Increased Global NGL and LNG Demand – How Appalachia Is Benefitting

Gas Processors Association Midstream 3rd Annual Appalachian Basin Regional Conference

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Welcome to the 3rd Annual ABGPA Annual Conference …

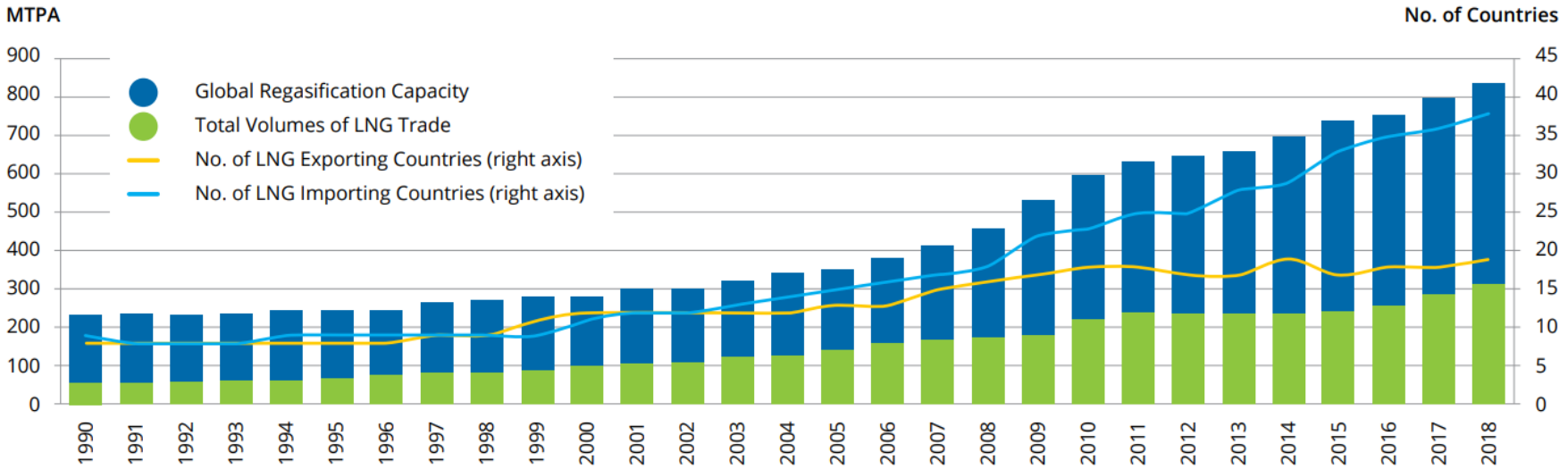
- Todays topic is *Increased Global NGL and LNG Demand – How Appalachia Is Benefitting*
- Howard Murphy, Director of Energy Services, Earthres Group, Inc., Morgantown, WV
- EARTHRES provides engineering and consulting services in Mining, Solid Waste, Commercial/Institutional/Industrial, and Energy
- Energy services are in the Upstream, Midstream, and Downstream with a focus on natural gas gathering, transmission, processing, NGLs and LNG

Demand for NGLs and LNG

- Has global demand for NGLs and LNG actually increased?
- The numbers tell the story –
  - LNG trade volume increased 9.8% from 2017 to 2018, with 2018 totaling 316.5MT (Million Tonnes)
  - In 2018 new liquefaction plants came on line in Australia, Russia, and the U.S.
  - 2018 import growth was dominated by China and South Korea
  - Panama and Bangladesh began importing in 2018

Demand for LNG

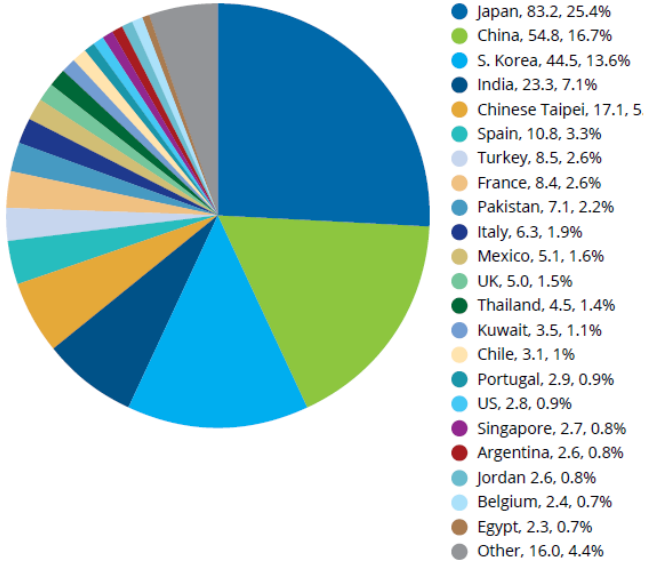
LNG Trade Volume – 1990 to 2018



SOURCE: IGU World LNG – 2019 Edition Report

Demand for LNG – Who is Importing?

2018 LNG Imports and Market Share



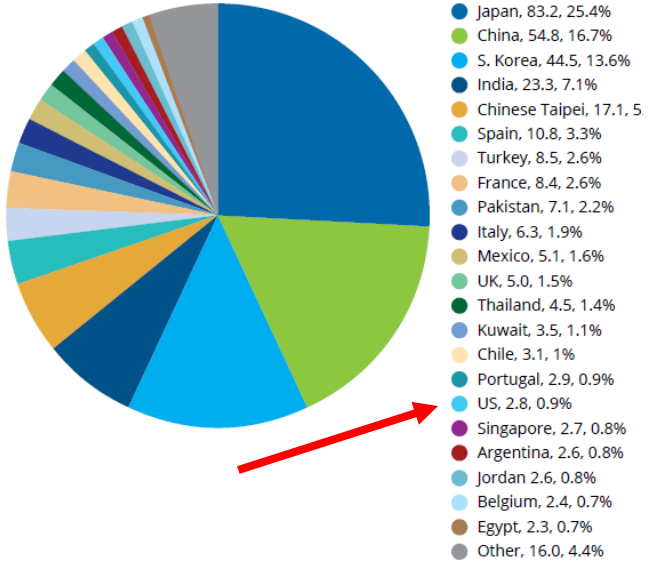
Note: Number legend represents total imports in MT, followed by market share %. "Other" includes markets with imports less than 2.0 MT (by order of size): Poland, the Netherlands, Brazil, Malaysia, the Dominican Republic, the United Arab Emirates, Greece, Bangladesh, Lithuania, Israel, Canada, Malta, Jamaica, and Colombia.

SOURCE: IGU World LNG – 2019 Edition Report

Demand for LNG – Who is Importing?

2018 LNG Imports and Market Share

… note the U.S. import of 2.8 MT



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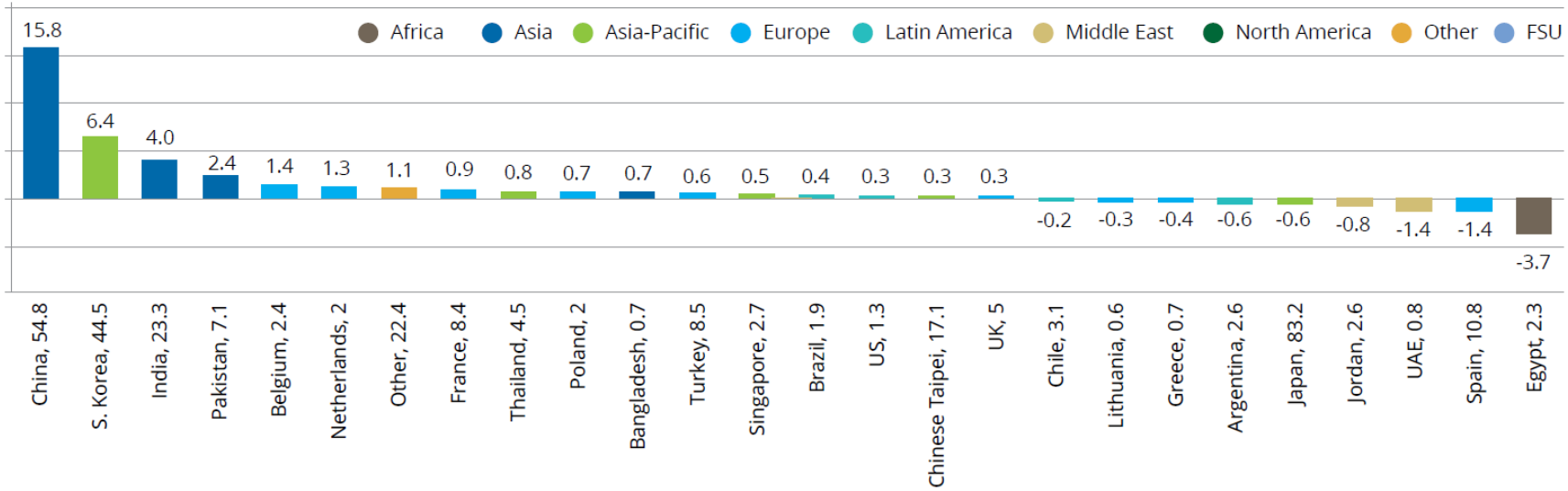
SOURCE: IGU World LNG – 2019 Edition Report

Demand for LNG – Whose Imports are Growing?

2018 Incremental Annual Increase in LNG Imports

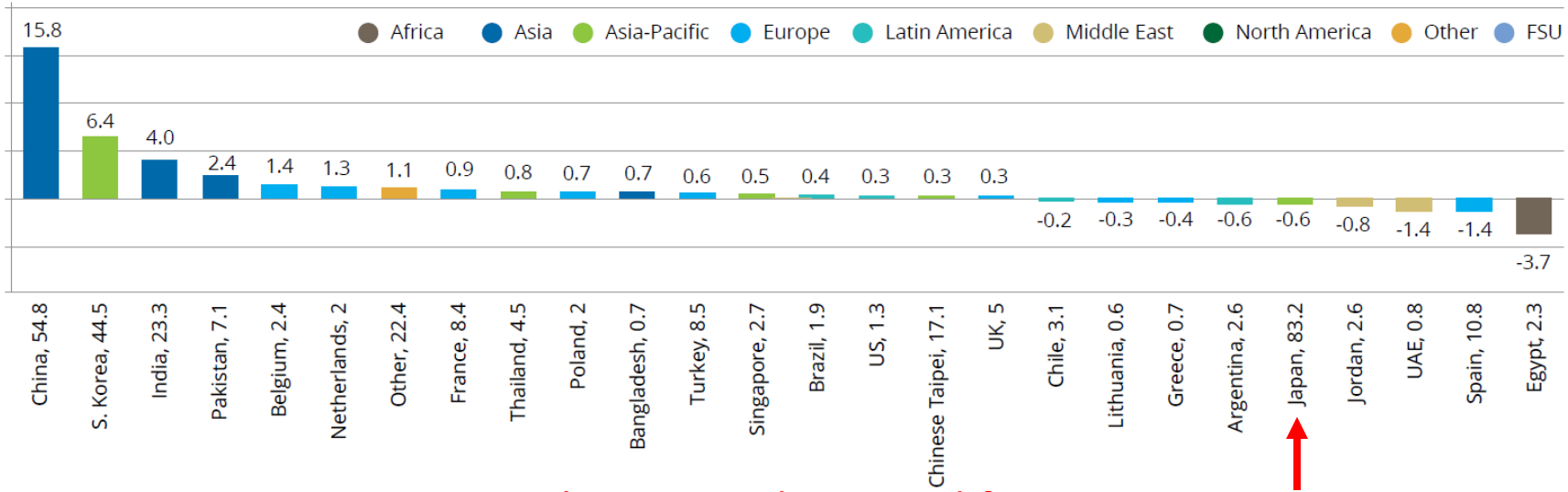


Note: "Other" includes markets with incremental imports of less than ±0.2 MT: Malaysia, Italy, Mexico, Kuwait, Portugal, the Dominican Republic, Malta, Panama, Israel, Canada, Jamaica, and Colombia.

SOURCE: IGU World LNG – 2019 Edition Report

Demand for LNG – Whose Imports are Growing?

2018 Incremental Annual Increase in LNG Imports



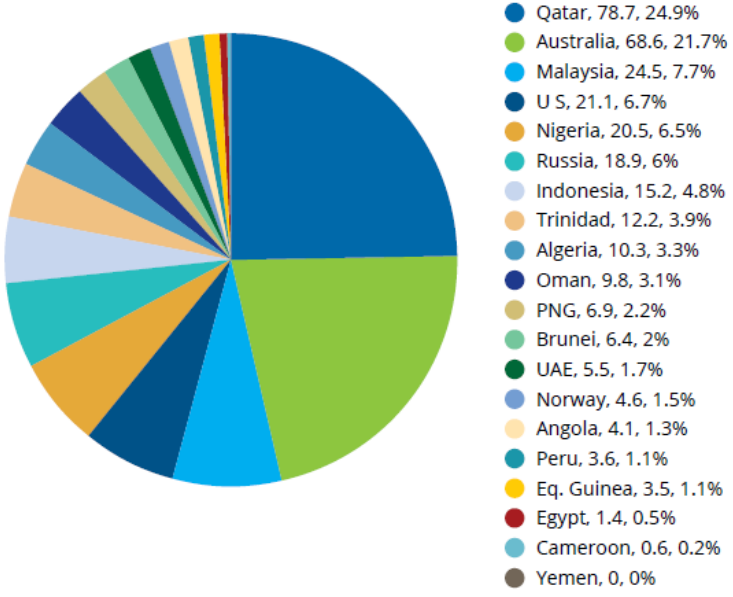
Note that Japan decreased from 2017 to 2018

Note: "Other" includes markets with incremental imports of less than ±0.2 MT: Malaysia, Italy, Mexico, Kuwait, Portugal, the Dominican Republic, Malta, Panama, Israel, Canada, Jamaica, and Colombia.

SOURCE: IGU World LNG – 2019 Edition Report

Demand for LNG – Who is Exporting?

LNG 2018 Exports and Market Share



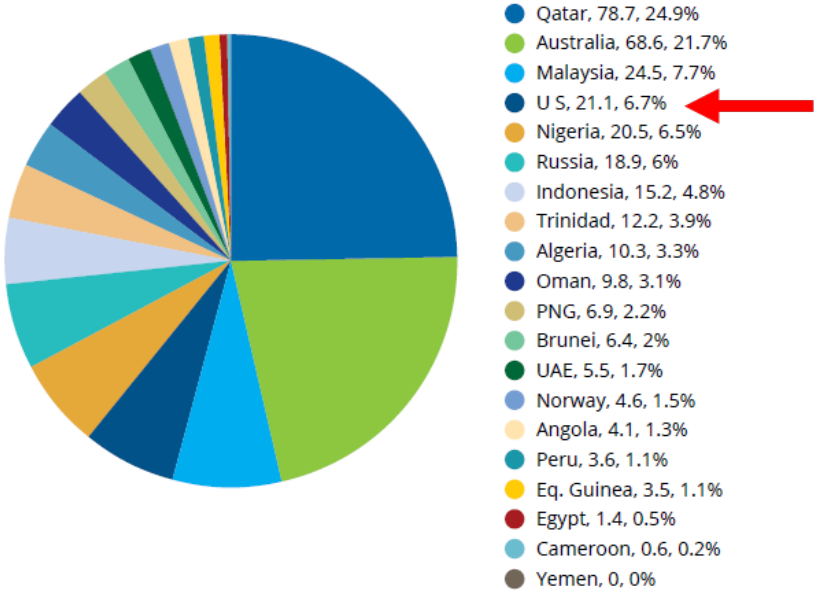
Note: Numbers in the legend represent total 2018 exports in MT, followed by market share.

SOURCE: IGU World LNG – 2019 Edition Report

Demand for LNG – Who is Exporting?

LNG 2018 Exports and Market Share

- In 2009 the U.S. was near the bottom of this list
- 21.1 MTPA is approximately 2.77 BCF/D



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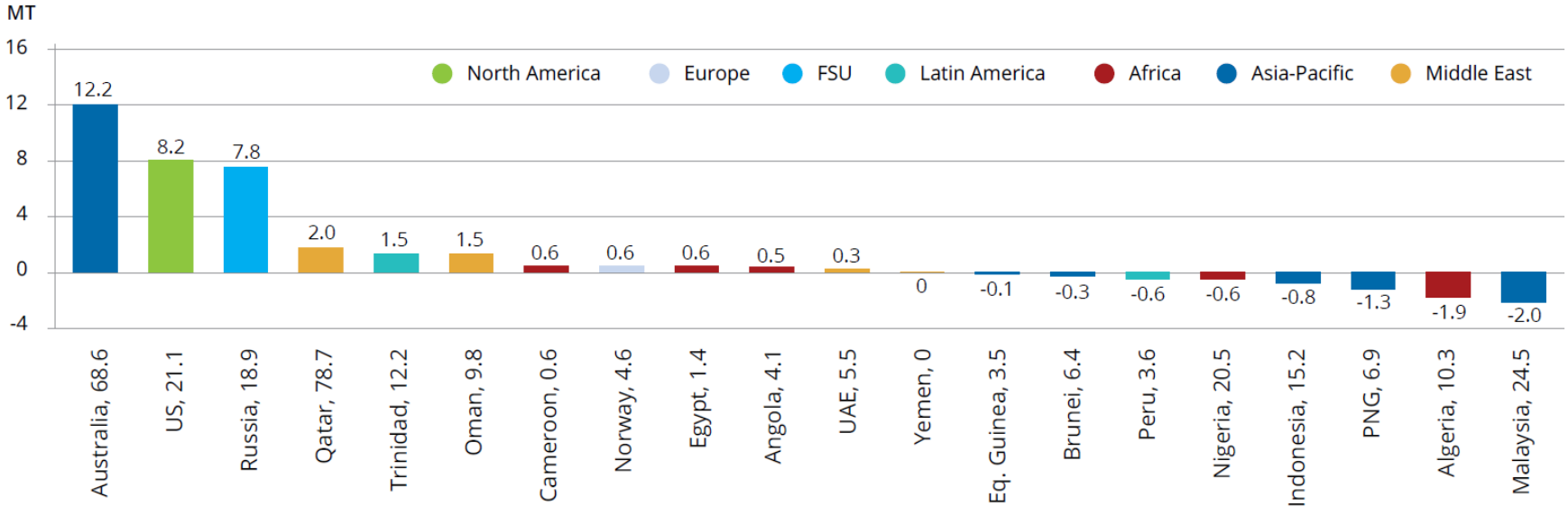
Demand for LNG – Whose Exports are Growing?

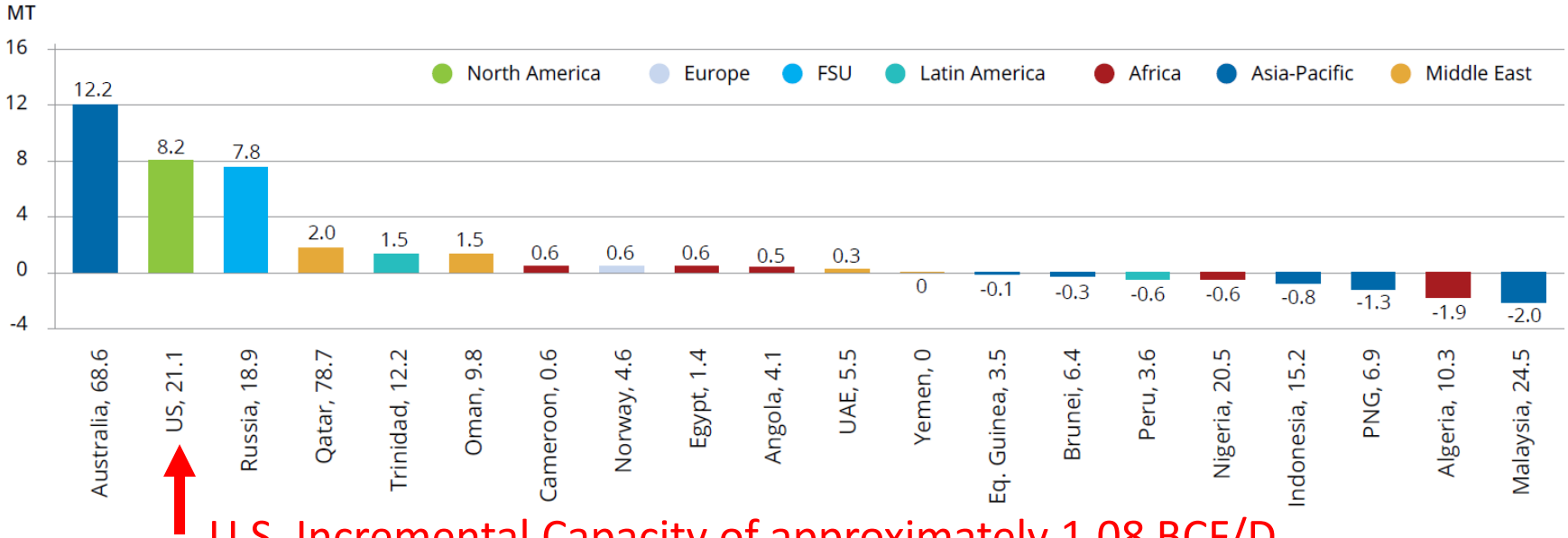
2018 Incremental Annual Increase in LNG Exports



SOURCE: IGU World LNG – 2019 Edition Report

Demand for LNG – Whose Exports are Growing?

2018 Incremental Annual Increase in LNG Exports



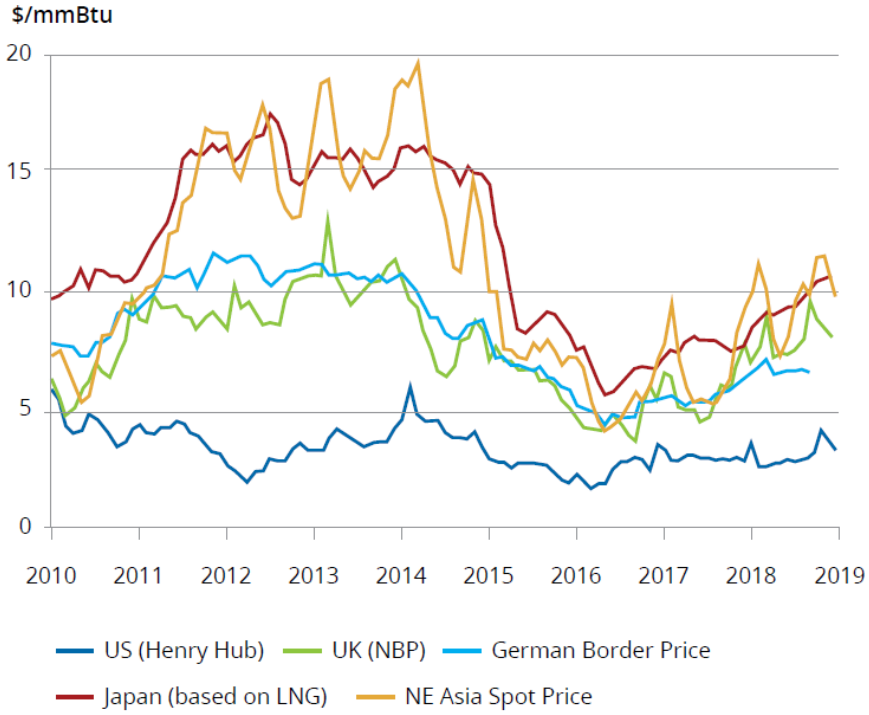
U.S. Incremental Capacity of approximately 1.08 BCF/D

SOURCE: IGU World LNG – 2019 Edition Report

Demand for LNG – Is LNG Pricing Driving Demand?

Monthly Average LNG Regional Prices

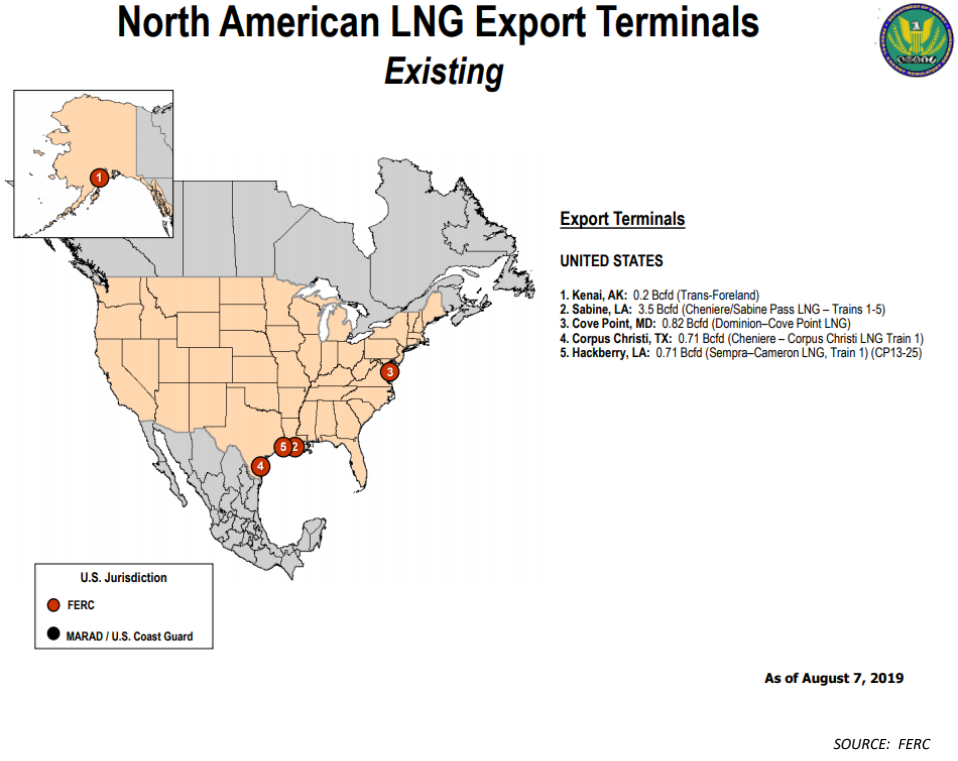
- Note the volatility in the curves
- Note the absolute value of the LNG pricing relative to Henry Hub
- In todays pricing environment, in areas where gas can be delivered by pipeline LNG is typically not competitive



SOURCE: IGU World LNG – 2019 Edition Report

U.S. LNG for Export – Where is it Produced?

- Kenai, AK began operations as an export terminal in the late 1960s
- In the current wave of projects, Sabine was the first export terminal to enter service – in February, 2016
- Cove Point began import-only operations in the late 1970s, added export capability in 2018
- Cove Point supply is principally from the Appalachian Basin



SOURCE: FERC

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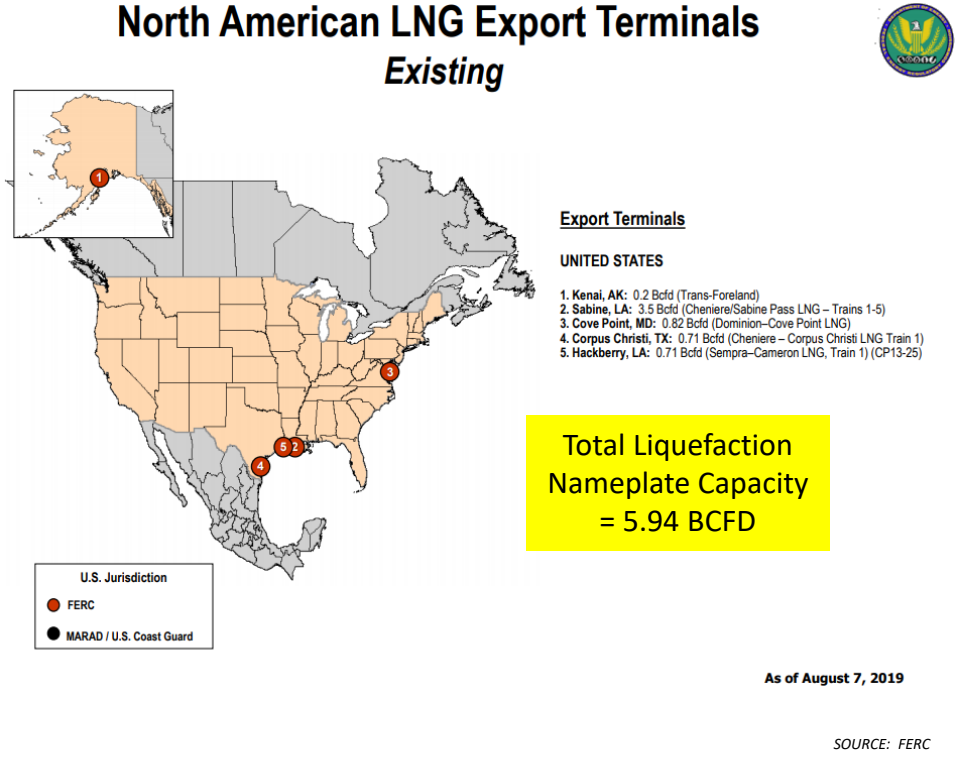
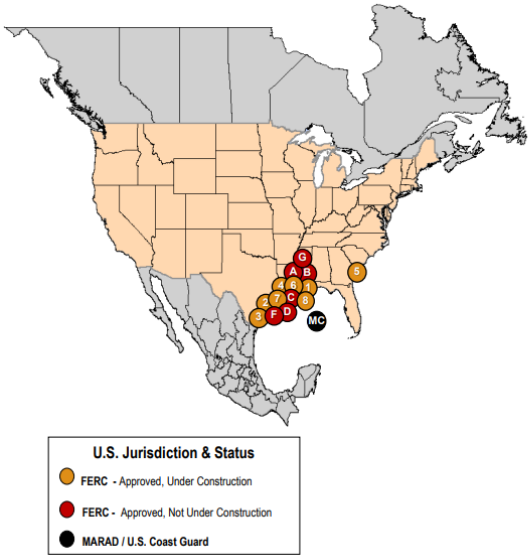


U.S. LNG for Export – Where is it Produced?

- Elba Island and Lake Charles began operations in the late 1970s as an import only terminal, adding or plan to add export capability
- Total Approved Liquefaction Nameplate Capacity = 24.10 BCFD; 13.53 BCFD under construction, 10.57 BCFD not under construction
- Supply principally from Appalachian and mid-continent Basins

North American LNG Export Terminals
Approved, Not Yet Built



Export Terminals

UNITED STATES

APPROVED - UNDER CONSTRUCTION - FERC

1. **Hackberry, LA:** 1.43 Bcfd (Sempra–Cameron LNG, Trains 2 & 3) (CP13-25)
2. **Freeport, TX:** 2.14 Bcfd (Freeport LNG Dev/Freeport LNG Expansion/FLNG Liquefaction) (CP12-509) (CP15-518)
3. **Corpus Christi, TX:** 1.4 Bcfd (Cheniere – Corpus Christi LNG Trains 2 & 3) (CP12-507)
4. **Sabine Pass, LA:** 0.7 Bcfd Train 6 (Sabine Pass Liquefaction) (CP13-552)
5. **Elba Island, GA:** 0.35 Bcfd (Southern LNG Company) (CP14-103)
6. **Cameron Parish, LA:** 1.41 Bcfd (Venture Global Calcasieu Pass) (CP15-550)
7. **Sabine Pass, TX:** 2.1 Bcfd (ExxonMobil – Golden Pass) (CP14-517)
8. **Calcasieu Parish, LA:** 4.0 Bcfd (Driftwood LNG) (CP17-117)

APPROVED – NOT UNDER CONSTRUCTION - FERC

A. **Lake Charles, LA:** 2.2 Bcfd (Southern Union – Lake Charles LNG) (CP14-120)
B. **Lake Charles, LA:** 1.08 Bcfd (Magnolia LNG) (CP14-347)
C. **Hackberry, LA:** 1.41 Bcfd (Sempra - Cameron LNG) (CP15-560)
D. **Port Arthur, TX:** 1.86 Bcfd (Port Arthur LNG Trains 1 & 2) (CP17-20)
F. **Freeport, TX:** 0.72 Bcfd (Freeport LNG Dev) (CP17-470)
G. **Pascagoula, MS:** 1.5 Bcfd (Gulf LNG Liquefaction) (CP15-521)

APPROVED – NOT UNDER CONSTRUCTION – MARAD/Coast Guard

MC. Gulf of Mexico: 1.8 Bcfd (Delfin LNG)

CANADA

For Canadian LNG Import and Proposed Export Facilities go to:

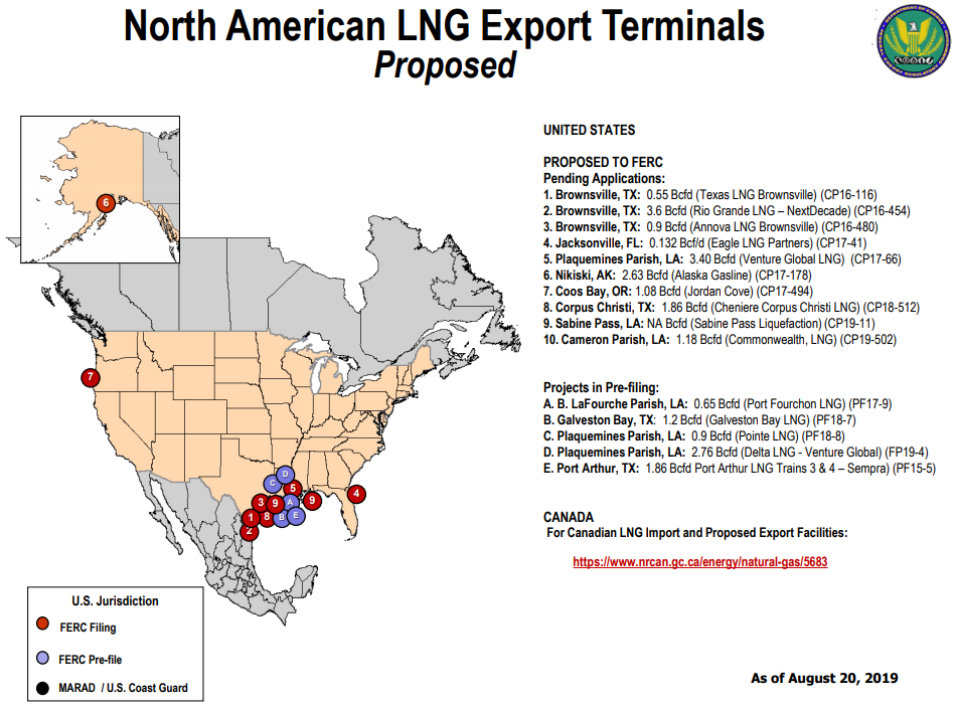
https://www.nrcan.gc.ca/energy/natural-gas/5683

As of August 8, 2019

SOURCE: FERC

U.S. LNG for Export – Where is it Produced?

- Total Proposed Liquefaction Nameplate Capacity = 22.70 BCFD
- Supply principally from Appalachian and mid-continent Basins



SOURCE: FERC

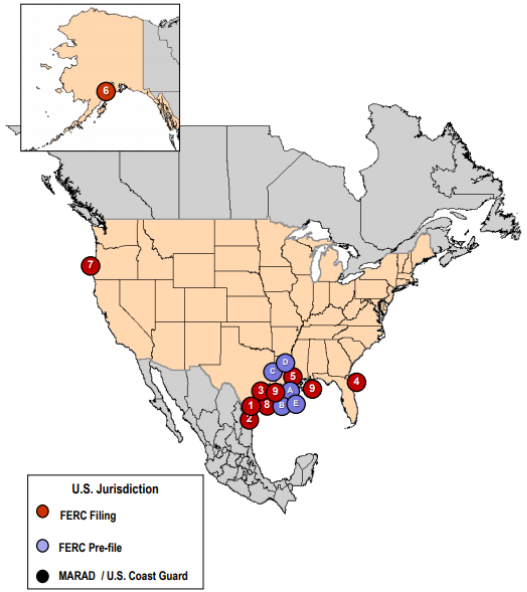
U.S. LNG for Export – Where is it Produced?

- Total Proposed Liquefaction Nameplate Capacity = 22.70 BCFD
- Supply principally from Appalachian and mid-continent Basins

Total Liquefaction Nameplate Capacity for (Existing + Approved) = 30.04 BCFD

Total Liquefaction Nameplate Capacity for (Existing + Approved + Proposed) = 52.74 BCFD

North American LNG Export Terminals
Proposed



UNITED STATES

PROPOSED TO FERC
Pending Applications:
1. **Brownsville, TX:** 0.55 Bcfd (Texas LNG Brownsville) (CP16-116)
2. **Brownsville, TX:** 3.6 Bcfd (Rio Grande LNG – NextDecade) (CP16-454)
3. **Brownsville, TX:** 0.9 Bcfd (Annova LNG Brownsville) (CP16-480)
4. **Jacksonville, FL:** 0.132 Bcf/d (Eagle LNG Partners) (CP17-41)
5. **Plaquemines Parish, LA:** 3.40 Bcfd (Venture Global LNG) (CP17-66)
6. **Nikiski, AK:** 2.63 Bcfd (Alaska Gasline) (CP17-178)
7. **Coos Bay, OR:** 1.08 Bcfd (Jordan Cove) (CP17-494)
8. **Corpus Christi, TX:** 1.86 Bcfd (Cheniere Corpus Christi LNG) (CP18-512)
9. **Sabine Pass, LA:** NA Bcfd (Sabine Pass Liquefaction) (CP19-11)
10. **Cameron Parish, LA:** 1.18 Bcfd (Commonwealth, LNG) (CP19-502)

Projects in Pre-filing:
A. **B. LaFourche Parish, LA:** 0.65 Bcfd (Port Fourchon LNG) (PF17-9)
B. **Galveston Bay, TX:** 1.2 Bcfd (Galveston Bay LNG) (PF18-7)
C. **Plaquemines Parish, LA:** 0.9 Bcfd (Pointe LNG) (PF18-8)
D. **Plaquemines Parish, LA:** 2.76 Bcfd (Delta LNG - Venture Global) (FP19-4)
E. **Port Arthur, TX:** 1.86 Bcfd Port Arthur LNG Trains 3 & 4 – Sempra) (PF15-5)

CANADA
For Canadian LNG Import and Proposed Export Facilities:

https://www.nrcan.gc.ca/energy/natural-gas/5683

As of August 20, 2019

SOURCE: FERC

Expectations for LNG Demand Growth

- In general, expectations for global demand growth for LNG remain strong over the next decade
- LNG project metrics –
  - LNG liquefaction and regasification projects typically take five to eight years to go from concept to in service
  - LNG liquefaction projects require significant capital investment – $4 to $25 Billion for a 5 to 17 MTPA plant, respectively

Expectations for LNG Demand Growth

- New LNG carriers (vessels) typically take three to five years from order placement to completion of sea trials and commissioning

Expectations for LNG Demand Growth

- Contract structures are moving toward shorter terms as the industry becomes more commoditized and the spot market grows
- The current backlog of projects that (a) have received Certificate approval, (b) have received a positive Final Investment Decision by the developers and have filed for Certificate approval, and (c) have received a positive Final Investment Decision by the developers and are in the process of filing, suggests strong business fundamentals in favor of LNG

Expectations for LNG Demand Growth

- The ongoing buildout of gas pipeline capacity out of the Appalachian Basin in virtually all directions extends the reach of Appalachian supplies to LNG Liquefaction facilities
- In 2012, a report commissioned by the U.S. Department of Energy found that *" . . . the U.S. was projected to gain net economic benefits from allowing LNG exports . . . "* and that *" . . . net economic benefits increased as the level of LNG exports increased."*

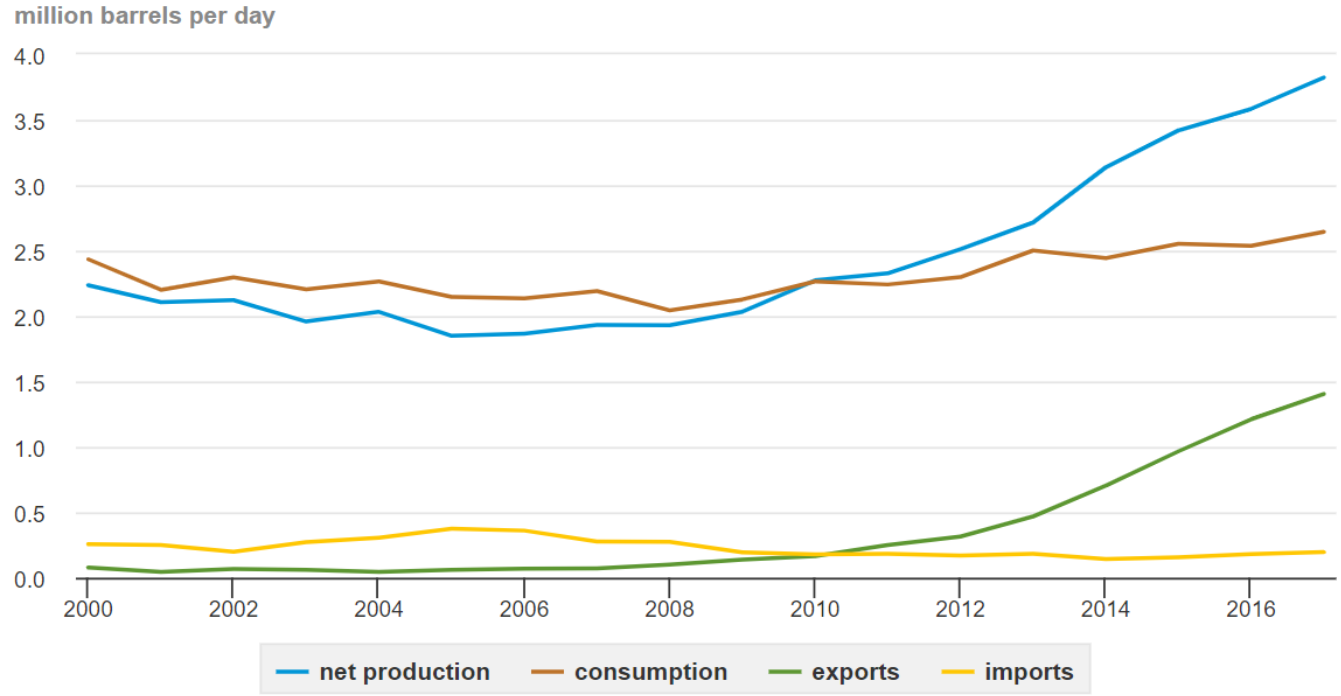
Expectations for LNG Demand Growth

- *Bottom line – market pull to be used as LNG feedstock is expected to be a significant opportunity for the Appalachian Basin for the next decade*

Demand for NGLs

U.S. NGL Production, Consumption, Export, and Import Volume – 2000 to 2017

- Flat performance up to about 2010
- Wet Marcellus volumes

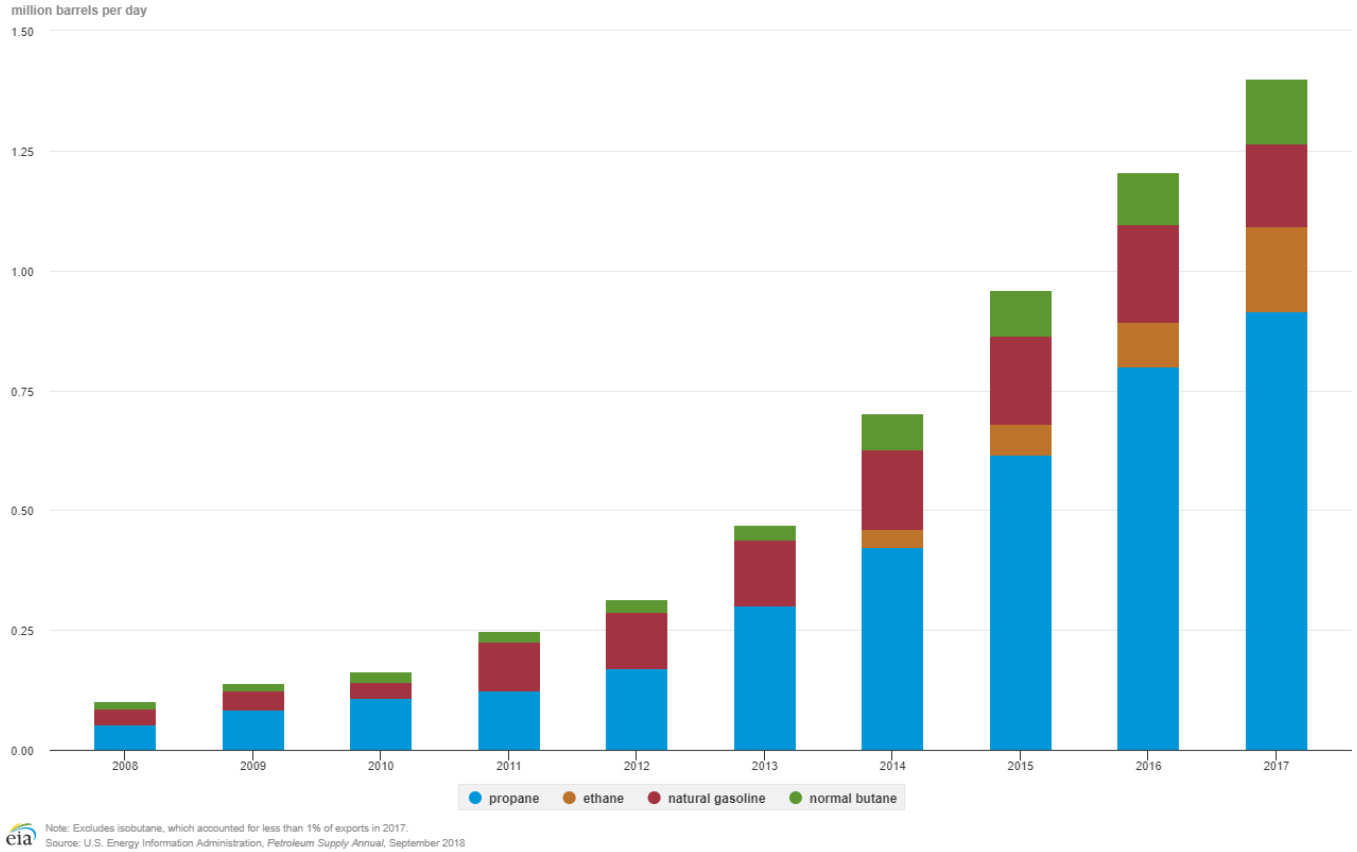


Note: Net production is net field production at natural gas plant processing plus net refinery and blender production. Consumption is product supplied. Stock/inventory change is excluded.
Source: U.S. Energy Information Administration, *Petroleum Supply Annual*, September 2018

Demand for NGLs

U.S. NGL Export Volume – 2008 to 2017

- 2008 = 0.1 Mbbls per day
- 2017 = 1.4 Mbbls per day
- 1,300% increase over nine years



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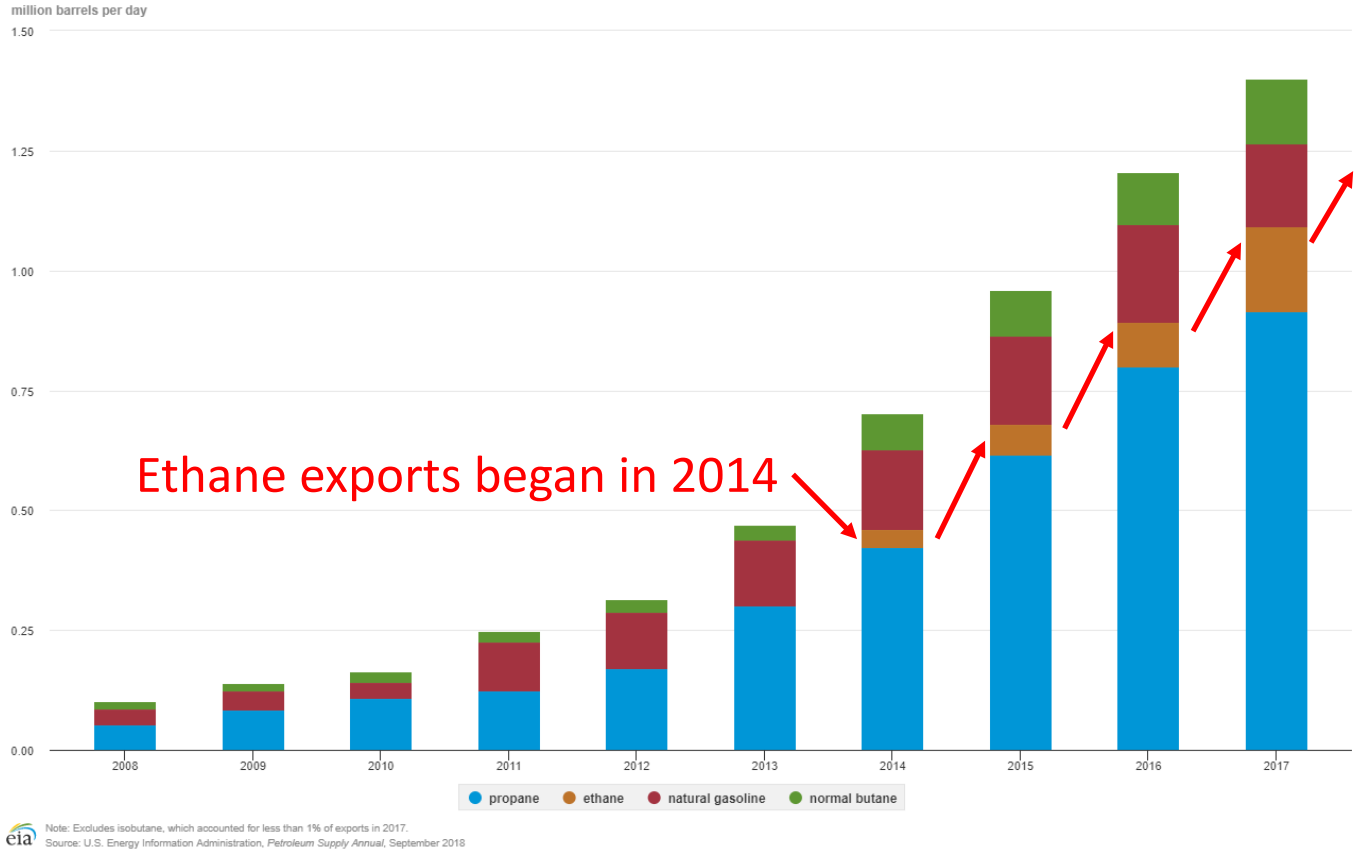


Demand for NGLs

U.S. NGL Export Statistics – 2017

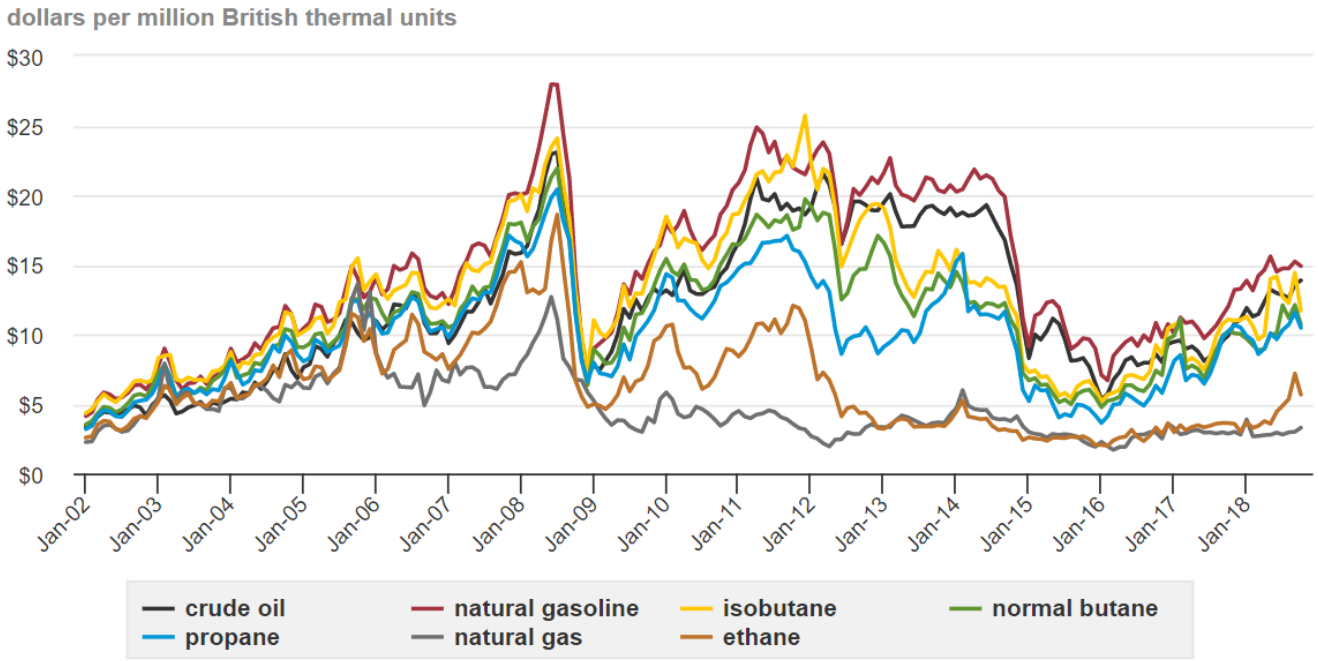
	Propane	Ethane	Natural gasoline	Normal butane
Number of destination countries	43	7	2	30
Total annual exports (million barrels/day)	0.91	0.18	0.17	0.14
Top five destinations and share of total	Japan, 23% Mexico, 15% China, 14% South Korea, 7% Singapore, 6%	India, 32% Canada, 31% United Kingdom, 18% Norway, 15% Brazil, 2%	Canada, 99% Norway, 1%	China, 15% South Korea, 14% Japan, 11% Canada, 9% Morocco, 7%

SOURCE: U.S. Energy Information Administration, September 10, 2019

Demand for NGLs

U.S. NGL Spot Prices – 2002 to 2018

- Prior to 2017 NGL prices constrained by export terminal capacity
- Current capacity bottlenecks now largely removed



Note: Prices are monthly average of close-of-day spot prices; crude oil is Brent; natural gas is Henry Hub; HGL products are at Mt. Belvieu non-LST (Lone Star Terminal).
Source: U.S. Energy Information Administration from Bloomberg

Expectations for NGL Demand Growth

- Like LNG, expectations for global demand growth for NGLs remain strong over the next decade
- NGL project metrics –
  - NGL processing projects typically take two to five years to go from concept to in-service
  - NGL projects require significant capital investment
  - Export transportation infrastructure – pipeline, terminal storage and loading, and vessels – need additional capacity

Expectations for NGL Demand Growth

- LPG/NGL vessels are typically smaller than LNG vessels (e.g., 100,000 versus 170,000 cubic meters capacity) and take two to three years from order placement to completion of sea trials and commissioning

- The advent of Ethane export via carriers opens markets and extends U.S. producer and processor reach, bolstering Ethane value

SOURCE: GasTech Insights, September 10, 2019

Expectations for NGL Demand Growth

- The ongoing buildout of petrochemical facilities, proposed petrochemical facilities, and proposed NGL pipeline capacity increases both inside and outside the Appalachian Basin opens Appalachian supplies to global NGL markets
- *Bottom line – market pull for NGL supplies around the globe is expected to be a significant opportunity for the Appalachian Basin for the next decade*

QUESTIONS?

Thank You!

Expectations for LNG Demand Growth

- Key Findings in the DOE Report included –

"This report contains an analysis of the impact of exports of LNG on the U.S. economy under a wide range of different assumptions about levels of exports, global market conditions, and the cost of producing natural gas in the U.S. . . . The economic impacts of different limits on LNG exports were examined under each of the market scenarios. Export limits were set at levels that ranged from zero to unlimited in each of the scenarios. . . . Across all these scenarios, the U.S. was projected to gain net economic benefits from allowing LNG exports. Moreover, for every one of the market scenarios examined, net economic benefits increased as the level of LNG exports increased. In particular, scenarios with unlimited exports always had higher net economic benefits than corresponding cases with limited exports."

SOURCE: Macroeconomic Impacts of LNG Exports from the United States, NERA Economic Consulting, December 3, 2012

Conversion Factors

Natural gas and LNG	To Convert billion cubic metres NG	billion cubic feet NG	million tonnes oil equivalent	million tonnes LNG	trillion British thermal units	million barrels oil equivalent
From	---------- Multiply by ----------					
1 billion cubic metres NG	1	35.3	0.90	0.74	35.7	6.60
1 billion cubic feet NG	0.028	1	0.025	0.021	1.01	0.19
1 million tonnes oil equivalent	1.11	39.2	1	0.82	39.7	7.33
1 million tonnes LNG	1.36	48.0	1.22	1	48.6	8.97
1 trillion British thermal units	0.028	0.99	0.025	0.021	1	0.18
1 million barrels oil equivalent	0.15	5.35	0.14	0.11	5.41	1

Units

1 metric tonne = 2204.62 lb.
= 1.1023 short tons
1 kilolitre = 6.2898 barrels
1 kilolitre = 1 cubic metre
1 kilocalorie (kcal) = 4.187 kJ = 3.968 Btu
1 kilojoule (kJ) = 0.239 kcal = 0.948 Btu
1 British thermal unit (Btu) = 0.252 kcal = 1.055 kJ
1 kilowatt-hour (kWh) = 860 kcal = 3600 kJ = 3412 Btu

SOURCE: IGU World LNG – 2019 Edition Report