow the pace of infrastructure development. Based on EIA data, consumption in the industrial sector declined by 4.1% y-o-y between April 2020 and August 2020. This reduction was offset by the power generation sector, which was up 3.4% y-o-y over the same period, and by a 1.3% increase in residential and commercial consumption.

However, as the COVID-19 pandemic eases, markets are expected to rebound. U.S. domestic gas use is expected to grow, rising to an average of roughly 88 billion cubic feet per day in 2025 (i.e., roughly 5% above the 2019 level). Export demand is also expected to rebound, with continued development and growth of LNG exports and pipeline exports to Mexico.

The rebound in demand will be supported by a rebound in drilling activity and new production. 2025 oil production is projected to be up by about 2.5 million barrels per day (i.e., roughly 20% above the 2019 level) as economically viable oil resources continue to be developed at expected oil prices. Likewise, U.S. natural gas production will resume growth, rising to 103.0 billion cubic feet per day in 2025 (i.e., 11.1% above the 2019 level).

The growth in demand and the regional shifts in production activity will support continued infrastructure development. The location of drilling and production activity continues to shift over time. Production growth in the Marcellus/Utica is expected to slow due to infrastructure constraints. Growth in natural gas production from the Haynesville/SCOOP/STACK is expected to grow to meet the shortfall. Additional infrastructure development will be needed to support the shift in regional production.

Even though regulatory impediments and permitting delays put projects at risk and potentially impair market development, the INGAA 2020 scenario shows that almost 33 billion cubic feet per day of major gas pipeline projects are expected to be placed into service from 2020 through 2025. This infrastructure expansion will be supported by continued growth in domestic natural gas demand, primarily in power generation. Also, pipeline safety will continue to be an important focus for pipeline companies as they continue to respond to the new PHMSA rules. These rules are expected to drive continued investment in safety programs for pipelines over the next 15 years.

Considering these results, the key findings from this study include:

Potential for infrastructure development is still significant, despite recent events.

As the impacts of COVID-19 diminish over time, the drivers of new infrastructure return. The INGAA 2020 scenario shows that almost 33 billion cubic feet (BCF) per day of capacity is expected to be placed into service through major gas pipeline projects from 2020 through 2025 (Exhibit ES 1). While projected development is down by almost six billion cubic feet per day, or about 15%, from the level projected in ICF Q1 2020, it still requires a substantial amount of new infrastructure. This result is not necessarily an intuitive finding, given the significant declines in supply development and declines in near-term gas use that have occurred in 2020.

Gas Infrastructure will continue to support power system reliability as renewable power generation expands.

Even as decarbonization efforts continue to evolve, gas generation will continue to increase, and will remain vital to maintaining electric reliability, providing a safety net for uncertainties in renewable generation in the near-term. The INGAA 2020 scenario projects that gas generation will continue to hold a relatively steady market share through 2025. Total gas use in the power sector is expected to increase from 31.0 billion cubic feet per day in 2019 to 33.3 billion cubic feet per day by 2025. This growth will support additional displacement of coal power generation and will support electric reliability.¹⁷ The pipeline infrastructure that supports gas generation is important to maintain the reliability and cost-effectiveness of electricity in the U.S.

Natural gas is still a highly desired and cost-effective source of energy for space heating, water heating, cooking, and industrial applications.

Domestic natural gas use is expected to rebound and increase through 2025 as the market recovers from the pandemic. Total domestic natural gas consumption is projected to rise to roughly 88 billion cubic feet per day by 2025, about 3 billion cubic feet per day above the 2019 level.

Significant increases in exports of oil, gas (LNG and pipeline exports to Mexico), and NGL will provide strong support for oil and gas development.

The focus for the development of U.S. oil and gas resources is increasingly pivoting to global markets. Oil products, NGL, and LNG exports will continue to provide a significant

¹⁷ The North American Electric Reliability Corporation (NERC) and the nation's Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs) NERC's December 15, 2020 *Long-Term Reliability Assessment* finds the evolving fuel resource mix is changing reliability, security and resilience landscape. "As more solar and wind generation is added, additional flexible resources are needed to offset these resources' variability. This is placing more operating pressure on those (typically natural gas) resources and makes them the key to securing Bulk Power System (BPS) reliability."

outlet for U.S. oil and gas supplies. U.S. supplies are competitive in global markets where consumers value supply diversity and the stability of the U.S. economy. Exports of U.S. natural gas will increase by over 10 billion cubic feet per day over the next five years. Global LNG trade is expected to reach 52.5 billion cubic feet per day by 2025, an increase of 14% compared to 2019. Emerging Asian markets remain the driving force behind the expansion of LNG imports, led by China and India, while the U.S. accounts for two thirds of the net growth on the export side.

While growth of LNG exports in 2020 was limited by COVID-19, growth will resume as global economies rebound; annual average LNG exports from the U.S. are projected to rise to almost 11 billion cubic feet per day in 2025, well above the 2019 average of roughly 5 billion cubic feet per day. Likewise, pipeline exports of gas to Mexico are projected to rise to nearly 7.5 billion cubic feet per day in 2025 versus 5 billion cubic feet per day in 2019; U.S. gas is a very cost-effective resource for recently constructed power plants located near the U.S. border.

Infrastructure development is swinging to the Permian, Haynesville, SCOOP and STACK areas.

Associated gas development will continue to lead the way for domestic gas production. Gas production from oil-rich resources started to boom around 2015 when production of the Permian Basin shales began in earnest. Even with the recent downturn of oil well drilling, development of oil resources will remain significant. Thus, associated gas production will account for 60% of the increase in total gas production through 2025. Also, production from the most prominent non-associated gas resources in the Marcellus and Utica basins is being restricted by delayed infrastructure development. As a result, resource and infrastructure development are swinging more heavily toward the Permian Basin and the Haynesville, SCOOP and STACK areas, which have historically been more friendly for oil and gas development. The increased emphasis on exports is also shifting the geographic focus.

Pipeline safety investments will continue to be an important focus for the foreseeable future.

Pipeline safety programs will continue to be a significant area of focus for pipeline companies, both during next five years and in the longer term. The investment needed to support these safety programs will be a major component of industry long term capital plans.

The PIPES Act of 2020, which was recently signed into law, adds additional emphasis on pipeline safety programs. The legislation includes a variety of Congressional mandates to modernize and strengthen PHMSA's programs.

Upside potential and downside risks for oil and natural gas markets through 2025

Considering the growing opposition to the use of hydrocarbons along with the uncertainties regarding oil prices, economic recovery, policy and regulation, oil and gas infrastructure development is more challenging. Even so, structural changes in the energy infrastructure landscape are expected to have a limited impact on oil and gas markets within the next five years.

While permitting new infrastructure is challenging in today's environment, new capacity is economically justified, even considering the strong headwinds created by COVID-19.

Appendix A: ICF Modeling Tools

Gas Market Model (GMM)

ICF's Gas Market Model (GMM) is an internationally recognized modeling and market analysis system for the North American gas market. The GMM was developed by Energy and Environmental Analysis, Inc., now a wholly-owned business unit within ICF, in the mid-1990s to provide forecasts of the North American natural gas market under different assumptions. In its infancy, the model was used to simulate changes in the gas market that occur when major new sources of gas supply are delivered into the marketplace.

The GMM has been used to complete strategic planning studies for many private sector companies. The different studies include:

- Analyses of different pipeline expansions;
- Measuring the impact of gas-fired power generation growth;
- Assessing the impact of low and high gas supply; and
- Assessing the impact of different regulatory environments.

In addition to its use for strategic planning studies, the model has been widely used by institutional clients and advisory councils, including the recent Interstate Natural Gas Association of America (INGAA) study. The model was also the primary tool used to complete the widely referenced study on the North American Gas market for the National Petroleum Council in 2003.

GMM is a full supply/demand equilibrium model of the North American gas market. The model solves for monthly natural gas prices throughout North America, given different supply/demand conditions, the assumptions for which are specified by the user.

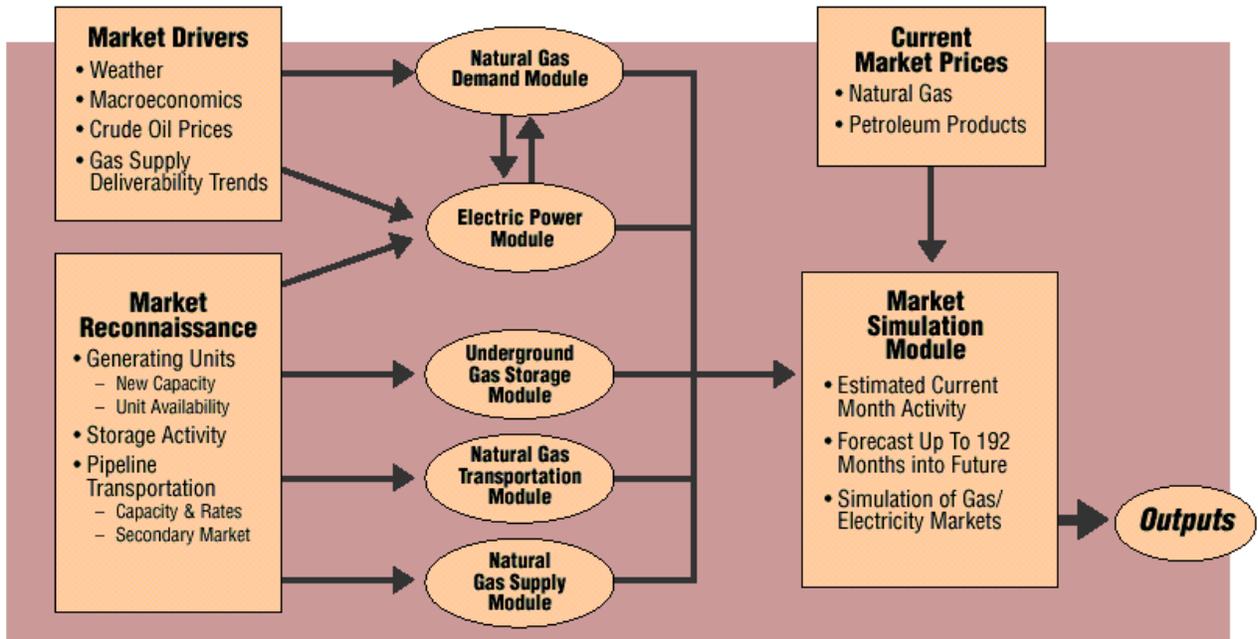
There are nine different components of ICF's model, as shown in Figure 23. The inputs for the model are provided through a "drivers" spreadsheet. The user provides assumptions for weather, economic growth, oil prices, and gas supply deliverability, among other variables. ICF's market reconnaissance keeps the model up to date with generating capacity, storage and pipeline expansions, and the impact of regulatory changes in gas transmission. This is important to maintaining model credibility and confidence of results.

Overall, the model solves for monthly market clearing prices by considering the interaction between supply and demand curves at each of the model's nodes. On the supply side of the equation, prices are determined by production and storage price curves that reflect prices as a function of production and storage utilization (Figure

24). Total U.S. and Canadian gas supplies include production, LNG imports, and storage withdrawals (in the withdrawal season only).¹⁸ Gas production is solved in 81 distinct regions throughout the U.S. and Canada and is represented by both short- and long-run supply curves. In the short run (i.e., the current month), gas production is bound by the amount of available productive capacity. In the long run, productive capacity changes as a function of the available gas resource, the cost of development, and the solved gas price. North American LNG imports and exports are exogenously specified by the selected scenario. For each modeling, ICF includes its own projection of North American LNG imports and export by terminal.

Prices are also influenced by “pipeline discount” curves, which reflect the change in basis or the marginal value of gas transmission as a function of the load factor of the pipeline corridor. The structure of the transmission network is shown in Figure 25. The discount curves have been empirically fit to historic basis values and pipeline load factors on each pipeline corridor. Pipeline capacity expansions are exogenously specified for each scenario.

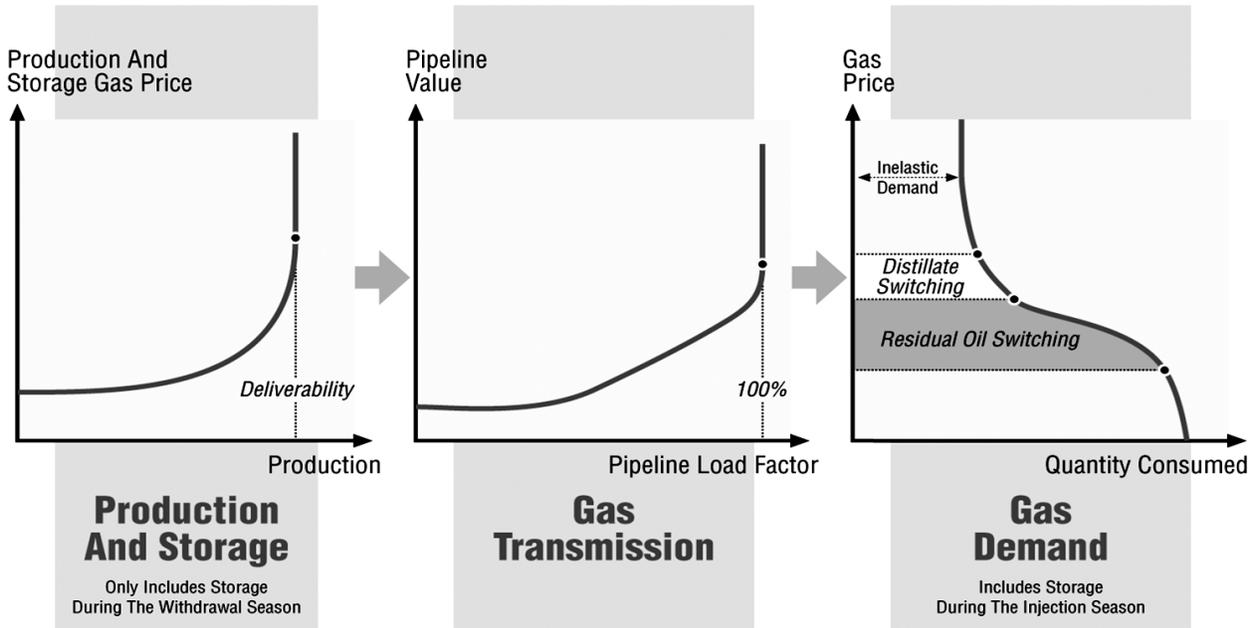
Figure 23: GMM Structure



¹⁸ Storage withdrawals are solved within the model based on “storage supply curves” that reflect the level of withdrawals relative to gas prices. The curves have been fit to historical price and withdrawal data.

Figure 24: Natural Gas Supply and Demand Curves in the GMM

Gas Quantity And Price Response



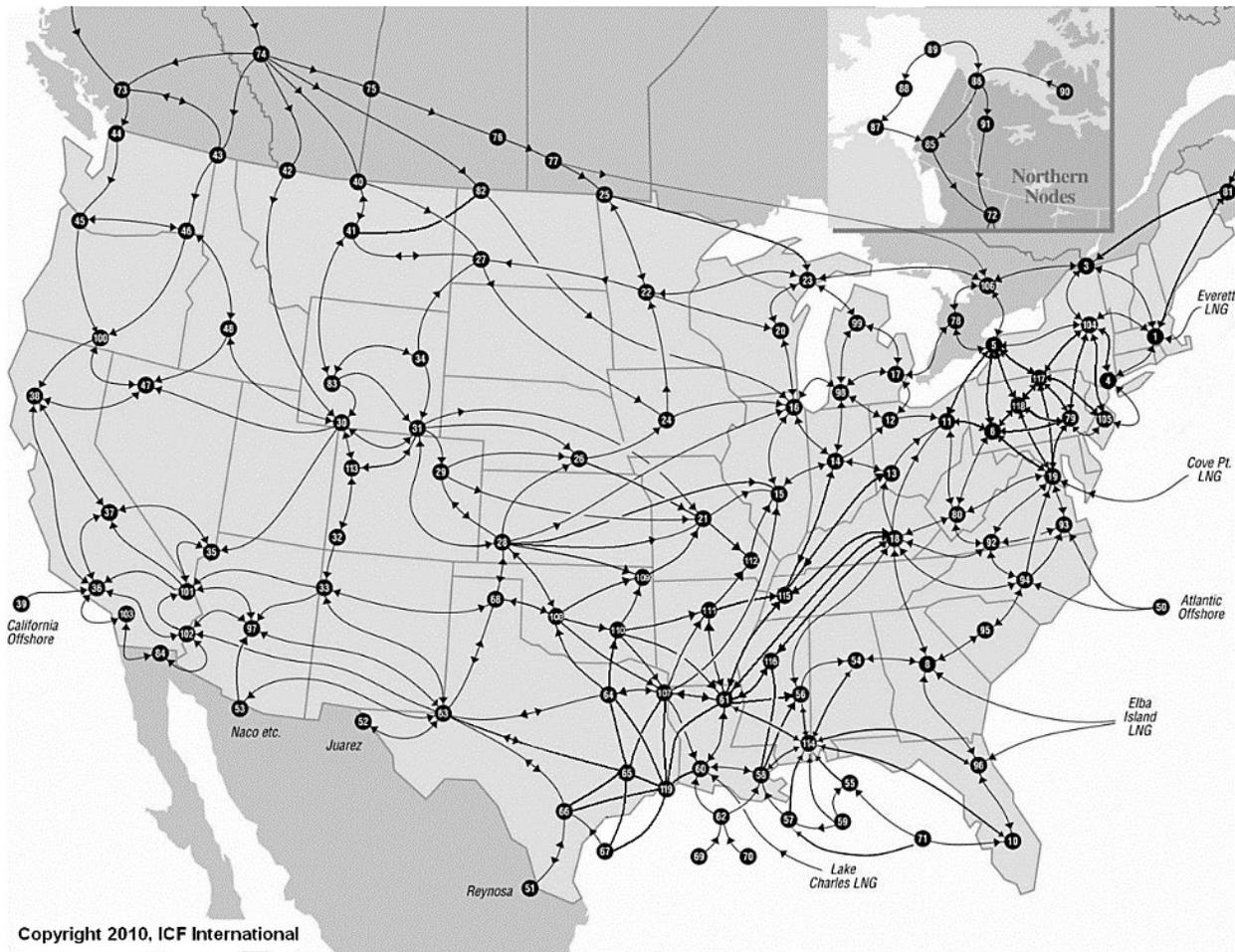
On the demand-side of the equation, prices are represented by a curve that captures the fuel-switching behavior of end-users at different price levels. The gas demand routine solves for gas demand across different sectors, given economic growth, weather, and the level of price competition between gas and oil. The electric power module solves for the power generation dispatch on a regional basis to determine the amount of gas used in power generation, which is allocated along with end-use gas demand to model nodes. The GMM forecast for power generation is consistent with ICF's Integrated Planning Model (IPM[®]), and the GMM power module allows for elasticity around IPM results to allow for seasonal/monthly variations. The GMM provides IPM with gas supply curves and basis that is used to determine gas prices for power plants within the IPM framework. The demand forecast for gas in the power sector from the IPM is then used as a benchmark to iterate both models until the gas prices and gas demand from power plants are converged in both models. Furthermore, IPM provides coal and oil retirements, and generation forecasts from nuclear, hydro, and non-hydro renewables used in the GMM electric power model.

The GMM balances supply and demand at all nodes in the model at the market clearing prices determined by the shape of the supply, demand, and transportation curves. The model nodes are tied together by a series of network links in the gas transportation module. The gas supply component of the model solves for node-level natural gas deliverability or supply capability, including LNG import levels. The model

solves for gas storage injections and withdrawals at different gas prices. The components of supply (i.e., gas deliverability, storage withdrawals, supplemental gas, LNG imports, and imports to Mexico) are balanced against demand (i.e., end-use demand, power generation gas demand, LNG exports, and pipeline exports to Mexico) at each of the nodes to solve for gas prices in the market simulation module.

Unlike other commercially available models for the gas industry, ICF does significant back-casting (calibration) of the model's curves and relationships on a monthly basis to make sure that the model reliably reflects historical gas market behavior, instilling confidence in the projected results.

Figure 25: GMM Transmission Network



Detailed Production Report (DPR)

ICF's Detailed Production Report (DPR) is a gas and oil vintage well production model that provides a complete outlook for U.S. and Canada natural gas, natural gas liquids (NGLs), and crude oil (Figure 26). The DPR presents annual production projections for more than 50 basins throughout the U.S., Canada and includes total production for both the U.S. and Canada. The report's gas production projections are linked to ICF's Natural Gas-Strategic Outlook, which provides additional insight into the future of the North American natural gas market.

The DPR contains many findings that will be of interest to oil and gas producers, field services companies, and the investment community, including:

- Projected gas, oil, and NGL production by year and by region through 2035.
- Projected gas and oil well activity by year and region through 2035.
- Vintage production charts for each region, showing how production changes over time.
- Estimated ultimate recovery (EUR) statistics for oil, gas, and NGLs wells by region.

The DPR was developed by ICF in the 2011 and its forecasts have been widely used by a number of institutional clients and advisory councils. INGAA midstream infrastructure studies in 2011, 2014, and 2016 relied on the DPR for natural gas, NGL, and oil production trends based on projections of gas and oil drilling activity to assess midstream infrastructure needs in the U.S. and Canada through 2035.

The DPR's historical gas/oil well completions, gas/NGLs/crude oil production, and gas-to-liquids ratio are calibrated to most recent statistics. The historical data is also used to estimate gas/NGLs/crude oil EURs. The main drivers for DPR forecasts are gas production forecasts from ICF's Gas Market Model (GMM) and expected gas and oil well production decline curves (

Figure 27). The GMM node-level annual gas production is mapped to each of the 56 DPR plays/production basins and broken out by gas resource type (Figure 28). DPR projections are also affected by assumptions for expected gas versus oil directed drilling ratio over time, EUR improvements due to advancement in horizontal drilling and hydraulic fracturing technology, EUR reductions that occur as drilling activities move away from sweet spots, and changes to production decline profiles due to changes in production operation such as "well throttling" implemented to improve EURs.

Figure 26: Example Vintage Production from DPR

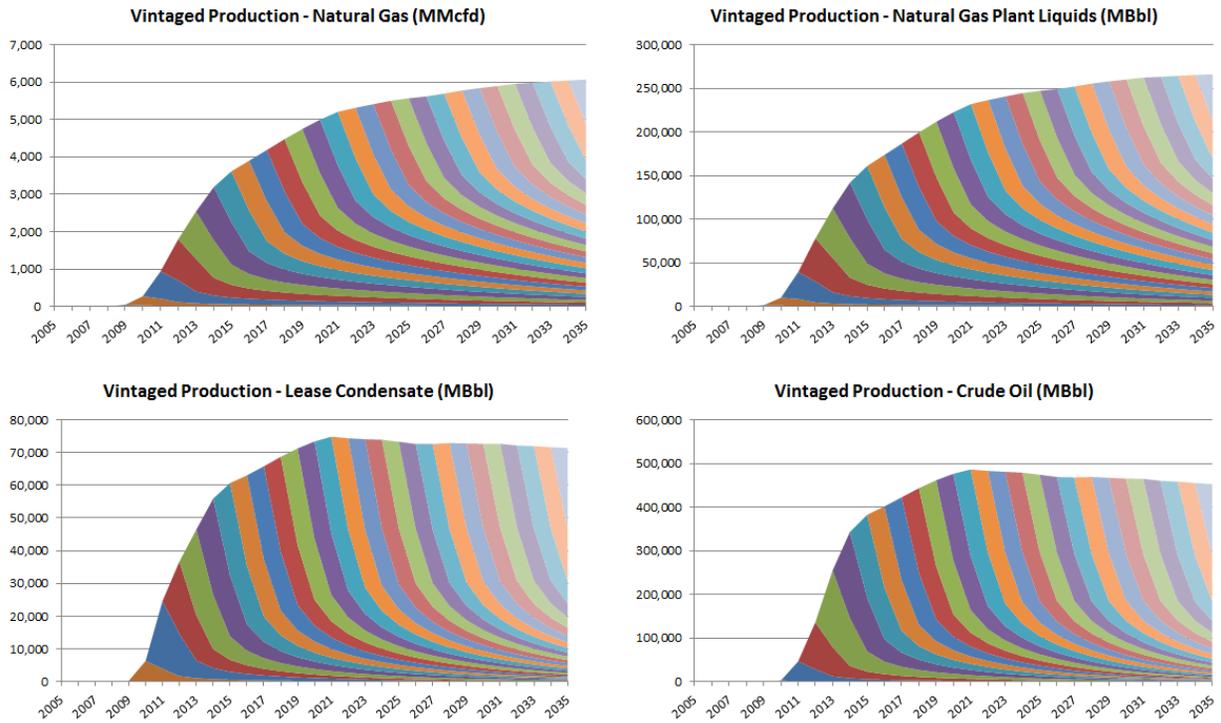


Figure 27: Example Oil and Gas Well Decline Curves

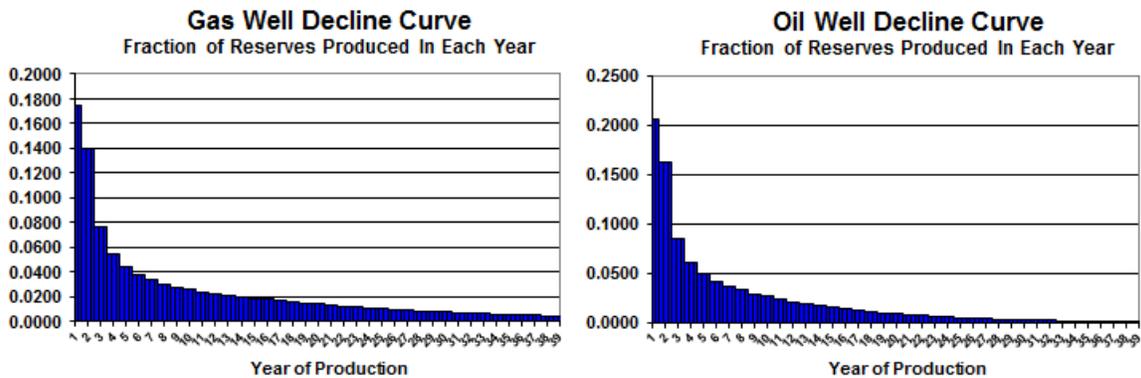
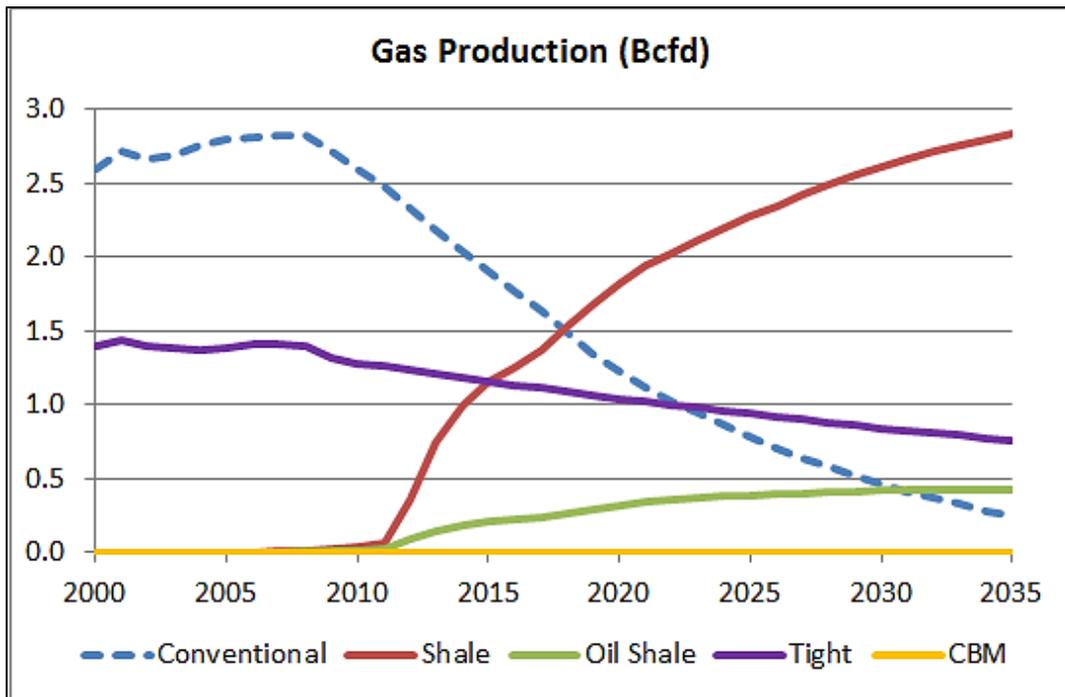


Figure 28: Example Breakout of Gas Production by Type



Appendix B: Data Sources

<i>Describes Model Component</i>		
Component of GMM Model	Category	Source
Market Drivers	Weather	NOAA for US; Government of Canada
Market Drivers	GDP	1) Quarterly historical U.S. GDP - BEA 2) Forecasted U.S. GDP for 1 year from WSJ survey of Economists 3) Forecasted U.S. and Canadian GDP - ICF Assumption (Currently 2.1% for U.S. and 2.0% for Canada) 4) Quarterly historical Canadian GDP - StatsCan
Market Drivers	Oil Prices and Marker Price	EIA for historical RACC price; Futures and ICF view for long-term Coal - EIA for historical and IPM for forecast Expected RACC price - Same as RACC price Expected Gas Price at Henry Hub - same as Henry Hub for historical period and ICF view for forecast period Expected 7-year Bond Rate - 7% assumption
Demand	Residential	EIA for historical demand; ICF view for long-term
Demand	Commercial	EIA for historical demand; ICF view for long-term
Demand	Industrial	EIA for historical demand; ICF view for long-term
Demand	Power	EIA for historical demand; ICF view for long-term using the IPM Model
Demand	LNG Exports	Using ICF World LNG Model
Demand	Pipeline Exports to Mexico	EIA and PointLogic for historical pipeline exports to Mexico; ICF view for long-term
Supply	Supply	Historical from PointLogic, EIA; ICF view for long-term
Pipeline Transportation	Pipeline Network	PointLogic; ICF view based on historical load factors and basis
Gas Storage	Storage	EIA for historical storage withdrawals; ICF view for long-term
LNG Imports	LNG Imports	Historical from EIA, ICF view for long-term