GROWING EXPORTS

PREVIEW | FundamentalEdge | May 2019

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*This is a **PREVIEW** of a 25+ Page Report*

Contents

Introduction and Key Takeaways

- This month's *FundamentalEdge* report presents an update of the May 2018 "US Exports" report, which continue to grow as production of crude oil, natural gas, and NGLs surpasses domestic demand. Therefore, the supply surplus is finding a final destination overseas.

- ***Crude oil*** exports have been growing since 2017 as US production reached historic levels thanks to growth from prolific shale basins, which in large part produces lighter crude that is better suited for refinery fleets in Asia and Europe. Exports to Asia are finding new destinations as China's imports have declined to virtually zero. Iranian sanctions by the US, the situation in Venezuela, and US-China trade wars will play a big role in US exports moving forward. The US supply growth is likely to be exported rather than displacing currently imported volumes.

- The LNG liquefaction market is the key player for ***natural gas*** exports. By the end of 2019, the US will have 6 operating terminals and near 10 Bcf/d of capacity. Additionally, over 40 Bcf/d and 20 terminals have been proposed in the US. However, Drillinginfo expects US LNG exports to reach 10 Bcf/d in 2023, as growth from non-US LNG export facilities drives global LNG prices down.

- For ***NGLs***, strong production growth is expected to continue. Export markets will continue to grow, as supply will outpace domestic demand. As additional infrastructure hits the market, ethane, propane, and butanes will grow export volumes. Pentanes plus domestic demand is expected to grow in the short term, due to bottleneck issues and production cuts in Canada.

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Crude Oil

US Oil Exports: Weekly Volumes

Every incremental barrel of production since the middle of 2016 has been exported.

The US-China trade disputes and sanctions have impacted export levels to China; however, the trend in increasing exports will continue, as domestic refineries are at optimal levels of light, sweet crude oil intake, barring further discounts.

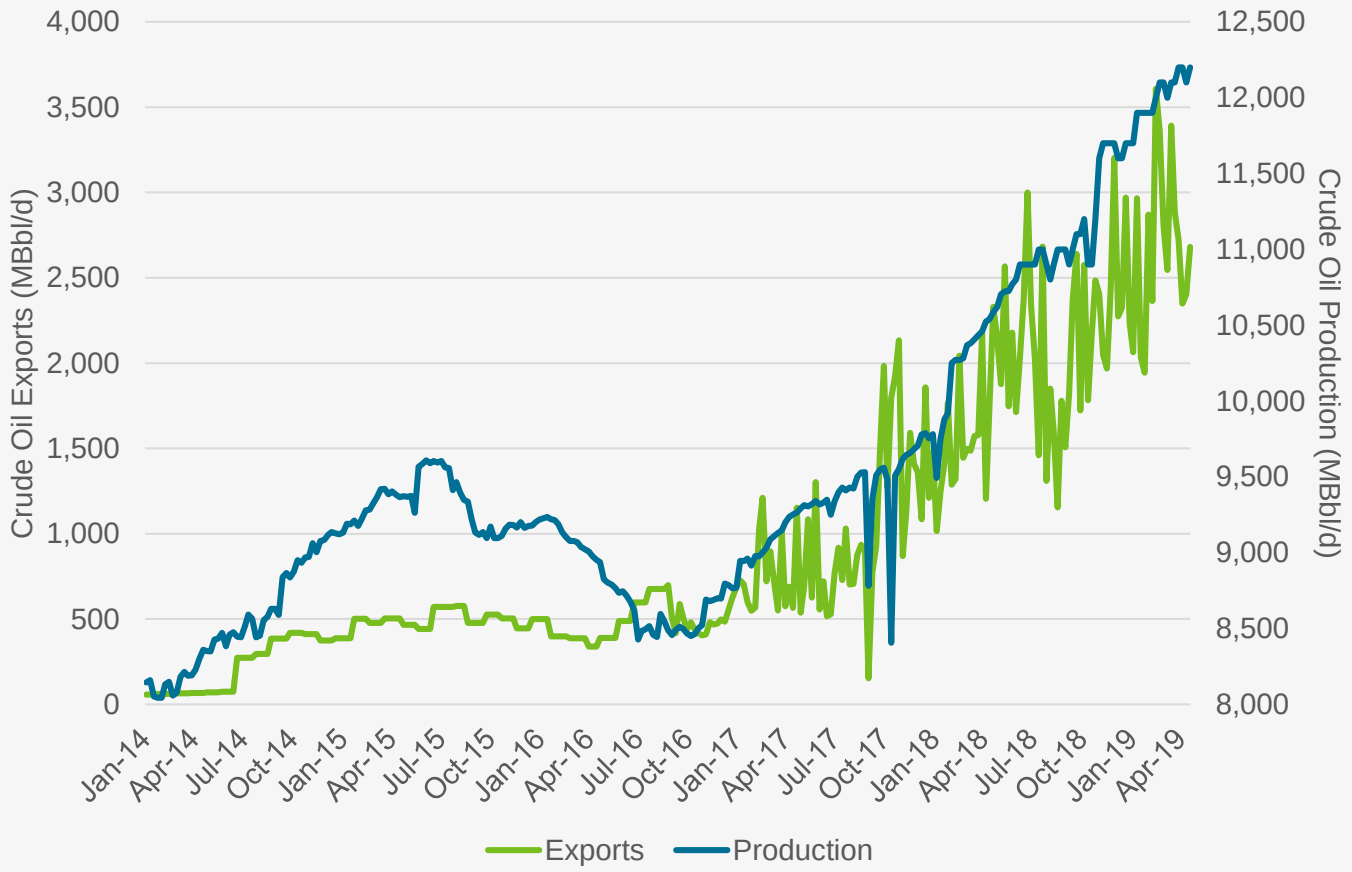
This means that a lot of infrastructure needs to be built to get the crude oil to the water to take it abroad.

According to the EIA's Weekly Petroleum Status Report, exports have been steadily increasing since early 2017.

This confirms that all incremental barrels that are being produced are being exported instead of pushing out more imported barrels.

CHART 2

US Oil Production and Exports



Source: EIA

2018 Export Dynamics Shifting

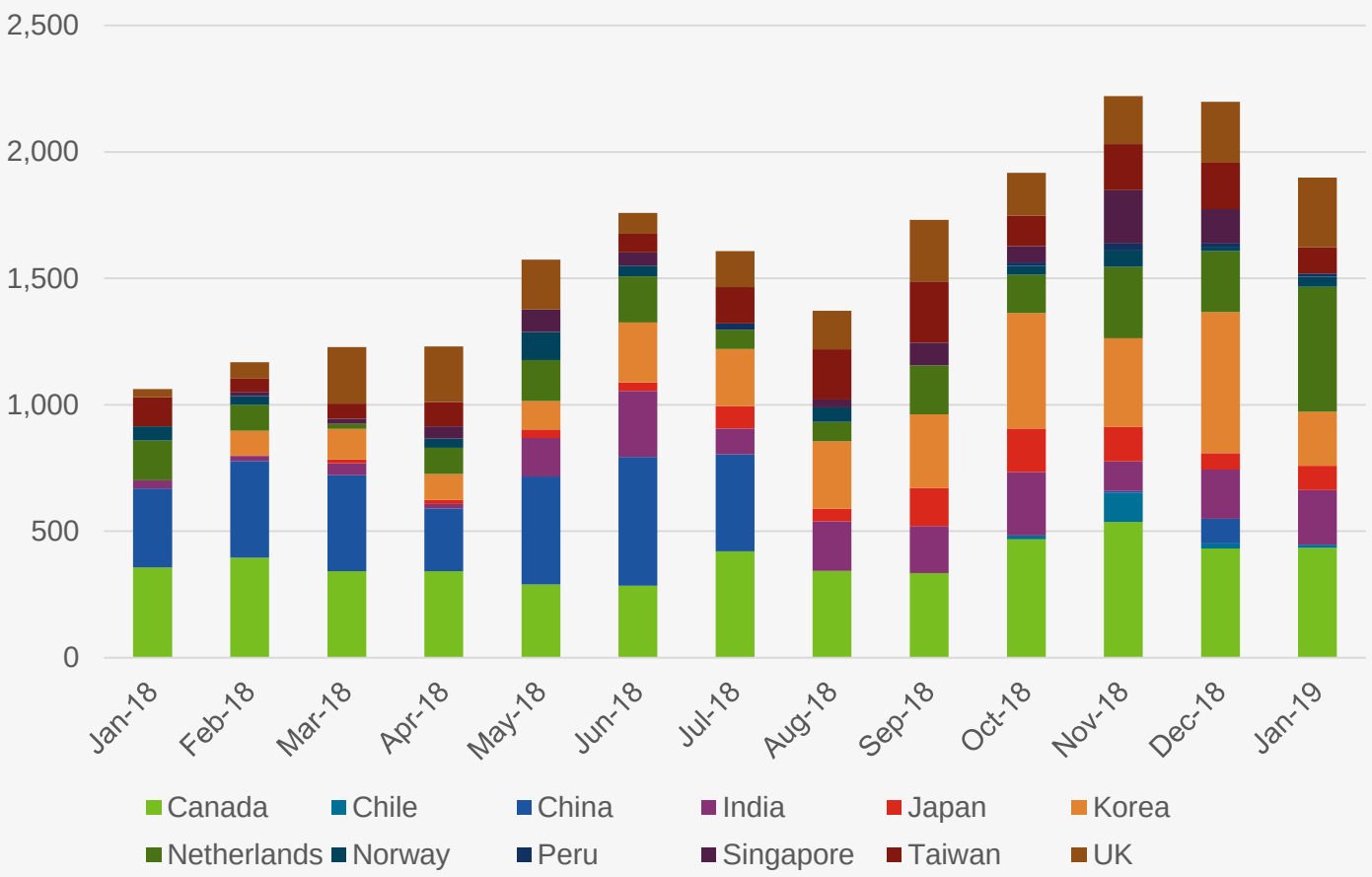
This chart illustrates how US exports are still increasing although exports to China and Venezuela have been lost due to trade wars and sanctions.

Ever since US imposed sanctions on Venezuela and China stopped importing US crude, some other countries have increased their imports from US. Some of these countries being India, Japan, Korea, Taiwan, Singapore, Chile, and Peru.

It will be interesting to see if US and China can ever reach an agreement and how China will react to US decisions on reducing Iranian imports to zero. If China increased their imports from US again, this will open up the possibility for even higher production from the US.

CHART 4

Export by Key Destinations



US Production and Exports Outlook

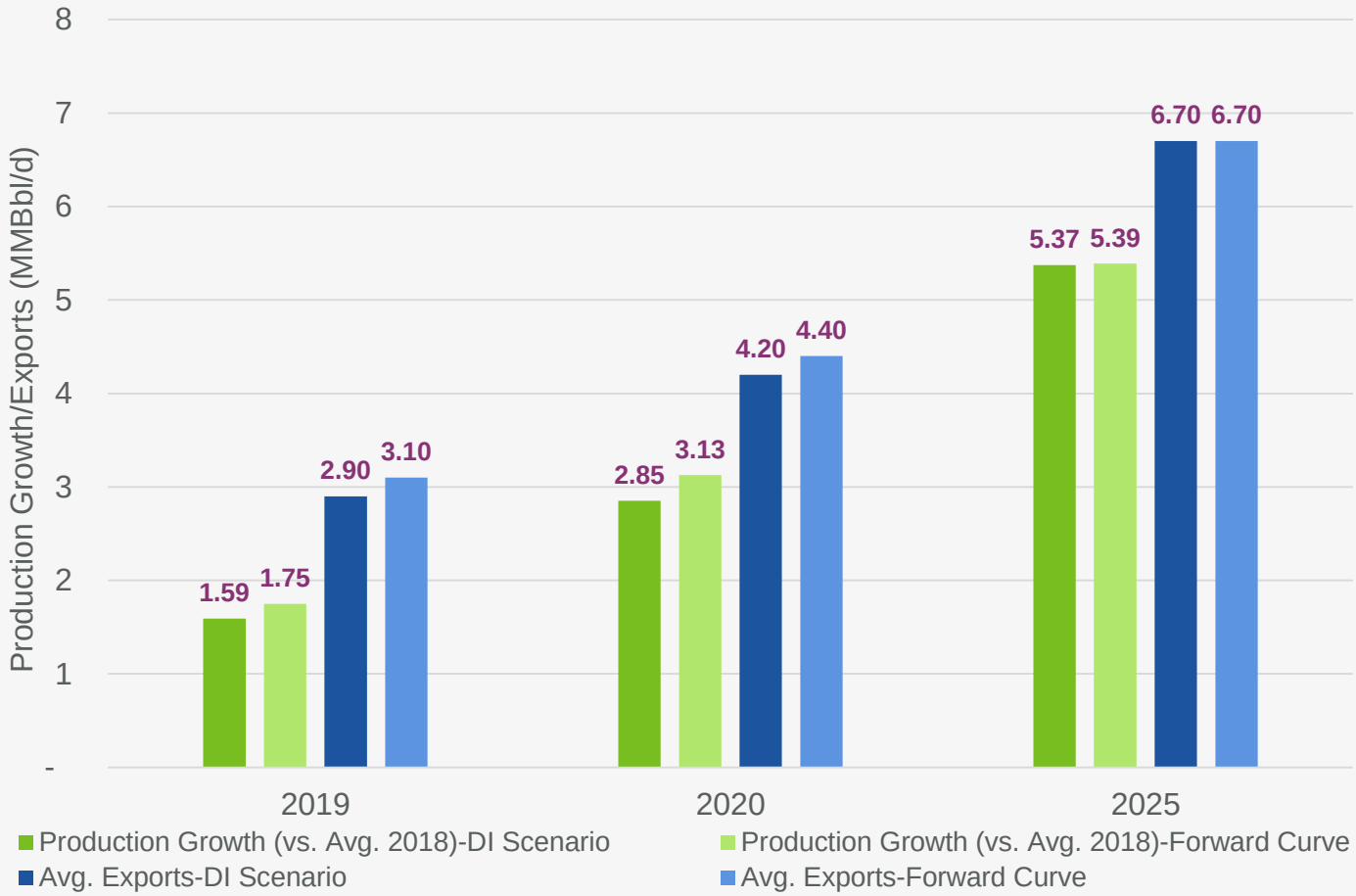
As US crude oil production grows, all incremental barrels are (and will continue to be) exported. The US production growth is largely in lighter crude oils, which will be the ones exported as they are a better fit in non-US refining fleets (see next slide).

To facilitate this rapid increase in exports, additional infrastructure will be necessary.

Most of this infrastructure will be built in Houston and Corpus Christi. Corpus Christi is expected to be the leading point of export moving forward, thanks to its proximity to the Permian & Eagle Ford basins and a less congested port.

CHART 5

Crude Oil Production Growth and Exports Forecast



** Forward Curve as of 4-23-2019*

Source: DI ProdCast and Analysis

Crude Exports – Base Case

CHART 6

Crude Oil Exports by Quality

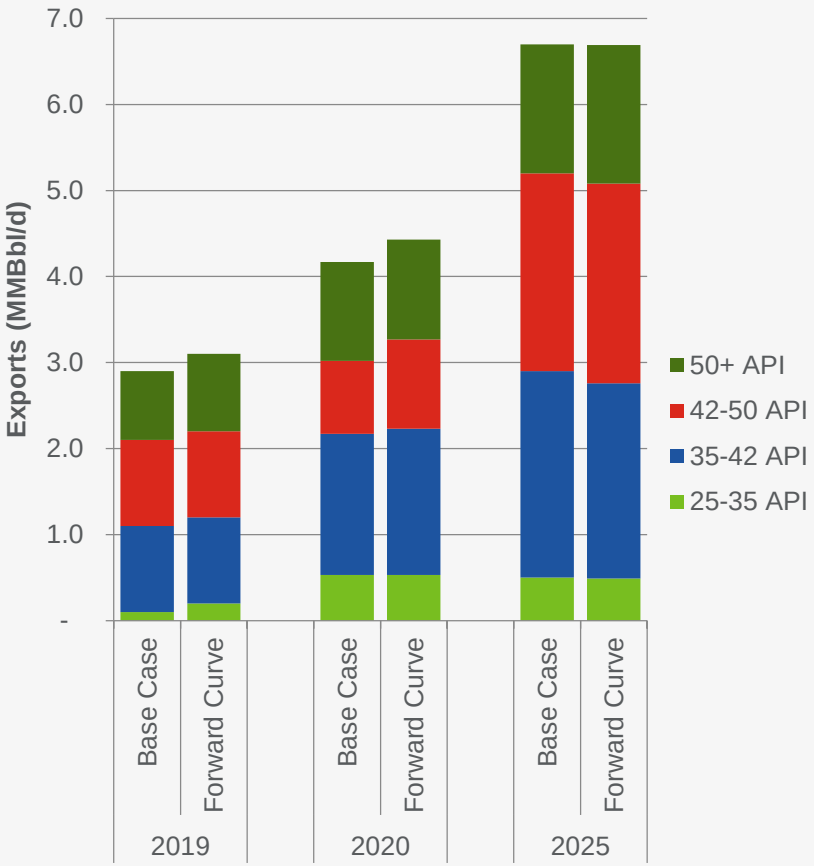
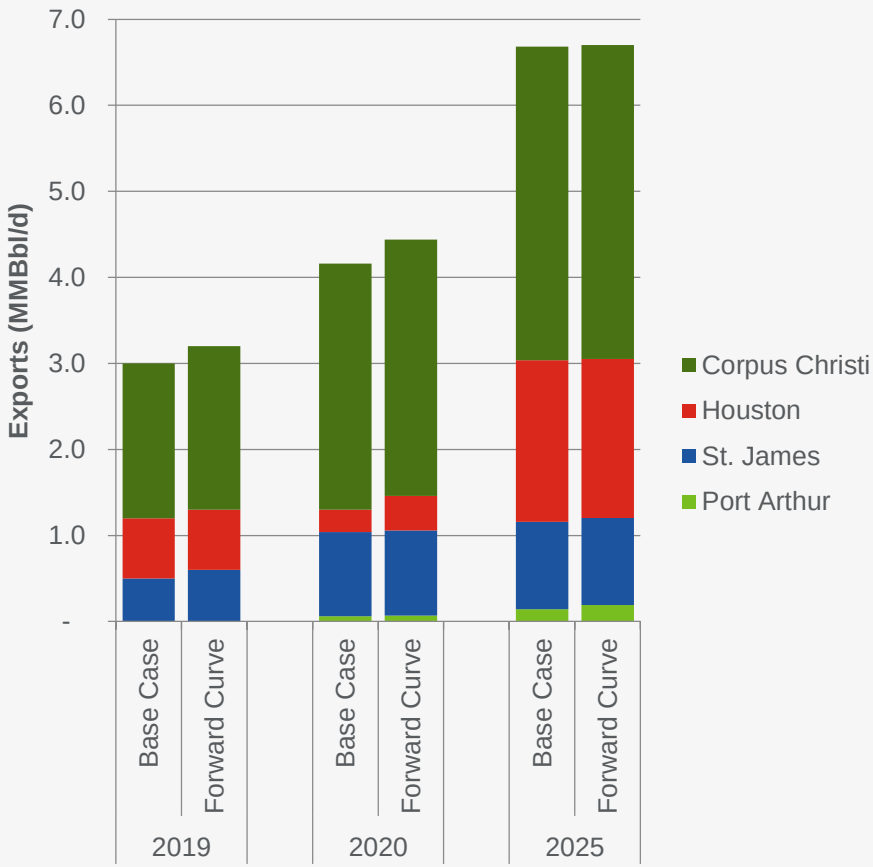


CHART 7

Crude Oil Exports by Export Hub



** Forward Curve as of 4-23-2019*

Source: DI OptiFlo-Crude, Analysis

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Natural Gas

LNG Exports Will Set Total US Exports of Natural Gas

As natural gas production continues to grow faster than domestic demand, more gas is finding a final destination outside of the US.

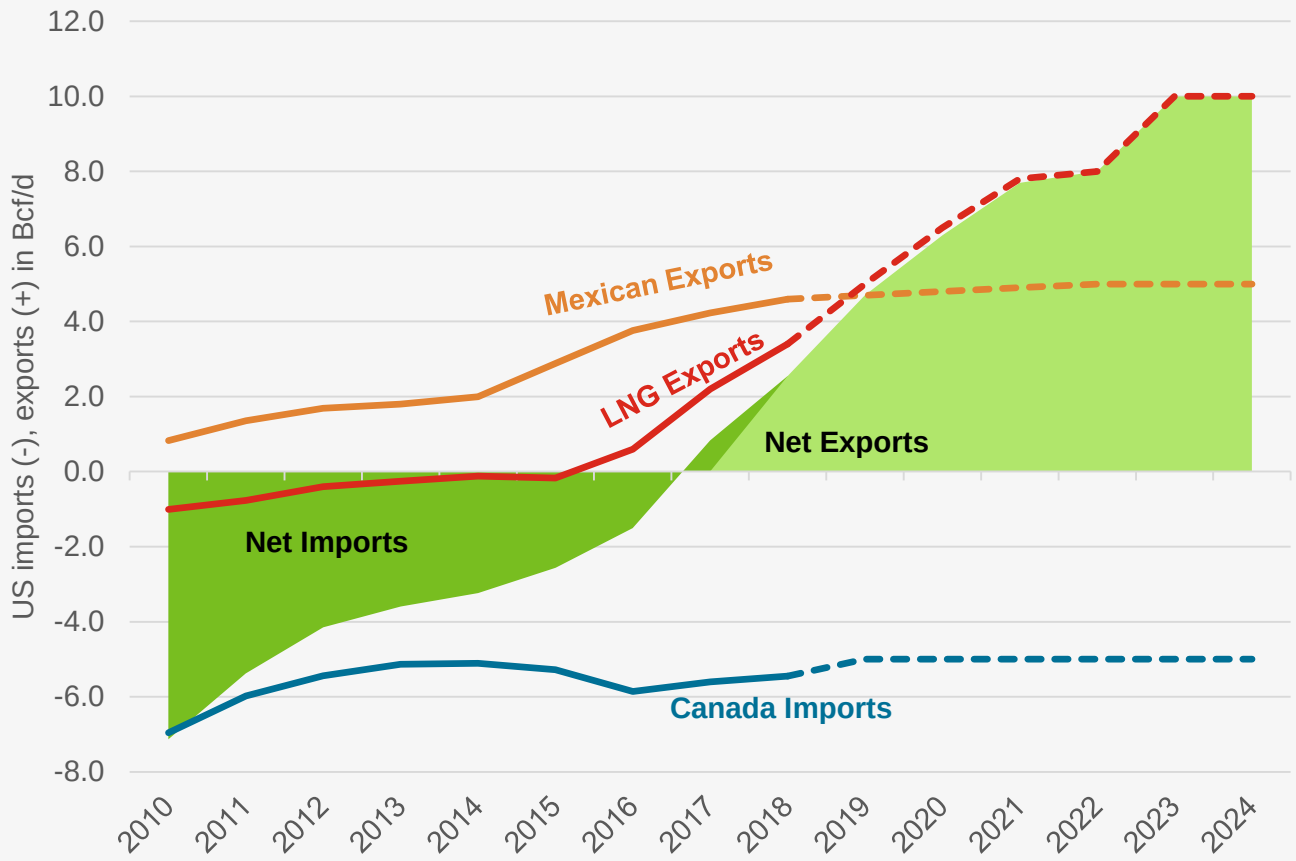
In early 2017, the US became a net exporter of natural gas for the first time. During 2018, net exports reached an average of 2.5 Bcf/d in 2018.

Over the next 5 years, Canadian imports and Mexican exports will each represent 5 Bcf/d, netting zero imports/exports. Therefore, the amount of LNG exports will equal total net exports in the US.

By 2024, the US is expected to net export ~10 Bcf/d of natural gas. This is the level of LNG exports expected that year.

CHART 8

Natural Gas Net Exports



Source: EIA, DI Analysis

LNG Exports To-Date

The US has 3 operational terminals: Sabine Pass (Trains 1-4), Cove Point and Corpus Christi (Train 1). These terminals have a combined liquefaction capacity of 5 Bcf/d. As shown in Chart 9, daily export volumes have surpassed this capacity level; this is due to commissioning/testing volumes on Sabine Pass Train 5, Corpus Christi Train 2, Cameron, and Freeport.

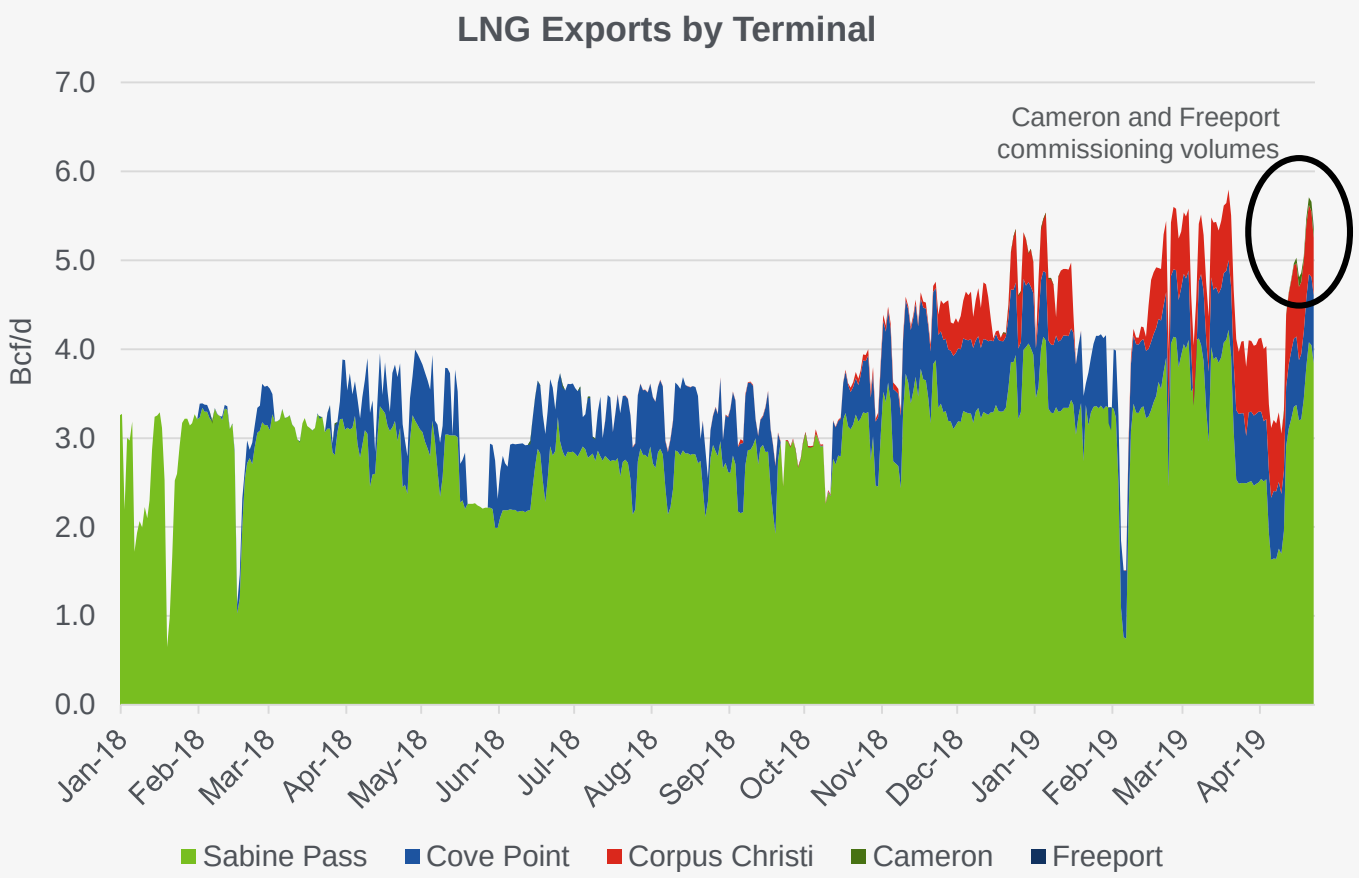
This year will be a busy one for the LNG export market as 3 new facilities are expected to come online: Elba Island, Cameron LNG, and Freeport LNG. Additionally, currently operating terminals will be increasing their capacity with added trains: Sabine Pass and Corpus Christi.

Recent news:

- *Cameron LNG began pipeline feed gas flow in Mid-April.*
- *Elba Island Train 1 has a set date of May 1 to begin operations.*
- *Freeport LNG is expecting its first commissioning cargo on July 25th.*
- *Golden Pass to begin construction after receiving final investment decision in February.*

CHART 9

LNG Exports - Historical Activity



Source: DI Pipeline Flow Data

All Proposed LNG Export Capacity

Drillinginfo's 5-year forecast for LNG exports includes only projects currently under construction.

Additionally, there are 4 projects already approved but not under construction and many others announced.

In total, there is currently about 43 Bcf/d of LNG liquefaction capacity that could be brought online over the next 10 years.

Recently Announced Projects (FERC Pre-filled)

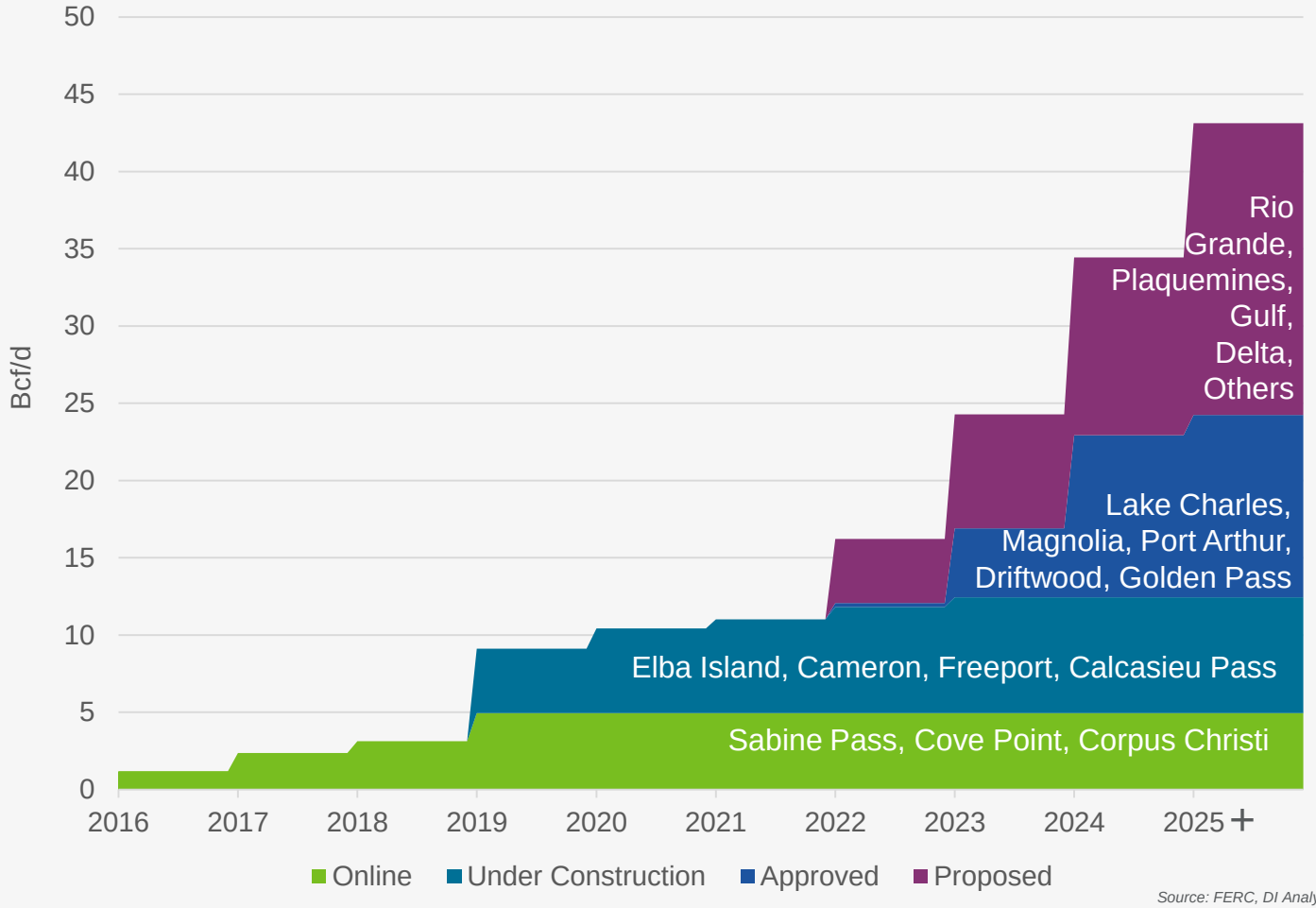
Aug2018: Galveston Bay LNG (1.2 Bcf/d), owned by Next Decade.

Sept2018: Pointe LNG (0.9 Bcf/d), with an estimated in-service date of 2Q 2025. Located in Plaquemines Parish, LA.

April2019: Delta LNG (2.6 Bcf/d), by Venture Global. It will include a pipeline (Delta Express), which will run from Perryville, LA, to the terminal in Plaquemines Parish, LA. The project could start operating by November 2024.

CHART 11

All Proposed LNG Export Capacity



Source: FERC, DI Analysis

Mexico Supply: Production VS. Imports

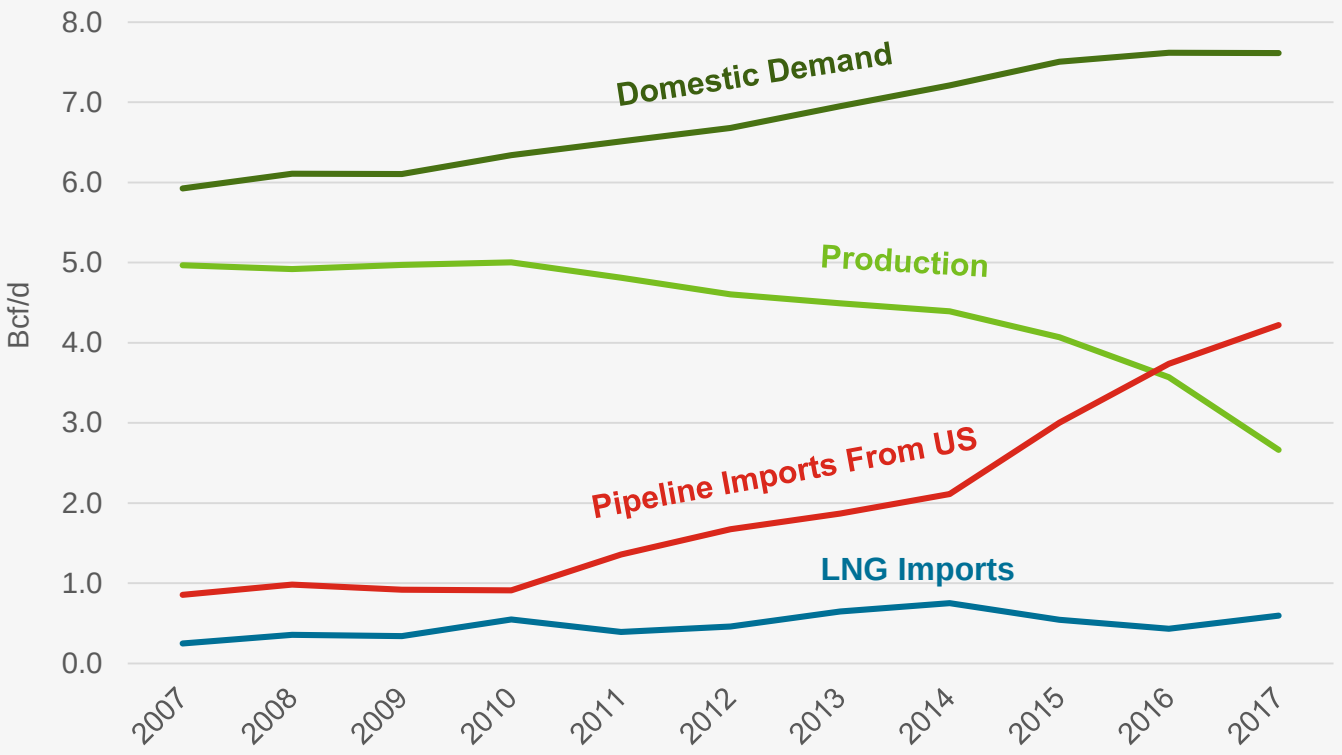
Production of natural gas in Mexico started to decline back in 2010, dropping 1.95 Bcf/d by 2017.

Mexico is able to import via LNG through 3 currently operating terminals: Altamira, Ensenada, and Manzanillo. However, LNG imports have remained relatively flat at 0.5 Bcf/d. Instead, Mexico has chosen to import gas from the US to take advantage of low-cost commodity prices on the other side of the border.

As shown in Chart 12, imports via pipeline from the US have increased 3.3 Bcf/d, which is higher than the decline in production during the same timeframe (2017 VS. 2010). The additional supply from imports has been serving growing demand, mostly from the power sector.

CHART 12

Mexico Supply by Source



Source: SENER

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NGLs

Ethane Exports by Origin and Destination

Historically, pipeline to Canada was the only source for exporting ethane. Until 2016, the Williston and Utica basins accounted for all of the ethane exports, sending it north to Canada via the Mariner West and Vantage pipelines.

In 2016, Marcus Hook and Morgan's Point went into service, adding waterborne exports out of the Northeast and the Gulf Coast. Utopia East came to market in January '18, adding another 50 MBbl/d of export capacity from the Northeast to Canada.

Ethane exports will continue to grow as infrastructure hits the market. Orbit Gulf Coast Terminal is expected to come online in 4Q'20, adding ~150 MBbl/d of additional ethane export capacity. The next project after Orbit slated to hit the market is from American Ethane. They have announced an ethane export terminal in Beaumont, TX. Export capacity at the terminal is expected to be 480 MBbl/d, nearly doubling total ethane export capacity when it hits the market.

CHART 14

Ethane Exports by US Region

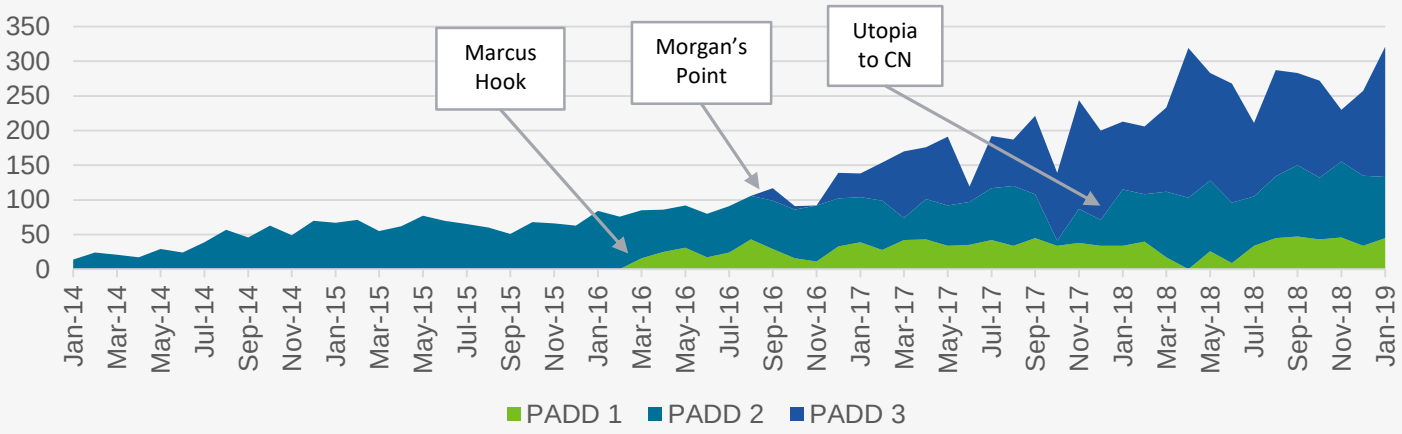
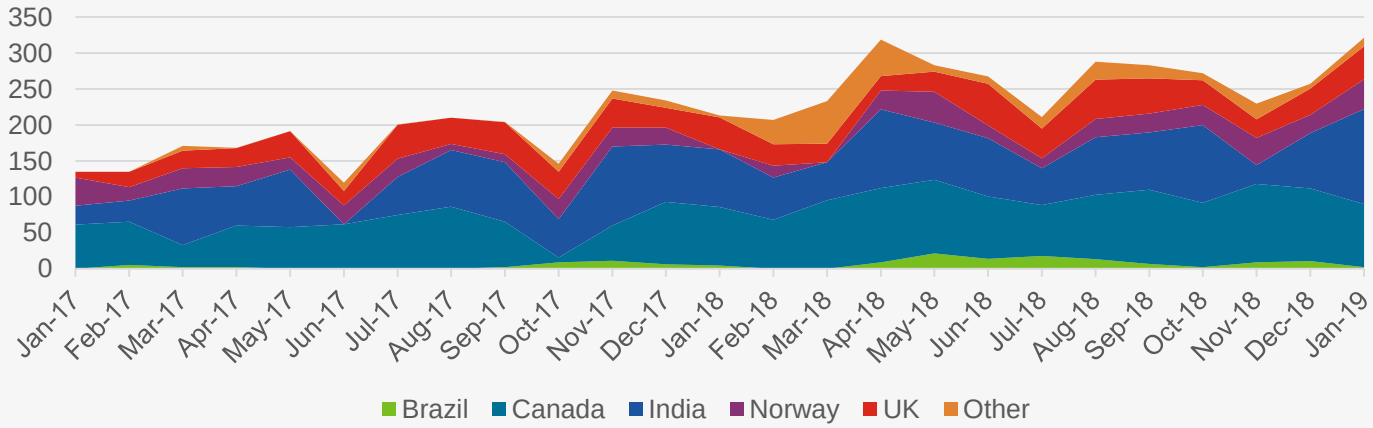


CHART 15

Ethane Exports by Destination



Source: EIA, Hodson

LPG Exports by Origin and Destination

US LPGs are primarily exported from the Gulf Coast. However, additional capacity from ME2 and ME2X will continue to bring export capabilities to the Northeast.

ME2 is currently partially in service, and is expected to be fully complete later this year. ME2X is also expected to come online by the end of 2019. Both pipelines transport liquids to the Marcus Hook terminal.

Propane stocks are currently sitting above the 5-year average, keeping a lid on propane prices.

With stocks above the 5-year average and prices favorable, exports are expected to grow in 2019. Currently, nearly 50% of exports go to Asia to meet their high-demand market.

CHART 16

LPG Exports by US Region (MBbl/d)

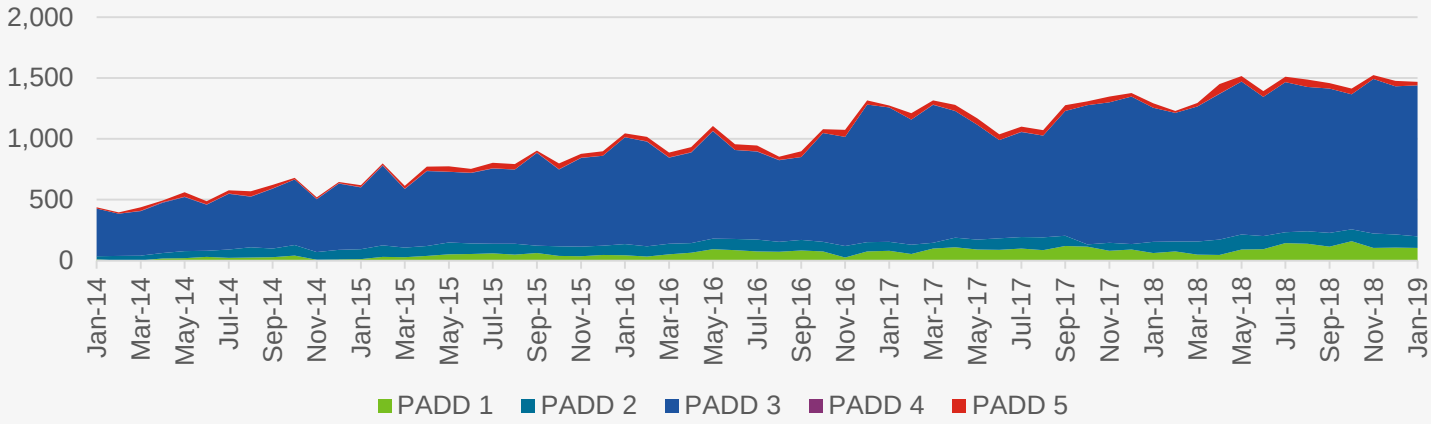


CHART 17

Propane Stocks (MBbl)

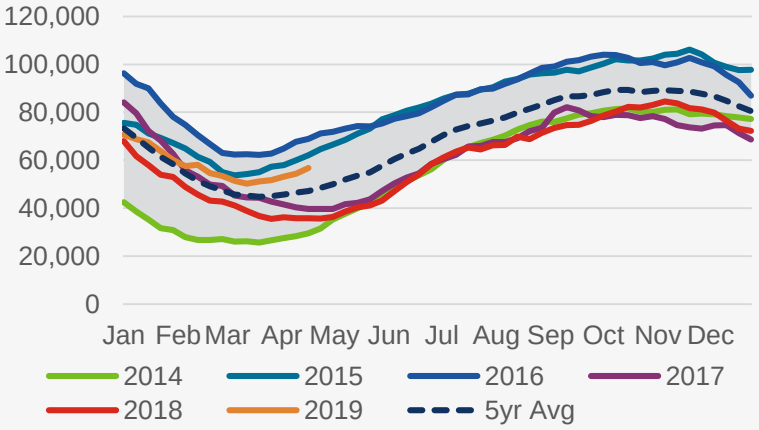
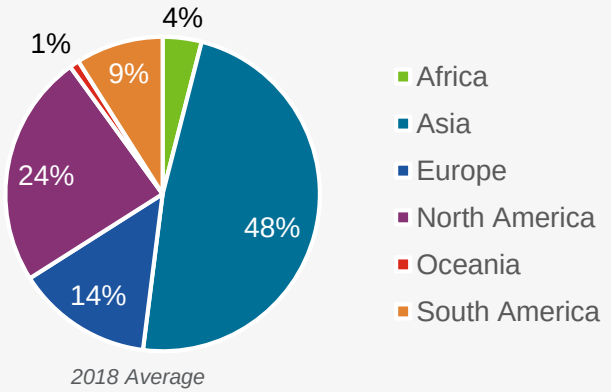


CHART 18

LPG Exports by Destination



2018 Average

Source: EIA

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CASE STUDY:
IMO 2020 – Potential Impacts and Coker Refinery

IMO 2020 Case Study With OptiFlo-Crude

On January 1, 2020, the global shipping industry will undergo a radical change, with all ships having to reduce the sulfur content within marine fuels from 3.5% to 0.5%, as mandated by the International Maritime Organization (IMO).

Marine fuel provides a valuable outlet for refineries as it has the highest sulfur content specification out of the major refinery products. Furthermore, the markets for light-sulfur fuel oil and other relatively high-sulfur products are small compared to that of 3.5% bunker fuel (Chart 24) so as the new specification takes effect there will not be another "release valve" for high-sulfur fractions above the 0.5% threshold.

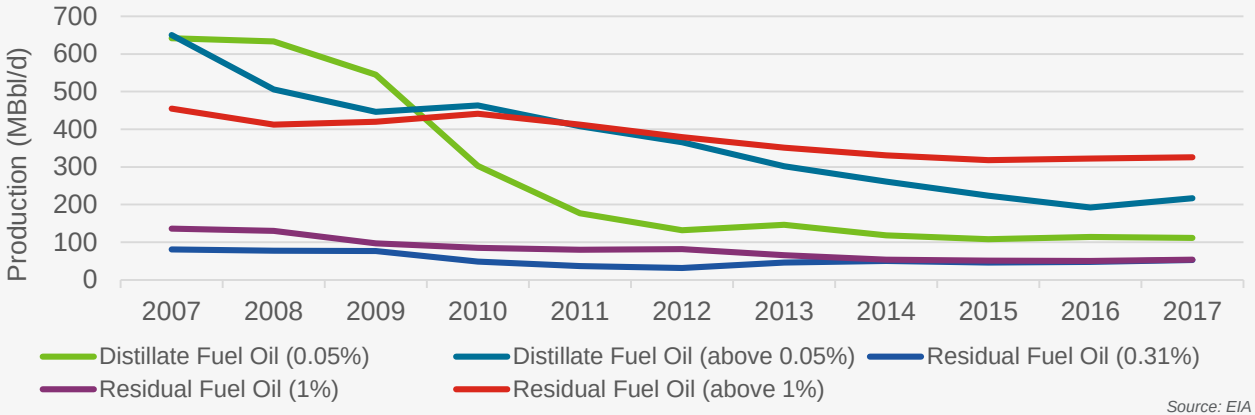
In this case study, Drillinginfo uses a refinery optimization model to look at the potential effects of this regulation for a single complex refinery with a delayed coking unit.

The most standard refinery processing unit is an atmospheric distillation unit (ADU), which splits crude oil into the gases, naphthas, kerosene, gas oils, and residues that it consists of. The yields of these fractions, expressed as a percentage of the crude oil input, and their physical properties, including sulfur content among others, can vary greatly between different crude oil assays.

In this case we are interested in a heavy assay, the type that is often refined in the US Gulf Coast, because the ability to process this type of crude gives complex coking refineries their advantage in the market. The yields of a standard Western Canadian Select (WCS) assay are illustrated in Chart 25.

CHART 24

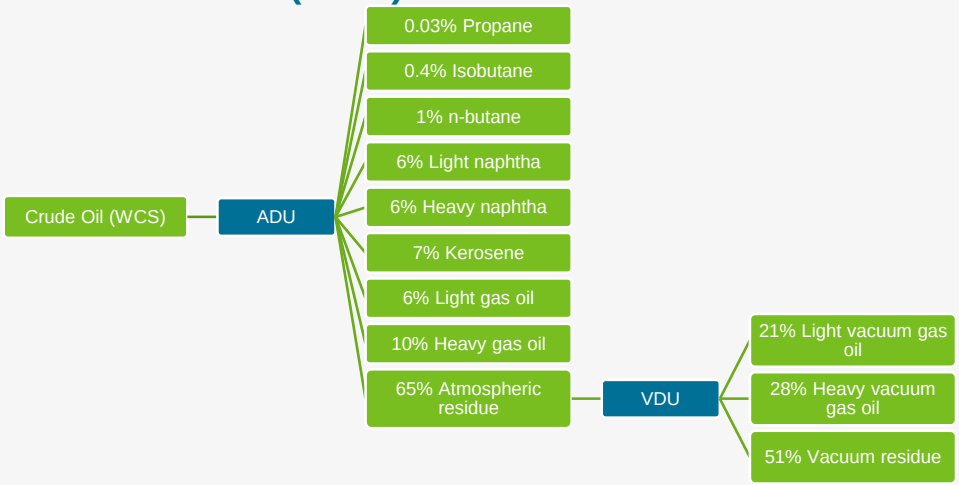
US Refinery Production of High-Sulfur Fuel Oils (EIA)



Source: EIA

CHART 25

ADU/VDU Fraction Yields (Wt.%) for a Standard WCS Crude Oil Assay



IMO 2020 Case Study With OptiFlo-Crude

After the fractions exit the ADU, their path through various refinery units is anything but standard. The flows of these fractions through the refinery depend not only on the available processing units and their capacities, but also on product specifications and prices, as the refiner will decide how much of each fraction to send into each unit in order to maximize profit. This type of problem – maximizing a profit objective subject to operational constraints – is the perfect application for linear and nonlinear programming.

In the base case scenario, the selected refinery's operations are optimized given today's 3.5% maximum sulfur specification for bunker fuel. The past 12-month average prices for end products are used as inputs. Figure 26 illustrates the basic flow diagram for this refinery, from the ADU into the other units.

The optimal product outputs for this refinery are displayed in Table 2. On a volume basis, the outputs are 42% diesel, 35% gasoline, 8% jet fuel, and a combined 15% for all other products.

CHART 26

Basic Flow Diagram for Selected Refinery

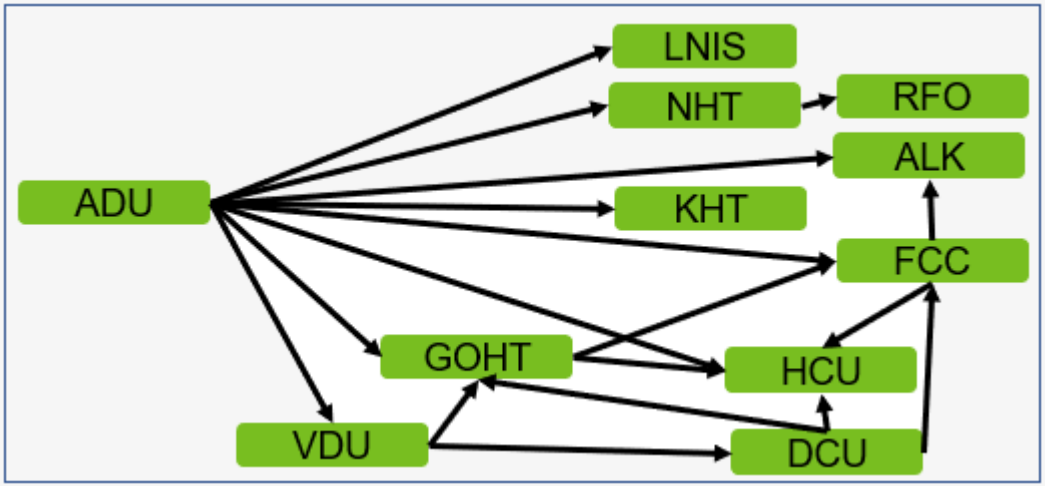


TABLE 2

Selected Refinery Production – Base Case

Product	Production Weight (Mkg/d)	Production Volume (MBbl/d)
Refinery gas	1.8	--
LPG	2.3	29.0
Gasoline	17.3	149.1
Ultra low-sulfur diesel	20.7	148.7
Jet fuel	3.9	30.0
Light-sulfur fuel oil (1%)	0.5	3.5
Bunker fuel (3.5%)	1.1	7.2
Coke	1.7	--
Waste/resid	0	--

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Thank you!

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