

Transition of global LNG-based natural gas trade: The role of US Shale and Export Competitiveness

Korean Resource Economics Association

Seoul, South Korea
June 20, 2019

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Outline

- Confusion - What is LNG; What is LNG not?
- US shale
- US export capacity
- US competitiveness
 - Shipping cost
 - Netback pricing
 - Marginal cost vs Full cost recovery
- South Korean imports
- US - China

Natural gas

- Some confusion introduced by media and some analysts
 - Names
 - Methane
 - Shale gas
 - Coalbed methane / coal seam gas
 - These are all natural gas, CH₄ (the first chapter of Chandra, *Fundamentals of natural gas: An international perspective*, 2nd edition, 2017, PennWell, provides a good discussion)
- Sources
 - Conventional
 - Unconventional
- Transportation of natural gas
 - Pipeline
 - LNG – liquefied natural gas
 - CNG – compressed natural gas

Confusion – What is LNG; What is LNG not?

- LNG is **NOT** a fuel.
- LNG is **NOT** a commodity.
- LNG is **NOT** distinct from natural gas.
- LNG does **NOT** compete with natural gas.
- **NO** process uses the $-162\text{ }^{\circ}\text{C}$ ($-260\text{ }^{\circ}\text{F}$) liquid as an input.
- LNG is a transportation and/or storage phase for natural gas.
- LNG is always re-gasified for use.
- Natural gas is the fuel/commodity.
- The markets are for natural gas.

Confusion – What is LNG; What is LNG not?

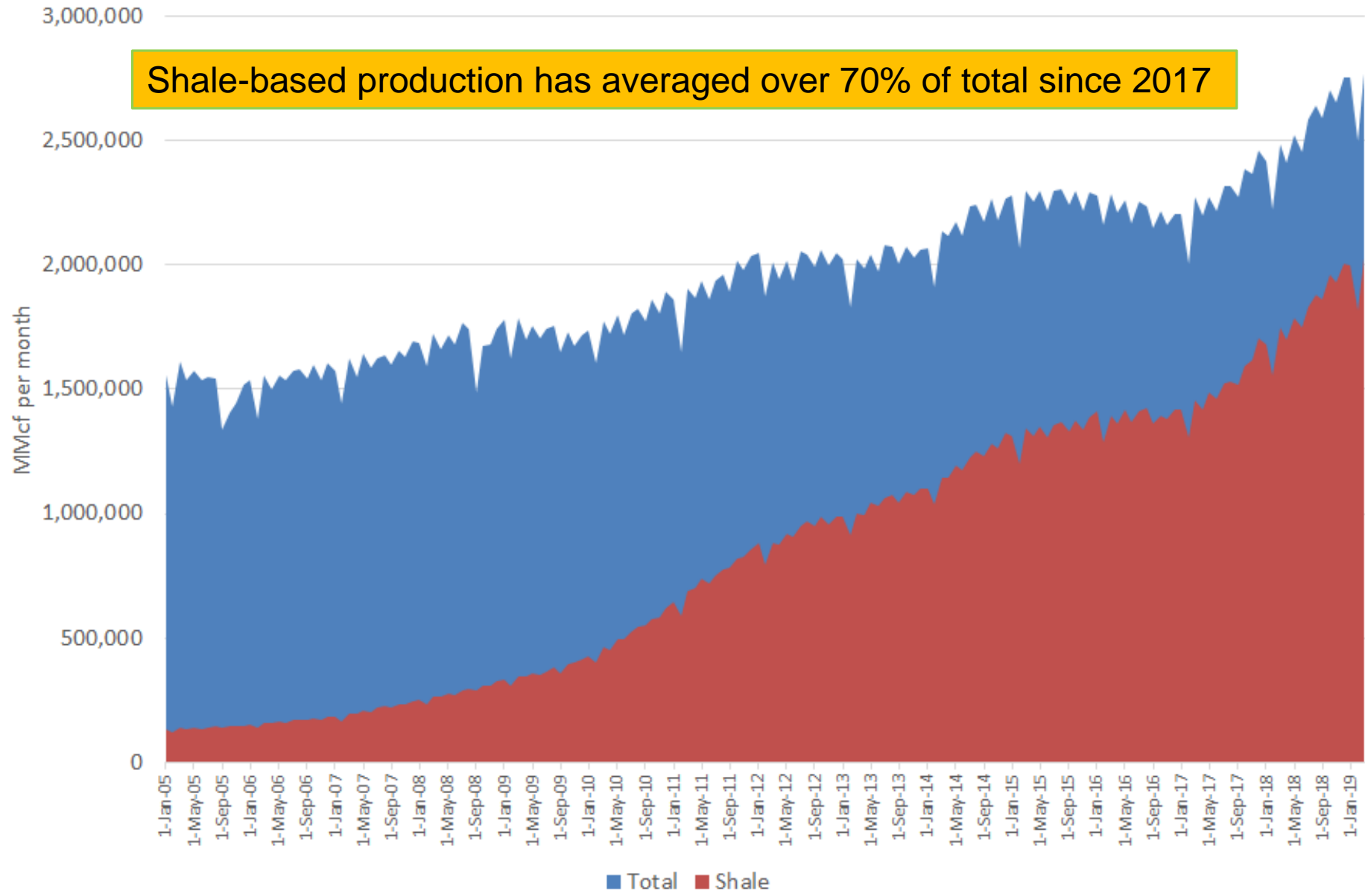
- Why does this matter?
- The confusion can lead to bad policy and regulation.
- Indeed, this has occurred!
- The WTO found against a claim by Russia, with the WTO saying that LNG is distinct from natural gas in the gaseous form, and therefore differences in treatment could not be claimed to be discriminatory.
 - See, WTO, *EU Energy Package* (Panel Report), WT/DS476/R, 10 August 2018; www.wto.org/english/tratop_e/dispu_e/cases_e/ds476_e.htm
 - See, “A False Dichotomy Between LNG and Natural Gas? A Comment on Recent Practices at the World Trade Organization,” by M. Wüstenberg, K. Talus and R.D. Ripple, *OGEL*, October 2018; www.ogel.org/journal-advance-publication-article.asp?key=581

US natural gas production and the role of shales



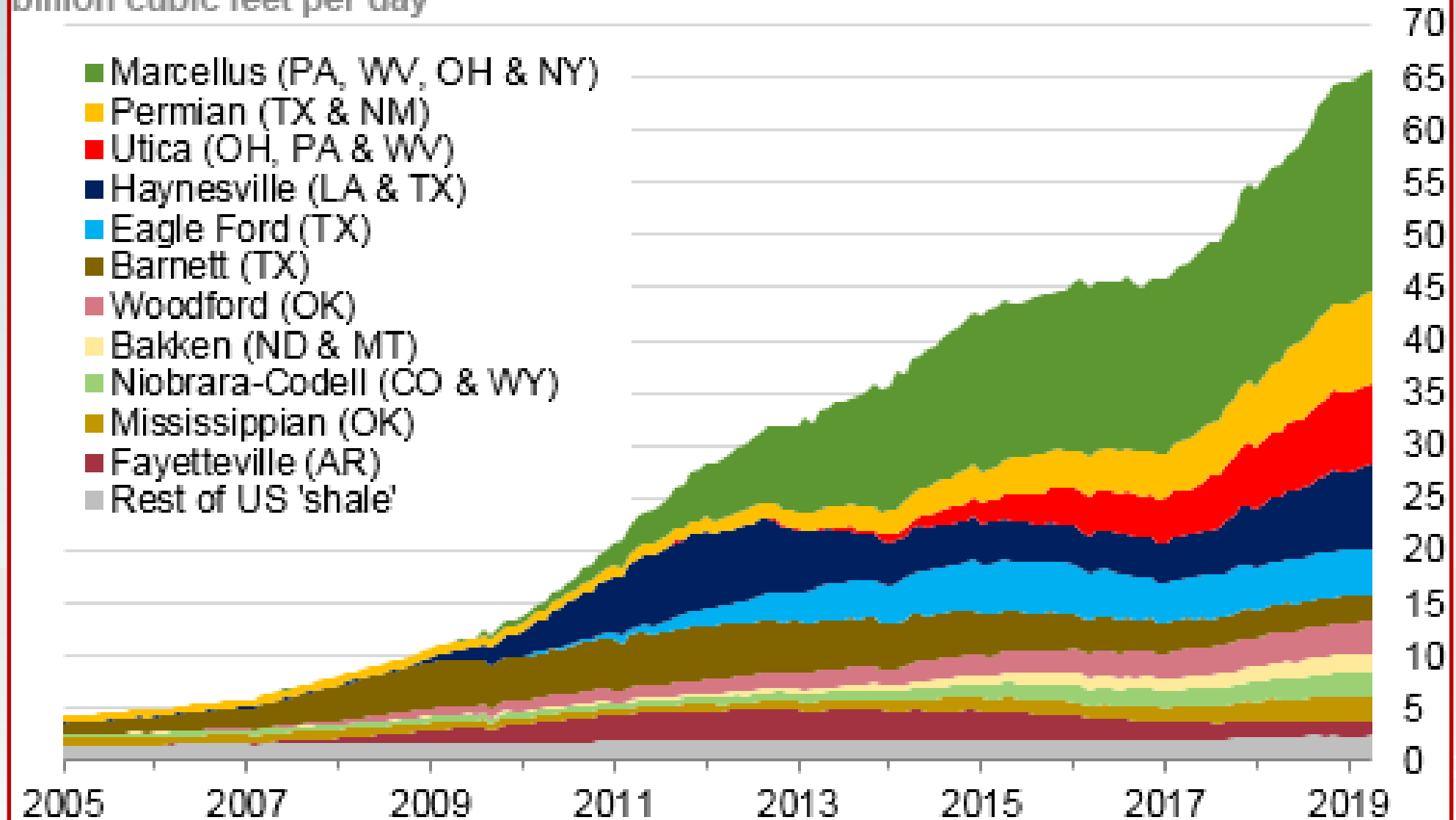
US Dry Gas Production: Total versus Shale (Jan 2005 - Mar 2019)

Source: EIA



Monthly dry shale gas production

billion cubic feet per day



Sources: EIA derived from state administrative data collected by DrillingInfo Inc. Data are through April 2019 and represent EIA's official tight gas estimates, but are not survey data. State abbreviations indicate primary state(s).



US shale production by play – 2016 -2019

2016 - 2019 (Apr) US Shale Production Statistics (source: EIA: MMcf and %)

	Marcellus	Permian	Utica	Haynesville	Eagle Ford	Barnett	Woodford	Bakken	Niobrara-Codell	Mississippian	Fayetteville	Rest of US 'shale'	Total shale production
2016	5,887,255.1	1,443,754.2	1,429,198.9	1,341,555.3	1,569,761.3	1,145,123.8	869,622.4	410,014.9	601,777.5	477,330.6	732,313.7	724,514.4	16,632,222.1
2017	6,241,313.9	1,881,283.8	1,788,596.8	1,635,751.0	1,489,508.0	1,033,190.3	952,547.2	463,852.8	629,763.4	585,985.2	605,350.0	734,826.4	18,041,968.9
2018	7,082,478.8	2,682,357.7	2,447,553.6	2,407,411.7	1,564,897.7	953,831.8	1,059,436.5	582,263.9	746,883.7	795,450.7	507,990.1	853,768.4	21,684,324.7
2019	2,526,337.8	1,034,211.1	916,146.1	940,021.7	517,675.7	294,918.5	369,693.9	218,064.5	283,518.2	271,941.8	158,214.6	291,048.3	7,821,792.1
Share of total													
2016	35.4%	8.7%	8.6%	8.1%	9.4%	6.9%	5.2%	2.5%	3.6%	2.9%	4.4%	4.4%	
2017	34.6%	10.4%	9.9%	9.1%	8.3%	5.7%	5.3%	2.6%	3.5%	3.2%	3.4%	4.1%	
2018	32.7%	12.4%	11.3%	11.1%	7.2%	4.4%	4.9%	2.7%	3.4%	3.7%	2.3%	3.9%	
2019	32.3%	13.2%	11.7%	12.0%	6.6%	3.8%	4.7%	2.8%	3.6%	3.5%	2.0%	3.7%	
Growth rate over the 2016 - 2019 (Apr) period based on Bcf/d													
Growth	30.1%	164.5%	109.6%	120.5%	-5.2%	-26.9%	29.3%	64.0%	49.1%	72.0%	-42.1%	17.9%	44.6%

Have US natural gas exports impacted US
natural gas prices?



Correlations

Levels

	\$/MMBtu	NG exports
\$/MMBtu	1	
LNG exports	0.512659	1

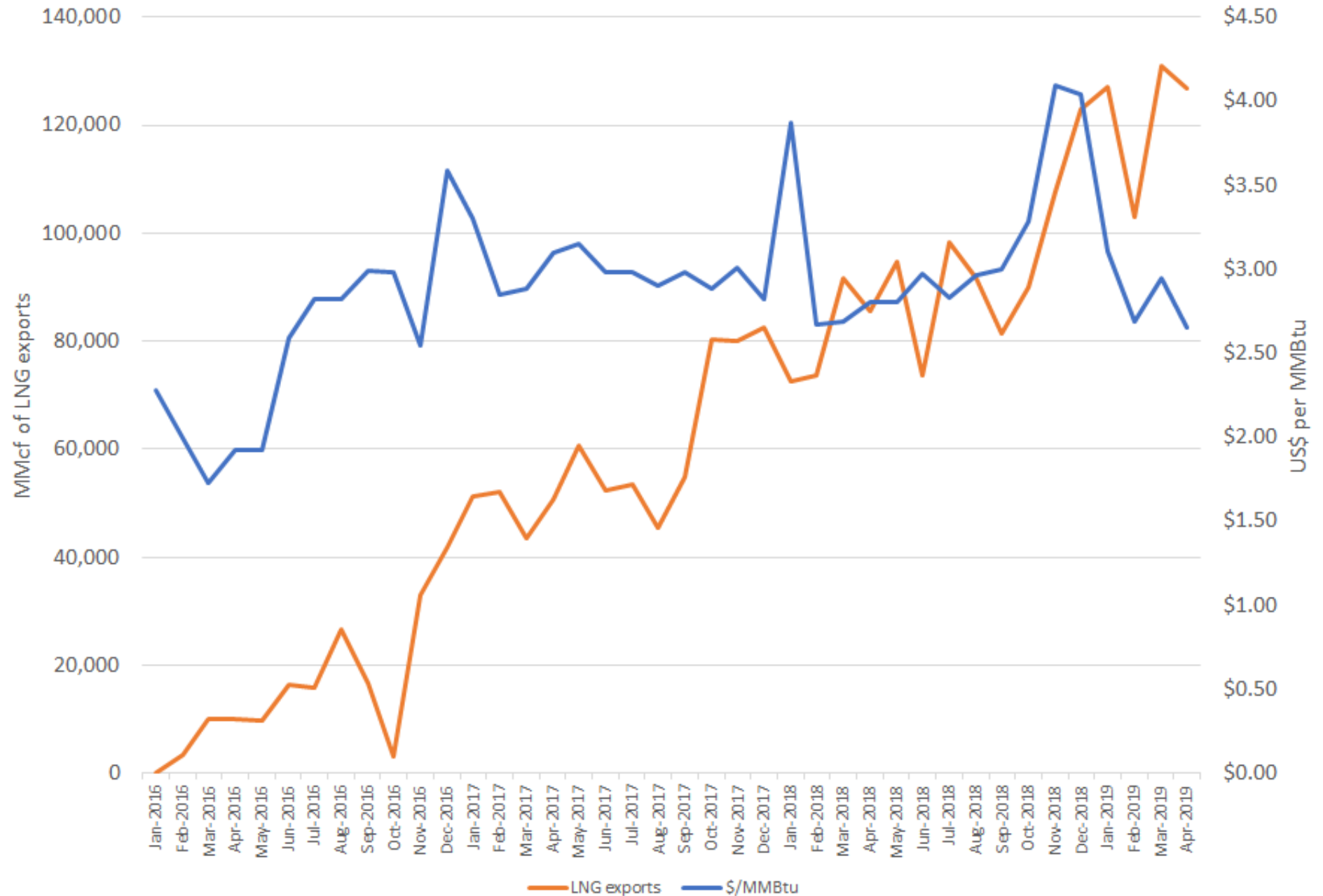
Percentage changes

	\$/MMBtu	NG exports
\$/MMBtu	1	
LNG exports	-0.20164	1

Absolute changes

	\$/MMBtu	NG exports
\$/MMBtu	1	
LNG exports	0.017126	1

Relationship: Henry Hub price and LNG-based natural gas exports



Will US Henry Hub prices be pushed upward?

- It does not appear so in the near future.
- Permian gas production is currently outstripping takeaway capacity.
- This has led to some producers being faced with having to pay “customers” to take the gas away, to avoid more flaring.
- Prices have reached -\$9.00 per MMBtu (note the negative).

US LNG-based natural gas exports

2016 US LNG-based natural gas exports

Country	Mcf	Share (%)
Chile	29,405,233	16.0%
Mexico	27,469,823	14.9%
China	17,220,633	9.4%
India	16,915,408	9.2%
Argentina	16,661,029	9.1%
Japan	11,137,261	6.1%
South Korea	10,166,100	5.5%
Jordan	9,870,110	5.4%
Brazil	9,196,380	5.0%
Turkey	8,762,481	4.8%
Kuwait	7,067,798	3.8%
Portugal	3,700,091	2.0%
Egypt	3,606,162	2.0%
U.A.E.	3,391,066	1.8%
Italy	3,328,199	1.8%
Dominican Rep	2,944,980	1.6%
Spain	2,930,435	1.6%
Total	183,773,189	
	Bcf/d	0.585

Number of countries
 2016 - 17
 2017 - 25
 2018 - 31

2017 US LNG-based natural gas exports

Country	Mcf	Share (%)
Mexico	140,321,287	19.9%
South Korea	130,185,448	18.4%
China	103,409,855	14.6%
Japan	53,298,599	7.5%
Jordan	36,321,482	5.1%
Spain	29,328,728	4.2%
Chile	25,745,690	3.6%
Turkey	24,854,835	3.5%
India	20,919,137	3.0%
Kuwait	20,213,124	2.9%
Portugal	19,522,724	2.8%
Brazil	17,647,879	2.5%
Argentina	16,276,094	2.3%
U.A.E.	13,408,114	1.9%
Taiwan	9,003,520	1.3%
Dominican Rep	8,690,714	1.2%
Lithuania	6,844,298	1.0%
Egypt	6,781,414	1.0%
Italy	6,492,590	0.9%
Poland	3,439,976	0.5%
United Kingdom	3,410,241	0.5%
Pakistan	3,165,927	0.4%
Thailand	3,112,643	0.4%
Netherlands	3,041,576	0.4%
Malta	867,346	0.1%
Total	706,303,241	
	Bcf/d	1.935

2018 US LNG-based natural gas exports

Country	Mcf	Share (%)
South Korea	252,222,898	23.3%
Mexico	182,246,499	16.8%
Japan	125,533,975	11.6%
China	90,473,315	8.4%
India	57,633,798	5.3%
United Kingdom	51,297,059	4.7%
Chile	41,185,539	3.8%
Jordan	38,794,499	3.6%
Brazil	35,645,036	3.3%
Argentina	27,559,510	2.5%
Turkey	23,205,176	2.1%
France	18,290,739	1.7%
Italy	17,389,895	1.6%
Taiwan	13,307,418	1.2%
Pakistan	12,955,558	1.2%
Portugal	12,512,401	1.2%
Netherlands	12,187,787	1.1%
Spain	10,309,802	1.0%
Kuwait	9,980,691	0.9%
Panama	6,786,399	0.6%
Egypt	6,553,756	0.6%
Dominican Rep	5,835,053	0.5%
Colombia	5,100,938	0.5%
Greece	3,721,510	0.3%
Singapore	3,678,628	0.3%
U.A.E.	3,637,851	0.3%
China, Taiwan	3,423,465	0.3%
Israel	3,270,275	0.3%
Poland	3,230,601	0.3%
Malta	2,926,992	0.3%
Jamaica	1,303,297	0.1%
Total	1,082,200,360	
	Bcf/d	2.96

2018
 Sabine Pass
 86.1%
 280 cargoes
 Cove Point
 13.2%
 48 cargoes
 Corpus Christi
 0.6%
 2 cargoes

Total exports
 (mcf)
 y-o-y
 2017-2018
 53% increase

US LNG exports -- Jan-Apr 2019		
Country	Imports-Mcf	Share (%)
South Korea	65,744,149	13.5%
Japan	45,268,658	9.3%
France	45,248,707	9.3%
Mexico	38,434,158	7.9%
Spain	34,194,603	7.0%
India	28,207,650	5.8%
Netherlands	26,851,379	5.5%
Chile	22,367,330	4.6%
Italy	20,640,063	4.2%
Turkey	19,280,736	4.0%
United Kingdom	17,752,608	3.6%
Portugal	17,498,103	3.6%
Poland	16,876,829	3.5%
Singapore	14,200,364	2.9%
China	10,550,433	2.2%
Brazil	7,718,592	1.6%
Jordan	7,316,550	1.5%
UAE	6,787,365	1.4%
Pakistan	6,647,484	1.4%
Panama	6,460,803	1.3%
Taiwan	6,348,828	1.3%
Colombia	5,869,198	1.2%
Argentina	4,369,366	0.9%
Greece	3,393,878	0.7%
Belgium	3,390,310	0.7%
Dominican Repub	2,941,555	0.6%
Jamaica	2,320,490	0.5%
Malta	412,820	0.1%

2019 (Apr)
Sabine Pass
71.6%
104 cargoes

Cove Point
17.4%
27 cargoes

Corpus Christi
11.0%
16 cargoes

28 country destinations

Where are we going?



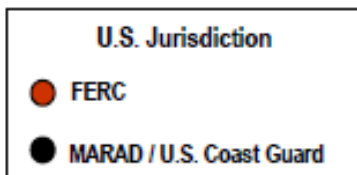
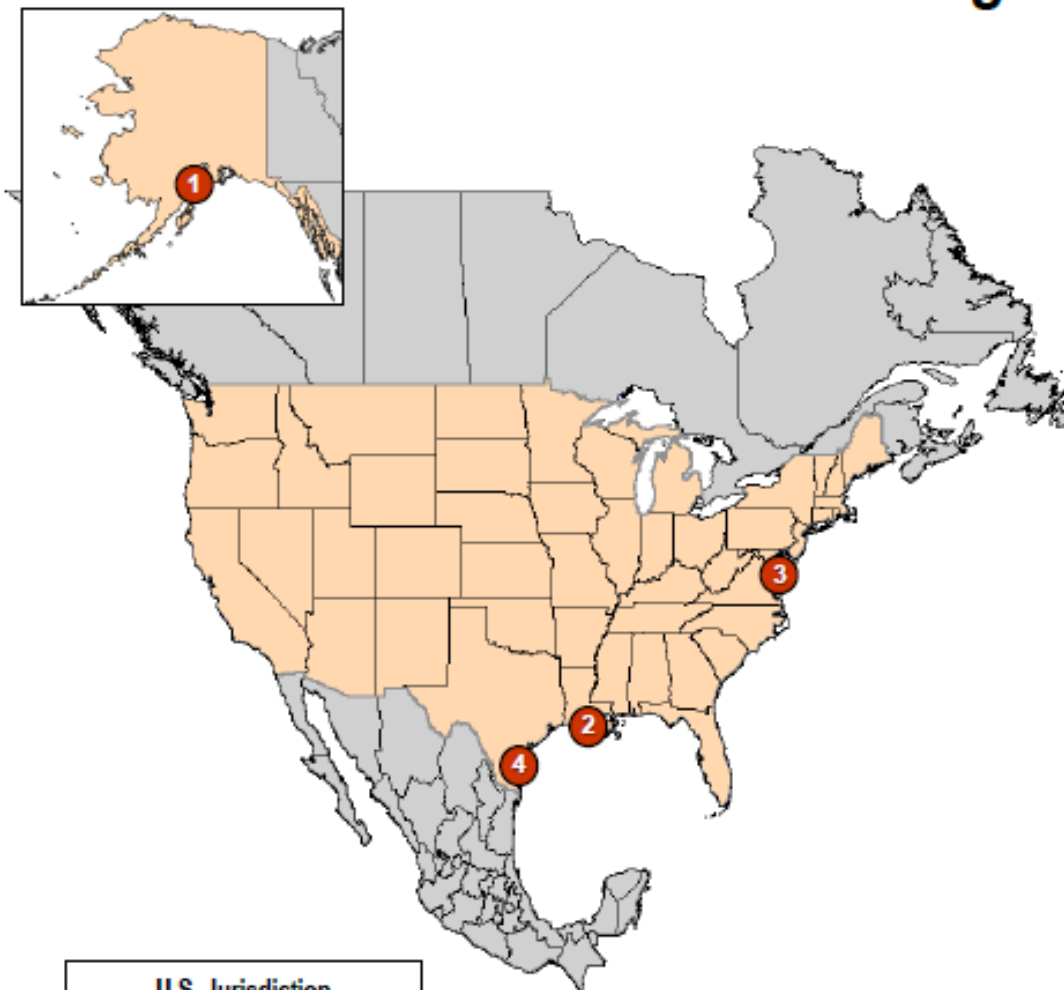
US LNG export projects - FERC

Existing Capacity	Bcf/d	Sponsor	Proposed to FERC
Cove Point, MD	0.82	Dominion	Pascagoula, MS 1.5 Gulf LNG
Sabine, LA	2.8	Cheniere	Cameron Parish, LA 1.41 Venture Global LNG
Kenai, AK	0.2	Conoco-Phillips	Brownsville, TX 0.55 Texas LNG
Subtotal	3.82		Brownsville, TX 3.6 Rio Grande LNG
			Brownsville, TX 0.9 Annova LNG
Approved - Under construction			Port Arthur, TX 1.86 Port Arthur LNG
Hackberry, LA	2.1	Sempr-Cameron LNG	Jacksonville, FL 0.132 Eagle LNG
Freeport, TX	2.14	Freeport LNG	Plaquemines, LA 3.4 Ventrue Global LNG
Corpus Christi, TX	2.14	Cheniere	Calcasieu, LA 4 Driftwood LNG
Sabine Pass, LA	1.4	Sabine Pass Liquefaction	Nikiski, AK 2.63 Alaska Gasline
Elba Island, GA	0.35	Southern LNG	Freeport, TX 0.72 Freeport LNG
Subtotal	8.13		Coos Bay, OR 1.08 Jordon Cove
			Corpus Christi, TX 1.86 Cheniere
Approved - Not under construction			Subtotal 23.642
Lake Charles, LA	2.2	Lake Charles LNG	
Lake Charles, LA	1.08	Magnolia LNG	Total 42.382
Hackberry, LA	1.41	Sempra-Cameron LNG	
Sabine Pass, LA	2.1	Golden Pass	
Subtotal	6.79		

The completion of the first Corpus Christi train (not reflected in the Existing Capacity numbers above) means that an additional 0.6 Bcf/d of capacity is operational.

North American LNG Export Terminals

Existing



Export Terminals

UNITED STATES

1. Kenai, AK: 0.2 Bcfd (ConocoPhillips)
2. Sabine, LA: 3.5 Bcfd (Cheniere/Sabine Pass LNG – Trains 1-5)
3. Cove Point, MD: 0.82 Bcfd (Dominion–Cove Point LNG)
4. Corpus Christi, TX: 0.71 Bcfd (Cheniere – Corpus Christi LNG Train 1)

Current export capacity from the lower-48 is 4.21 Bcfd, which equates to 32.25 mtpy.

As of May 8, 2019



North American LNG Export Terminals

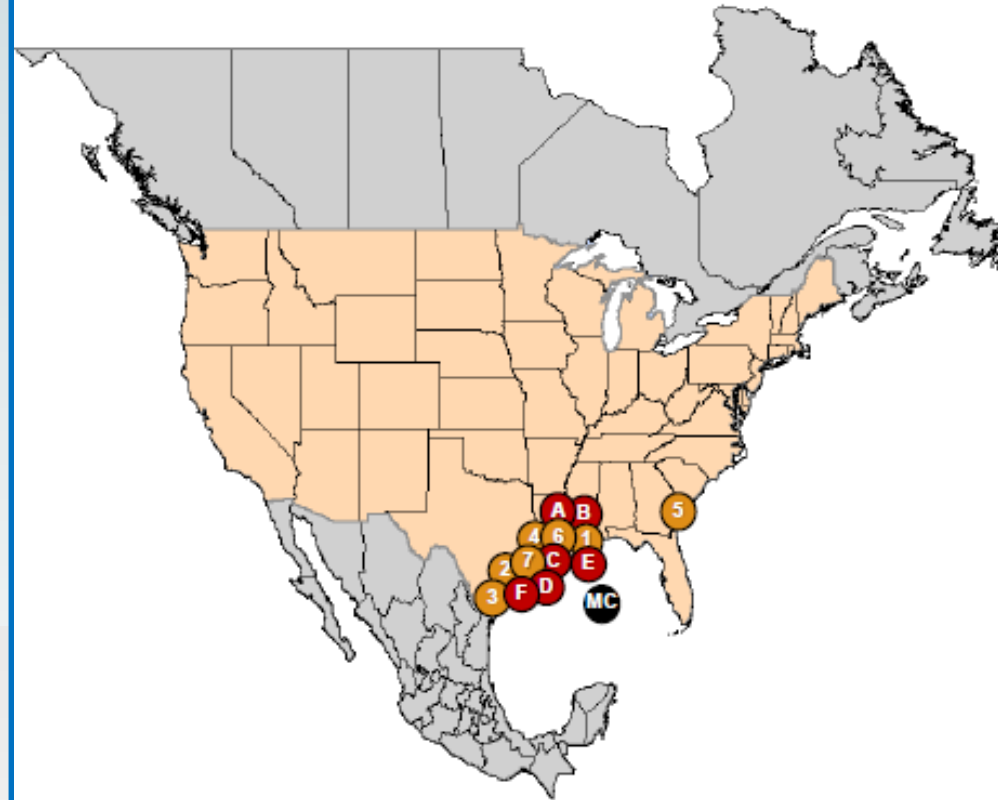
Approved, Not Yet Built

Current export capacity approved by FERC:

Under construction is 7.54 Bcfd, which equates to 57.3 mtpy. So when this is combined with operating capacity we get 89.55 mtpy.

Not under construction is 6.79 Bcfd, which equates to 51.6 mtpy.

LNG Canada has taken FID. It is planned to have 26 mtpy capacity.



Export Terminals

UNITED STATES

APPROVED - UNDER CONSTRUCTION - FERC

1. Hackberry, LA: 2.1 Bcfd (Sempra-Cameron LNG) (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) (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)

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) (CP17-20)
- E. Calcasieu Parish, LA: 4.0 Bcfd (Driftwood LNG) (CP17-117)
- F. Freeport, TX: 0.72 Bcfd (Freeport LNG Dev) (CP17-470)

- ##### 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>

★ Trains 2 & 3

As of May 17, 2019

Changing world of LNG export capacity

- USA existing – 32.25 mtpy
- USA under construction – 57.3 mtpy
 - Combined – 89.55 mtpy
- USA approved but not under construction – 51.6 mtpy
- Australia existing – 69.75 mtpy (Prelude FLNG 1st shipment this week)
- Australia under construction – 16.95 mtpy
 - Combined – 86.7 mtpy
- Qatar existing – 77 mtpy; plans to increase to 110 mtpy.
- World current total liquefaction capacity – 406 mtpy (20 countries)

BP Outlook 2035

2017 Outlook

Natural gas

Consumption, production, and balance

Consumption of natural gas										
Million tonnes oil equivale	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
North America	579.0	673.8	720.5	711.5	770.0	880.7	992.4	1026.9	1096.4	1123.6
S & C America	52.0	67.7	85.2	111.1	135.8	157.3	164.7	172.3	183.6	186.5
Europe	309.4	350.6	420.0	481.7	494.6	412.2	459.4	458.5	475.9	492.0
CIS	566.0	472.2	467.7	502.5	509.8	490.9	491.5	496.0	499.6	494.6
Middle East	87.4	126.9	171.4	251.4	359.5	441.2	501.2	564.9	620.6	682.7
Africa	35.6	42.7	51.8	76.5	96.5	121.9	134.4	157.4	185.7	220.0
Asia Pacific	136.5	189.9	268.6	369.8	520.5	631.0	800.0	921.6	1032.7	1119.1
Total Natural Gas Consump	1765.9	1923.8	2185.3	2504.5	2886.7	3135.2	3543.7	3797.6	4094.5	4318.5
Production of natural gas										
Million tonnes oil equivale	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
North America	584.0	651.7	693.9	683.0	745.2	900.4	1036.6	1128.9	1275.8	1330.7
S & C America	52.3	68.1	91.0	126.5	149.6	160.6	159.5	161.7	165.0	168.8
Europe	191.9	218.6	256.3	270.6	256.1	214.4	189.8	165.2	135.1	111.6
CIS	672.2	569.1	584.1	651.7	657.0	676.5	749.9	824.5	854.9	881.4
Middle East	94.6	134.1	189.6	288.9	446.0	556.1	604.7	673.5	733.1	792.8
Africa	62.0	76.8	119.4	159.3	192.0	190.6	190.7	211.1	237.2	280.3
Asia Pacific	134.6	187.4	251.3	339.3	448.0	501.0	642.5	678.4	708.8	756.0
Total Natural Gas Productio	1791.5	1905.7	2185.5	2519.4	2893.9	3199.5	3573.6	3843.4	4109.8	4321.5
Balance (production minus consumption)										
Million tonnes oil equivale	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
North America	5.0	-22.2	-26.6	-28.5	-24.8	19.7	44.3	102.1	179.4	207.1
S & C America	0.3	0.4	5.8	15.3	13.8	3.3	-5.2	-10.6	-18.6	-17.7
Europe	-117.5	-132.1	-163.7	-211.1	-238.5	-197.9	-269.7	-293.3	-340.8	-380.4
CIS	106.2	96.9	116.3	149.3	147.2	185.6	258.4	328.5	355.3	386.8
Middle East	7.1	7.3	18.2	37.5	86.5	114.9	103.4	108.6	112.4	110.6
Africa	26.3	34.1	67.6	82.8	95.5	68.7	56.3	53.6	51.4	60.3
Asia Pacific	-1.9	-2.5	-17.4	-30.4	-72.5	-130.0	-157.5	-243.2	-323.8	-363.1
Total Natural Gas Balance	25.6	-18.1	0.2	14.9	7.2	64.3	30.0	45.7	15.3	3.0

For context, the 45.7 Mtoe surplus represents about 5 Bcf/d; this is about 1% of production.

Note that while Europe is expected to have a larger shortfall than the Asia-Pacific, the expected surplus in CIS is sufficient to meet it.

The 363.1 Mtoe deficit implies about 39 Bcf/d 403 Bcm/y 297 mtpa

BP
Outlook
2035

2017
Outlook

Natural gas

Consumption,
production,
and balance

Consumption of natural gas										
Million tonnes oil equivalent	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
North America	579.0	673.8	720.5	711.5	770.0	880.7	992.4	1026.9	1096.4	1123.6
S & C America	52.0	67.7	85.2	111.1	135.8	157.3	164.7	172.3	183.6	186.5
Europe	309.4	350.6	420.0	481.7	494.6	412.2	459.4	458.5	475.9	492.0
CIS	566.0	472.2	467.7	502.5	509.8	490.9	491.5	496.0	499.6	494.6
Middle East									20.6	682.7
Africa									35.7	220.0
Asia Pacific									32.7	1119.1
Total Natural Gas									94.5	4318.5
Production of natural gas										
Million tonnes oil equivalent	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
North America									75.8	1330.7
S & C America									55.0	168.8
Europe									35.1	111.6
CIS									54.9	881.4
Middle East									33.1	792.8
Africa									37.2	280.3
Asia Pacific									38.8	756.0
Total Natural Gas									309.8	4321.5
Balance (production minus consumption)										
Million tonnes oil equivalent	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
North America	5.0	-22.2	-26.6	-28.5	-24.8	19.7	44.3	102.1	179.4	207.1
S & C America	0.3	0.4	5.8	15.3	13.8	3.3	-5.2	-10.6	-18.6	-17.7
Europe	-117.5	-132.1	-163.7	-211.1	-238.5	-197.9	-269.7	-293.3	-340.8	-380.4
CIS	106.2	96.9	116.3	149.3	147.2	185.6	258.4	328.5	355.3	386.8
Middle East	7.1	7.3	18.2	37.5	86.5	114.9	103.4	108.6	112.4	110.6
Africa	26.3	34.1	67.6	82.8	95.5	68.7	56.3	53.6	51.4	60.3
Asia Pacific	-1.9	-2.5	-17.4	-30.4	-72.5	-130.0	-157.5	-243.2	-323.8	-363.1
Total Natural Gas Balance	25.6	-18.1	0.2	14.9	7.2	64.3	30.0	45.7	15.3	3.0

Note that Australia is already accounted for within the Asia-Pacific, so the shortfall must be met from outside the region.

For context, the 45.7 Mtoe surplus represents about 5 Bcf/d; this is about 1% of production.

Note that while Europe is expected to have a larger shortfall than the Asia-Pacific, the expected surplus in CIS is sufficient to meet it.

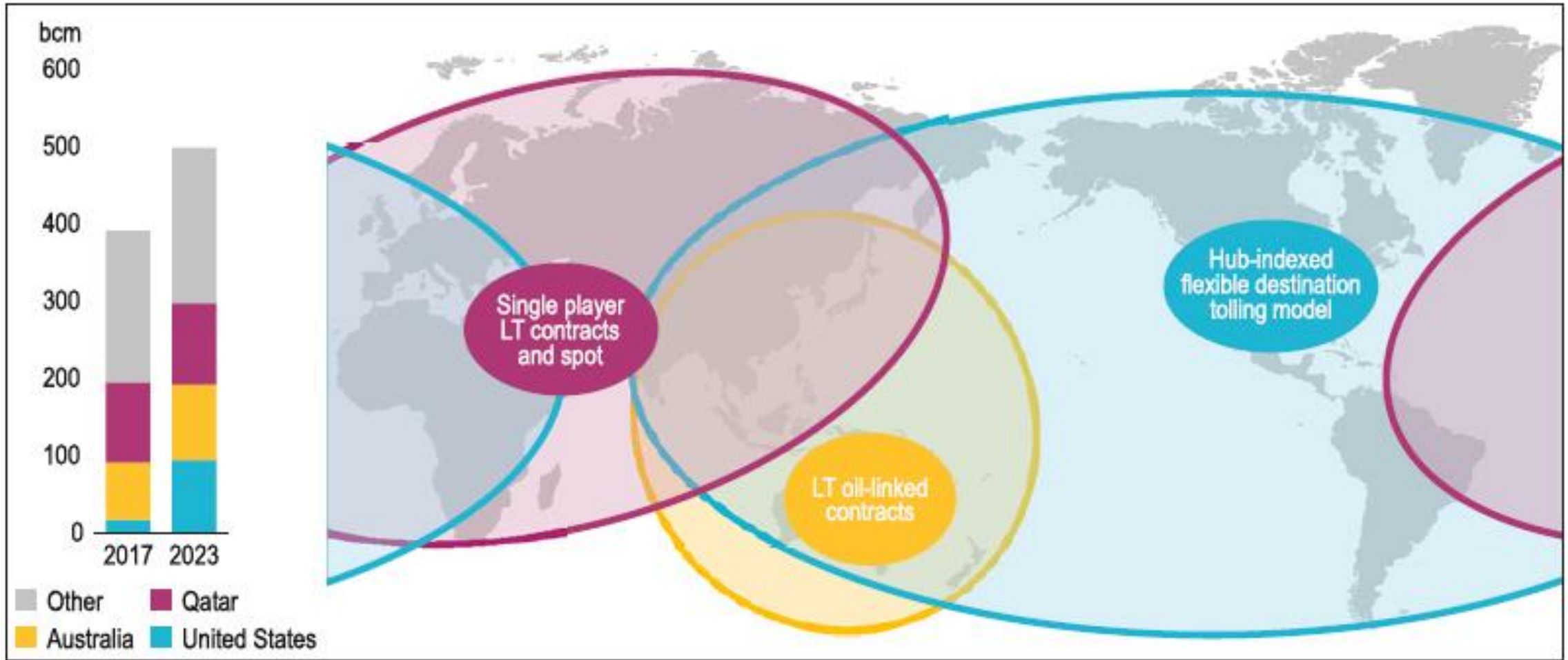
The 363.1 Mtoe deficit implies about 39 Bcf/d 403 Bcm/y 297 mtpa

Pricing

- Different business models
- Evolution toward more spot and short-term trade

Map 3.3

The three major LNG export players and their respective business models



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Note: LT = long-term.

Note that Cheniere is NOT a tolling operation.

Economics of US LNG-based exports

- Netback pricing versus cost-plus pricing
- Henry Hub (HH) price – \$2.37
- Cheniere Energy model (HH+15%) – \$2.726
- Asian spot price – around \$5.00 / MMBtu
- Asian oil-linked prices – around \$9.00 / MMBtu
- European price – \$3.50 - \$3.70 / MMBtu
- Shipping costs
 - Depend upon their own economics

Cheniere Energy model

1 million tonnes of LNG is equivalent to 1.36 Bcm (or 48 Bcf) of natural gas, according to BP conversions.

			HH price ->	2.37			
Project	Buyer	Contractual Quantity (mmtpa)	Liquefaction		HH price	HH + 15%	FOB Price
			Costs (US\$/mmBtu)				
Sabine Pass	BG	3.50	2.25	2.37	2.7255	4.98	
Sabine Pass	GNF	3.50	2.49	2.37	2.7255	5.22	
Sabine Pass	BG	2.00	3.00	2.37	2.7255	5.73	
Sabine Pass	GAIL	3.50	3.00	2.37	2.7255	5.73	
Sabine Pass	KOGAS	3.50	3.00	2.37	2.7255	5.73	
Sabine Pass	TOTAL	2.00	3.00	2.37	2.7255	5.73	
Sabine Pass	Centrica	1.75	3.00	2.37	2.7255	5.73	
Corpus Christi	PERTAMINA	0.76	3.50	2.37	2.7255	6.23	
Corpus Christi	Endesa	1.50	3.50	2.37	2.7255	6.23	
Corpus Christi	Endesa	0.75	3.50	2.37	2.7255	6.23	
Corpus Christi	Enel	1.11	3.50	2.37	2.7255	6.23	
Corpus Christi	Enel	1.11	3.50	2.37	2.7255	6.23	
Corpus Christi	Iberdrola	0.80	3.50	2.37	2.7255	6.23	
Corpus Christi	GNF	1.52	3.50	2.37	2.7255	6.23	
Corpus Christi	Woodside	0.85	3.50	2.37	2.7255	6.23	
Corpus Christi	EDF	0.77	3.50	2.37	2.7255	6.23	
Corpus Christi	PERTAMINA	0.76	3.50	2.37	2.7255	6.23	
Corpus Christi	EDP	0.77	3.50	2.37	2.7255	6.23	

US competitiveness

- Use the lowest FOB cost out of Cheniere - \$4.976 / MMBtu
- Compare to European and Asian prices
 - Europe - \$3.50 / MMBtu
 - UK - \$3.70 / MMBtu
 - Asia spot - \$5.00 / MMBtu
 - Asia contract - \$9.00 / MMBtu
- Since a lot of the Asian contracts are take-or-pay, it is not easy for the US to actually compete for these volumes.
- **So why did the US still export?**

Marginal/incremental cost economics

- As long as a producer/seller is able to at least cover marginal/incremental costs s/he will tend not to shutdown.
- This is because anything over and above marginal/incremental costs provides contributions toward covering some of the fixed costs.
- What is the marginal/incremental cost for exports related to the Cheniere operation?
 - \$3.4856 / MMBtu – this was the Henry Hub plus 15% feedstock component.

Shipping costs – Important to competitiveness

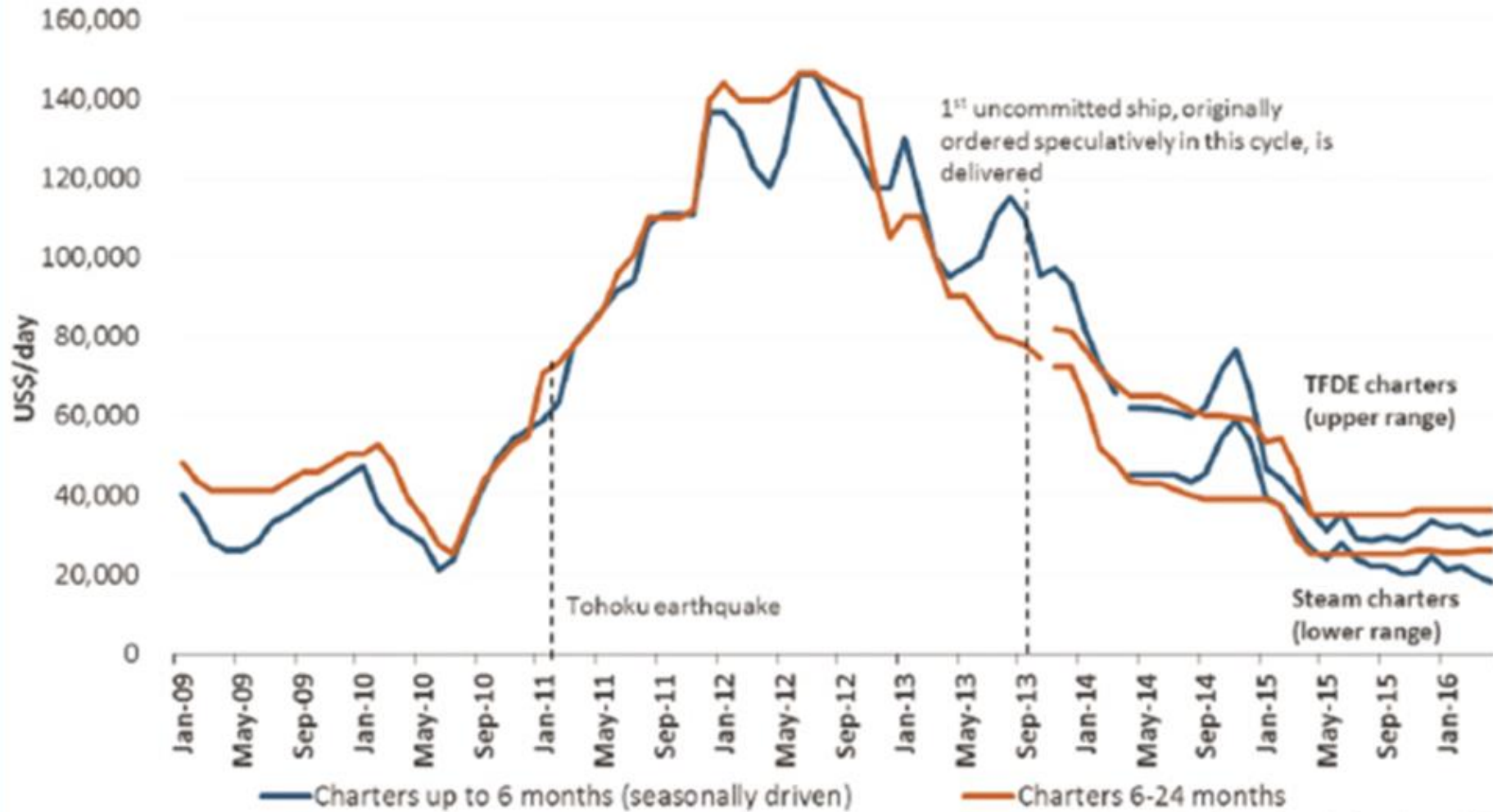
- LNG tanker rates are variable and based on their own complex supply and demand conditions
- Supply is impacted by observations and expectations for future demand
- These observations and expectations are affected by investment decisions for liquefaction capacity.
 - Delays in liquefaction FIDs and construction may lead to delays in new tanker orders, or it may lead to excess tanker capacity becoming available, which may impact available tanker supply/capacity and hence market price.

Shipping costs play a very important role

- Day rates
- Term contract rates

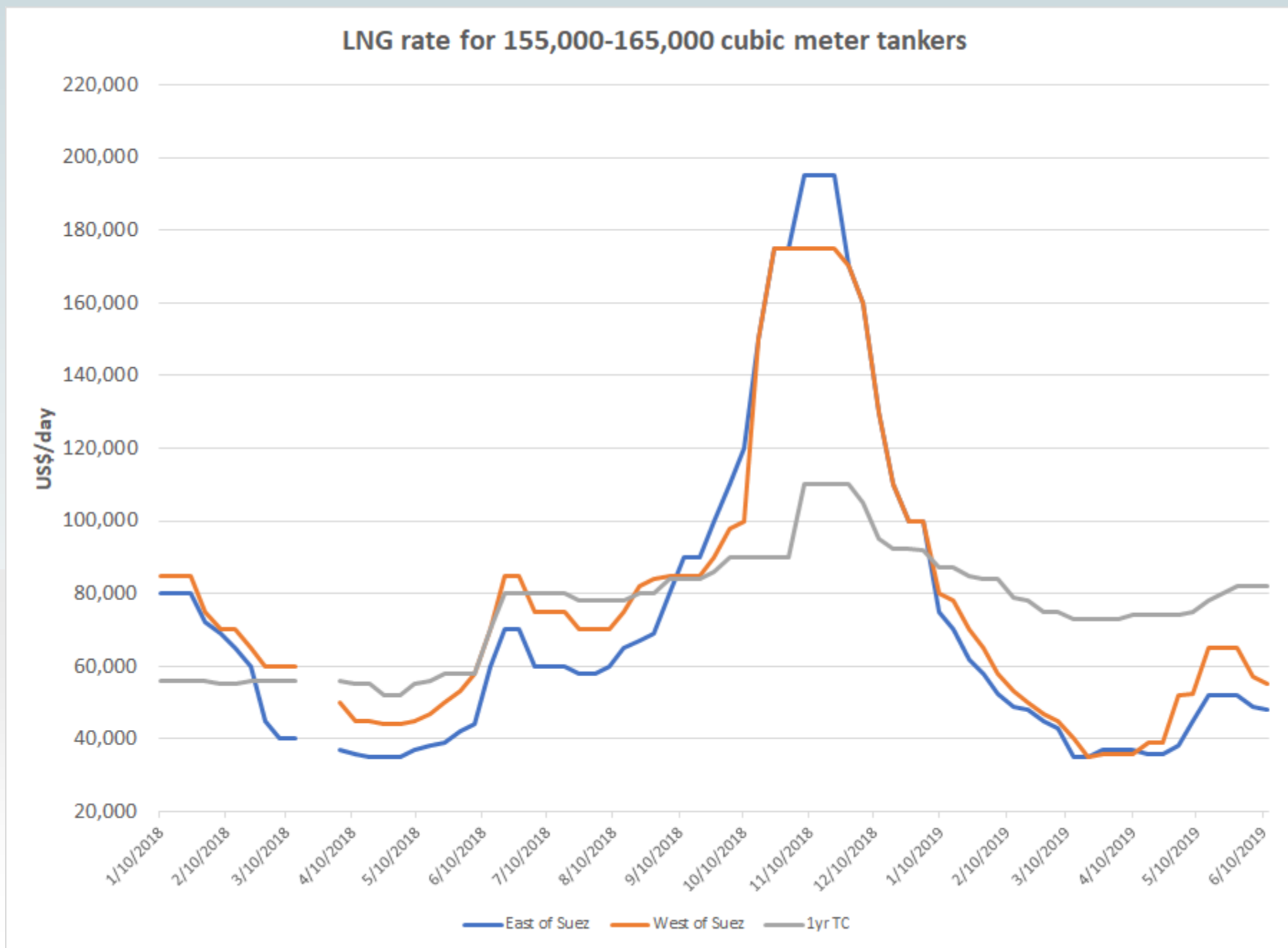
LNG tanker rates (2009-2016)

LNG Freight Rates for Ships of 145~165,000 m³



Source: Kenneth Wilson, in collaboration with FGE

LNG tanker rates – Fearnleys Weekly Reports



Shipping cost estimates – Term charter

LNG Carrier shipping cost comparison between XXX and YYY

160,000 m3 tanker => ~ 3,500,000 MMBtu

Accounts for round trip, includes 2 additional days for loading and unloading, \$35/nm fuel cost, \$0.21/MMBtu for Panama, \$150,000 each for port costs, \$30,000 insurance, and \$79,000 working capital charge

		Appr. Distance nautical miles	Fuel	15.5 knots		Day rate	Cost/MMBtu
Port-to-Port				Days	Hours	\$ 70,000	
Sabine	Zeebrugge	4908	\$ 343,560	13	5	\$ 1,989,167	\$ 0.91
	Shanghai (S.Afr.)	15098	\$ 1,056,860	40	14	\$ 5,821,667	\$ 2.42
	Shanghai (Panama)	10081	\$ 705,670	27	2	\$ 3,931,667	\$ 1.89
Dampier	Shanghai	3306	\$ 231,420	8	21	\$ 1,382,500	\$ 0.67

For tanker day rates of +/- \$20,000 around the \$70,000

Zeebrugge \$0.72 - \$1.10

Shanghai (Panama) \$1.51 - \$2.26

Shipping cost estimates – November 2018 **spot**

LNG Carrier shipping cost comparison between XXX and YYY

160,000 m3 tanker => ~ 3,500,000 MMBtu

Accounts for round trip, includes 2 additional days for loading and unloading, \$35/nm fuel cost, \$0.21/MMBtu for Panama, \$150,000 each for port costs, \$30,000 insurance, and \$79,000 working capital charge

		Appr. Distance nautical miles	Fuel	18 knots		Day rate	Cost/MMBtu
Port-to-Port				Days	Hours	\$ 175,000	
Sabine	Zeebrugge	4861	\$ 340,248	13	6	\$ 4,637,500	\$ 1.79
	Shanghai (S.Afr.)	15098	\$ 1,056,860	34	23	\$ 12,235,417	\$ 4.55
	Shanghai (Panama)	10081	\$ 705,670	23	8	\$ 8,166,667	\$ 3.29
Dampier	Shanghai	3308	\$ 231,560	7	16	\$ 2,683,333	\$ 1.10

6/12/2019											
www.xe.com quotes											
Northern European values				0.78771	GBP/USD	CME/NYMEX quote					
				0.88522	EUR/USD	HH		HH+15%			
ICE natural gas quotes						\$2.370		\$2.726			
								Net of liquefaction	Net of shipping		
						Net of HH+15%		BG \$2.25	\$3.00	0.91	
NBP	27.7	pence per therm	2.77	pounds sterling per MMBtu	3.516523	US\$ per MMBtu	0.791023	-1.45898	-2.20898	-2.36898 -3.11898	
TTF	11.12	euros per MWh	3.25816	euros per MMBtu	3.680622	US\$ per MMBtu	0.955122	-1.29488	-2.04488	-2.20488 -2.95488	
Multiply by 0.2930832 for conversion from MWh price to MMBtu price (3,412,000 Btu/MWh) (=1,000,000/3,412,000)											
Asia oil linked values											
				Net of liquefaction		Brent crude oil price					
				BG \$2.25	\$3.00	60.09					
				Net of HH+15%							
1.1237892	EUR/GBP		5.0395	4.2895	7.2895	10.015	heat rate parity based on 6 MMBtu per barrel				
						0.166667 implied slope					
3.1128961	EUR value of NBP		4.747865	3.997865	6.997865	9.723365	using Brent*0.1485 + 0.8				
Japan spot values											
				Japan spot					Shipping cost assumes \$70,000/d at 15.5 knots		
What if:		\$5.00	Net of liquefaction		Net of shipping						
			BG \$2.25	\$3.00	1.89						
Japan spot net of HH+15%		\$2.27	\$0.02	-\$0.73	-\$1.87	-\$2.62					

Implications of the **lack** of full-cost recovery

- What we see here is that there is incentive to continue to export where there are contractual obligations in place.
- But the incentive, currently, to expand export capacity is limited.
- We only decide to build capacity when we believe (usually on an expected outcome basis) that we will be able to recover our full investment plus a reasonable rate of return.
- The issue of the lack of full-cost recovery also affects Australia.
- This could also affect the proposed Alaska North Slope natural gas to LNG project that China is interested in.

South Korean LNG imports

- For 2018, imports arrived from 22 exporting countries.
- The top five were: Qatar (32.5%), Australia (17.9%), USA (10.7%), Oman (9.6%), and Malaysia (8.4%).
- S. Korea accounted for 14% of global LNG in 2018.
- 2018 LNG imports equaled 60.2 Bcm or 44 MT.
- Total LNG regasification capacity, from six locations, equals 120.9 mtpa.
- This implies 36.4% capacity utilization.
- During the 2018-2019(Apr) period, S. Korea imported ~36% of its LNG on spot terms, and it accounted for ~10% of all spot-based LNG imports for the period.

What about China

- LNG imports grew from 52.9 Bcm (2017) to 73.5 Bcm (2018).
- Number of supplier countries was 21 (2017) and 23 (2018).
- Australia has been China's largest supplier with 43.7% of LNG in 2018, down slightly from 45.1% in 2017.
- Pipeline imports grew from 39.9 Bcm (2017) to 47.9 Bcm (2018).
- Total import share increased from 38.6% of consumption to 42.9%.
- China accounted for ~20% (the largest share) of spot-based LNG over the 2018-2019(Apr) period.
- China LNG tariffs: 10% Sept. 2018, 25% June 2019
- LNG shipments from the US (Jan.-Apr): 2017 (4), 2018 (14), 2019 (3)
- US LNG total export volume was up 52% y-o-y for the Jan.-Mar. period 2018-to-2019.

Thank you!

Questions - Comments

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