Energy Part 4
Geopolitical Issues

Osher Lifelong Learning Institute

At Tufts University

Fall 2018

Peter Baldwin

617-306-7419

pete_baldwin@base-e.net

Basic Comparisons 2017

	China	USA	India	Japan	Germany	Russia
Population - July 2014 est	1,379,302,771	326,525,791	1,281,935,911	126,451,398	80,594,017	142,257,519
Population Growth Rate	0.41%	0.81%	1.17%	-0.21%	-0.16%	-0.08%
Area - km^2	9,596,960	9,826,675	3,287,263	377,915	357,022	17,098,242
GDP - Purchasing Power Parity ($trillion)	23.1	19.4	9.4	5.4	4.2	4.0
Installed Generating Capacity GW	1,646	1,074	309	322	204	264
% of World at 6301GW	26%	17%	5%	5%	3%	4%
Electric Production TWh	6,142	4,088	1,289	976	559	1,008
Electric Consumption TWh	5,920	3,911	1,048	934	515	890
Aggregate Load Factor	42.6%	43.5%	47.6%	34.6%	31.3%	43.6%
Natural Gas Production - BCM	138.4	766.2	31.2	4.5	8.7	598.6
Natural Gas Consumption - BCM	210.3	773.2	102.3	123.6	79.2	418.9
Refined Petroleum Products Production - mmbbl/d	10.9	20.1	4.8	3.5	2.2	6.2
Refined Petroleum Products Consumption - mmbbl/d	11.8	19.7	4.1	4.0	2.4	3.6
Coal Production - Million Tonnes Oil Equivalent	1827.0	455.2	283.9	0.7	42.9	184.5
Coal Consumption - Million Tonnes Oil Equivalent	1920.4	396.3	407.2	119.4	78.3	88.7

Source: CIA World Factbook

CIA World Factbook

World Total Installed Electrical Generating Capacity **6301GW**

base e

"Practical Strategies for Emerging Energy Technologies"

PS… .Total Value of Outstanding Student Loans - $1.5 trillion
U.S. health care cost 2014 - $3.3 trillion
U.S. Household Debt 2017 - $13.2 trillion

U.S. = 91.86 Quads
(Understates Renewables)

Primary Energy Consumption by Fuel 2017 - Mtoe

Primary Energy: Consumption by fuel*

Million tonnes oil equivalent	2016 Oil	Natural Gas	Coal	Nuclear energy	Hydro electric	Renew-ables	Total	2017 Oil	Natural Gas	Coal	Nuclear energy	Hydro electric	Renew-ables	Total	Percent of 2017 Total
US	907.6	645.1	340.6	191.9	59.7	83.1	2228.0	913.3	635.8	332.1	191.7	67.1	94.8	**2234.9**	16.5%
Canada	107.0	94.1	18.9	21.8	87.6	9.6	339.0	108.6	99.5	18.6	21.9	89.8	10.3	**348.7**	2.6%
Mexico	90.1	79.0	12.4	2.4	6.9	4.1	194.9	86.8	75.3	13.1	2.5	7.2	4.4	**189.3**	1.4%
Total North America	**1104.6**	**818.2**	**371.9**	**216.1**	**154.2**	**96.8**	**2761.9**	**1108.6**	**810.7**	**363.8**	**216.1**	**164.1**	**109.5**	**2772.8**	20.5%
Brazil	135.7	32.4	15.9	3.6	86.2	19.1	293.0	135.6	33.0	16.5	3.6	83.6	22.2	**294.4**	2.2%
Total S. & Cent. America	**320.8**	**150.6**	**34.9**	**5.5**	**156.4**	**28.6**	**696.8**	**318.8**	**149.1**	**32.7**	**5.0**	**162.3**	**32.6**	**700.6**	5.2%
France	79.2	38.3	8.2	91.2	13.6	8.4	238.9	79.7	38.5	9.1	90.1	11.1	9.4	**237.9**	1.8%
Germany	117.3	73.0	75.8	19.2	4.6	38.3	328.2	119.8	77.5	71.3	17.2	4.5	44.8	**335.1**	2.5%
Italy	59.8	58.5	11.0	-	9.6	14.8	153.8	60.6	62.0	9.8	-	8.2	15.5	**156.0**	1.2%
Spain	64.2	25.0	10.5	13.3	8.2	15.4	136.7	64.8	27.5	13.4	13.1	4.2	15.7	138.8	1.0%
Turkey	47.1	38.2	38.5	-	15.2	5.4	144.4	48.8	44.4	44.6	-	13.2	6.6	157.7	1.2%
United Kingdom	76.3	69.6	11.2	16.2	1.2	17.6	192.2	76.3	67.7	9.0	15.9	1.3	21.0	191.3	1.4%
Total Europe	**719.3**	**434.7**	**295.1**	**195.2**	**146.1**	**144.2**	**1934.6**	**731.2**	**457.2**	**296.4**	**192.5**	**130.4**	**161.8**	**1969.5**	14.6%
Russian Federation	152.5	361.3	89.2	44.5	41.8	0.3	689.6	153.0	365.2	92.3	46.0	41.5	0.3	**698.3**	5.2%
Total CIS	**202.8**	**492.6**	**156.2**	**63.3**	**56.3**	**0.8**	**972.0**	**203.4**	**494.1**	**157.0**	**65.9**	**56.7**	**0.9**	**978.0**	7.2%
Iran	80.7	173.1	0.9	1.5	3.5	0.1	259.8	84.6	184.4	0.9	1.6	3.7	0.1	**275.4**	2.0%
Saudi Arabia	173.8	90.6	0.1	-	-	^	264.5	172.4	95.8	0.1	-	-	^	**268.3**	2.0%
United Arab Emirates	45.7	62.3	1.5	-	-	0.1	109.6	45.0	62.1	1.6	-	-	0.1	**108.7**	0.8%
Total Middle East	**416.0**	**437.6**	**9.1**	**1.5**	**4.6**	**1.0**	**869.7**	**420.0**	**461.3**	**8.5**	**1.6**	**4.5**	**1.4**	**897.2**	6.6%
South Africa	28.7	4.0	84.7	3.6	0.2	1.8	123.0	28.8	3.9	82.2	3.6	0.2	2.0	**120.6**	0.9%
Total Africa	**192.6**	**114.5**	**94.9**	**3.6**	**27.1**	**5.2**	**438.0**	**196.3**	**121.9**	**93.1**	**3.6**	**29.1**	**5.5**	**449.5**	3.3%
Australia	50.5	35.9	43.6	-	4.0	5.4	139.5	52.4	36.0	42.3	-	3.1	5.7	**139.4**	1.0%
China	587.2	180.1	1889.1	48.3	261.0	81.7	3047.2	608.4	206.7	1892.6	56.2	261.5	106.7	**3132.2**	23.2%
India	217.1	43.7	405.6	8.6	29.0	18.3	722.3	222.1	46.6	424.0	8.5	30.7	21.8	**753.7**	5.6%
Indonesia	74.2	32.9	53.4	-	4.4	2.6	167.4	77.3	33.7	57.2	-	4.2	2.9	**175.2**	1.3%
Japan	191.4	100.1	118.8	4.0	18.1	18.8	451.2	188.3	100.7	120.5	6.6	17.9	22.4	**456.4**	3.4%
South Korea	128.9	41.0	81.9	36.7	0.6	3.1	292.2	129.3	42.4	86.3	33.6	0.7	3.6	**295.9**	2.2%
Taiwan	48.6	17.2	38.6	7.2	1.5	1.0	114.0	49.2	19.1	39.4	5.1	1.2	1.2	**115.1**	0.9%
Thailand	62.1	43.5	17.7	-	0.8	2.8	126.9	63.9	43.1	18.3	-	1.1	3.4	**129.7**	1.0%
Total Asia Pacific	**1601.1**	**625.1**	**2744.0**	**106.0**	**368.5**	**140.8**	**5585.5**	**1643.4**	**661.8**	**2780.0**	**111.7**	**371.6**	**175.1**	**5743.6**	42.5%
Total World	**4557.3**	**3073.2**	**3706.0**	**591.2**	**913.3**	**417.4**	**13258.5**	**4621.9**	**3156.0**	**3731.5**	**596.4**	**918.6**	**486.8**	**13511.2**	
	34.4%	23.2%	28.0%	4.5%	6.9%	3.1%	100.0%	34.2%	23.4%	27.6%	4.4%	6.8%	3.6%	100.0%	100.0%

13,511.2 Mtoe = 555.4 Quads

base e

"Practical Strategies for Emerging Energy Technologies"

Source: BP Statistical Review of World Energy 2018

Current Issues

- Climate Change
- Oil Supply/Demand
  - OPEC
  - USA
  - Iran & Saudi Arabia
  - Canada
  - Mexico
  - Venezuela
  - UK
- Natural Gas Supply/Demand
  - Pipeline vs. LNG
  - Gas to China & China-US Trade War
  - EU Gas Demand
    - Nord2
    - Turk Stream
  - USA Export
  - India Demand Growth
  - Australia
  - Russia
- Current Issues
  - Transportation
    - The New Silk Road
    - Straights of Malacca
    - South China Sea & Freedom of the Seas
    - Pak/China corridor
    - Panama canal
    - NAFTASCP-TANAP-TAP Pipeline
  - Turkey – The Crossroads of Everything
  - Saudi Arabia vs. Iran
  - NAFTA
  - Oil (Tar) Sands
  - Arctic Resource
  - Rural Electrification
  - Northeast gas pipeline

Climate Change

The Paris Accord

What are the key elements?

- To keep global temperatures "well below" 2.0°C (3.6°F) above pre-industrial times and "endeavor to limit" them even more, to 1.5 °C
- To limit the amount of greenhouse gases emitted by human activity to the same levels that trees, soil and oceans can absorb naturally, beginning at some point between 2050 and 2100
- To review each country's contribution to cutting emissions every five years so they scale up to the challenge
- For rich countries to help poorer nations by providing "climate finance" to adapt to climate change and switch to renewable energy.

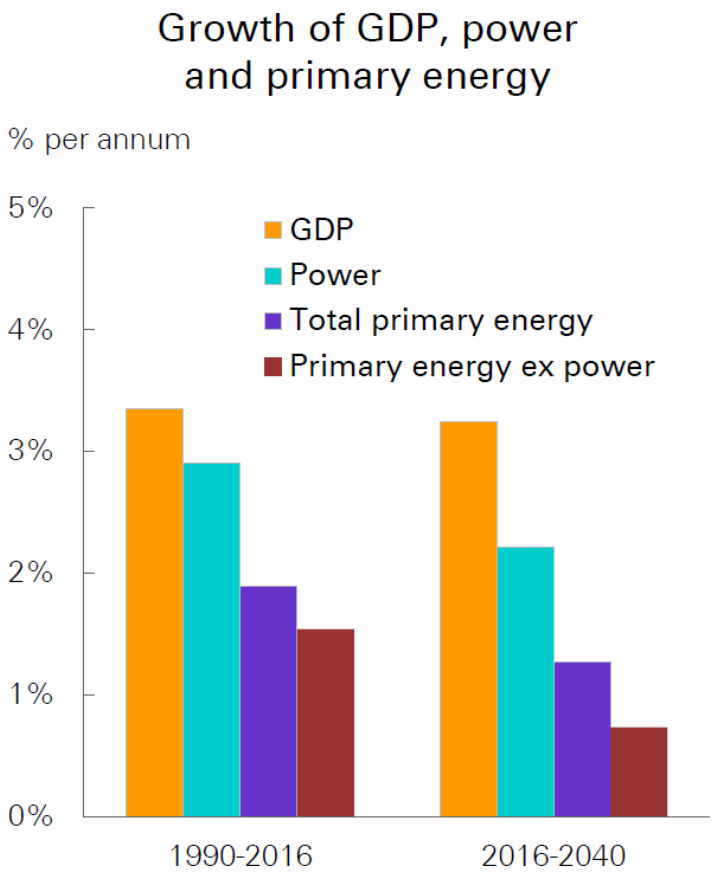
Developing countries say they need financial and technological help

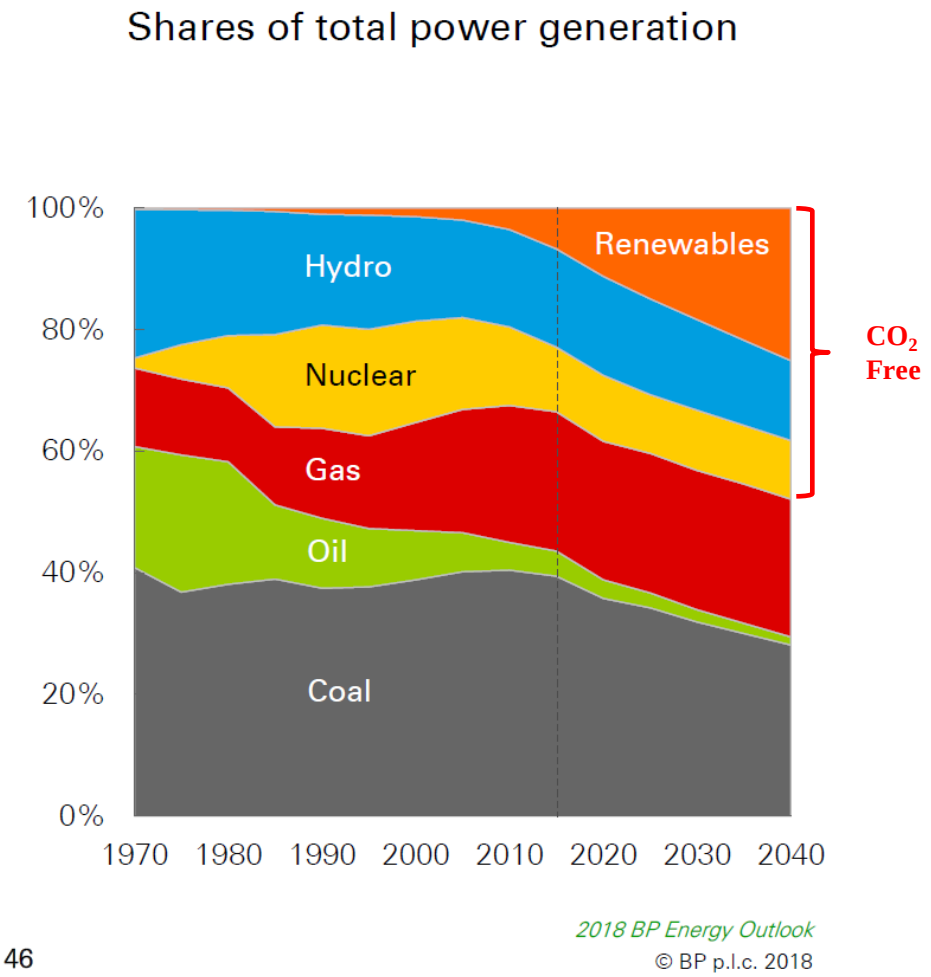
- Leapfrog fossil fuels and move straight to renewables.
- Currently they have been promised US $100bn (£67bn) a year by 2020 - not as much as many countries would like.
- The agreement requires rich nations to maintain a $100bn a year funding pledge beyond 2020, and to use that figure as a "floor" for further support agreed by 2025.
- The deal says wealthy countries should continue to provide financial support for poor nations to cope with climate change and encourages other countries to join in on a voluntary basis.

Limited number of elements of the Paris pact will be legally binding.

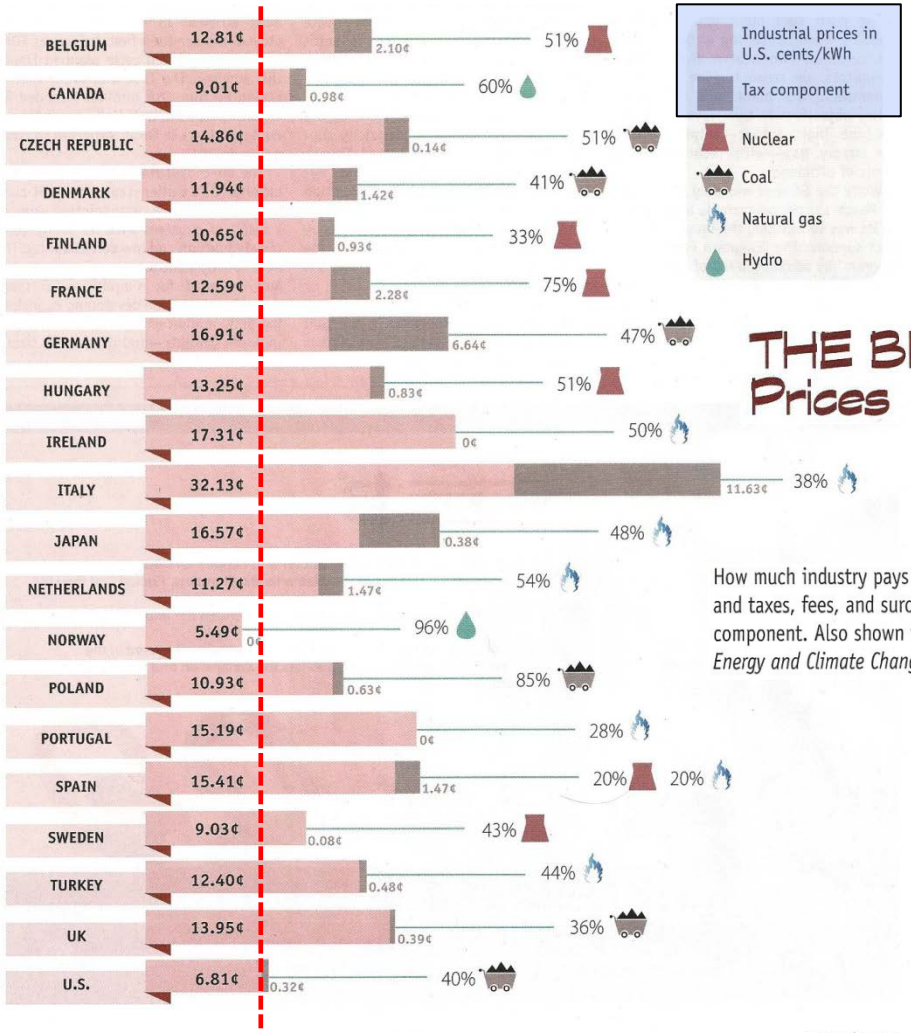
- The national pledges by countries to cut emissions are voluntary
- The pact promises to make an assessment of progress in 2018, with further reviews every five years.

The World Continues to Electrify





The Big Picture: World Industrial Power Prices



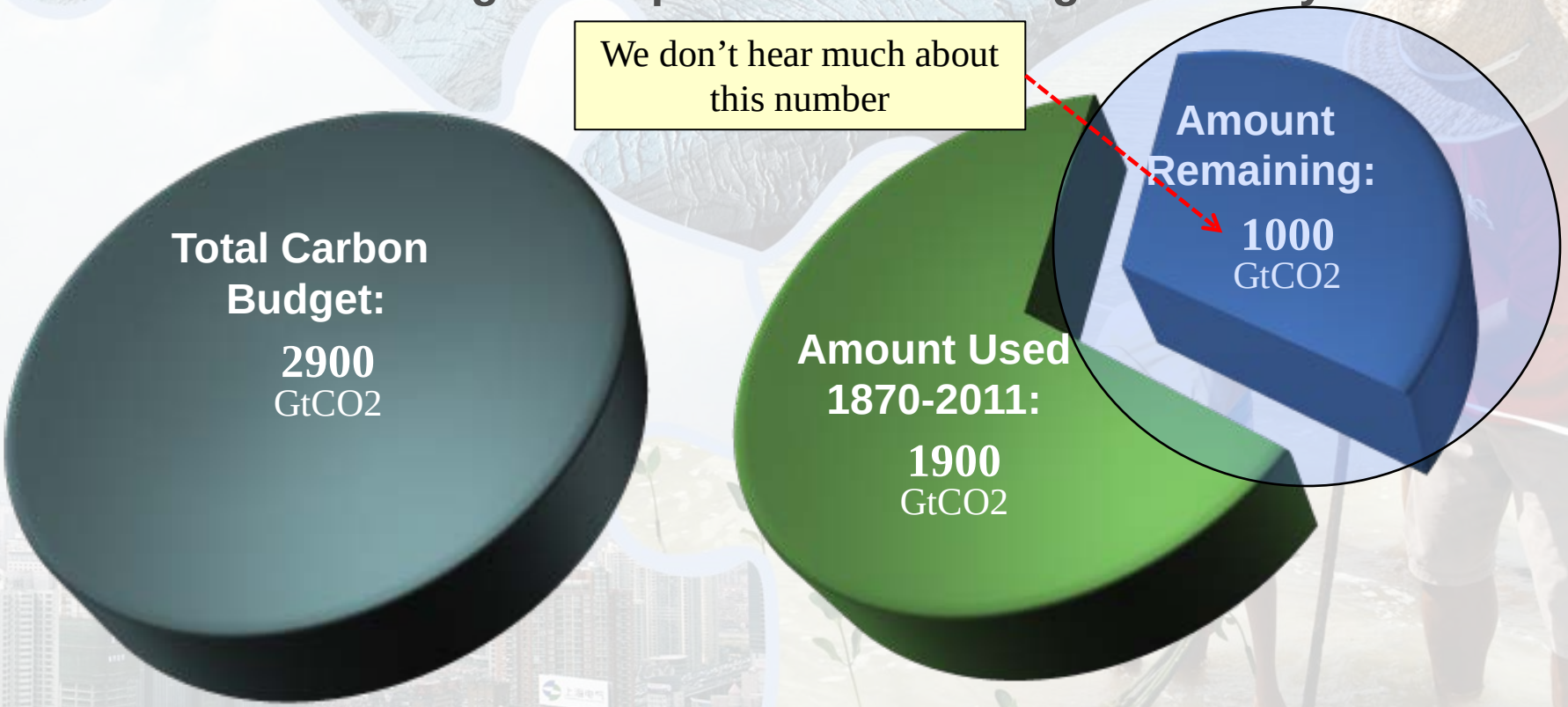
THE BIG PICTURE: World Industrial Power Prices

How much industry pays for power varies tremendously by country, owing to variations in generation costs, network costs, and taxes, fees, and surcharges. This comparison shows average industrial electricity prices in 2013, with each nation's tax component. Also shown is the fuel source that dominated each nation's power mix in 2013. *Source: UK Department of Energy and Climate Change, Eurostat, International Energy Agency* ***—Copy and artwork by Sonal Patel, associate editor***

Only Norway has a lower Industrial Electricity price (without taxes) than the U.S.

The window for action is rapidly closing

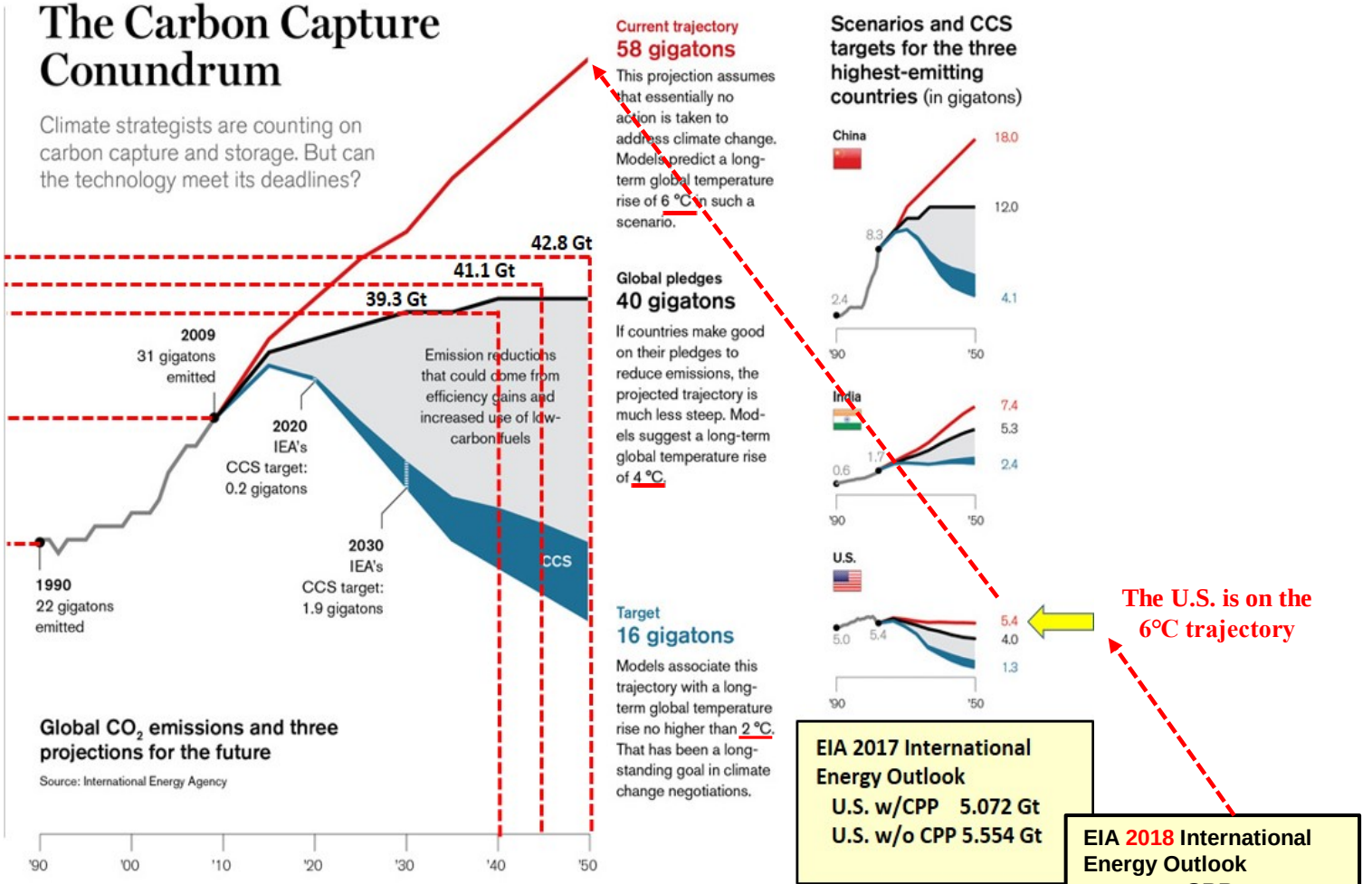
65% of our carbon budget compatible with a 2°C goal already used



AR5 WGI SPM

EIA Annual Energy Outlook 2018

Values from EIA WW Annual Energy Outlook 2017 (slide 19)



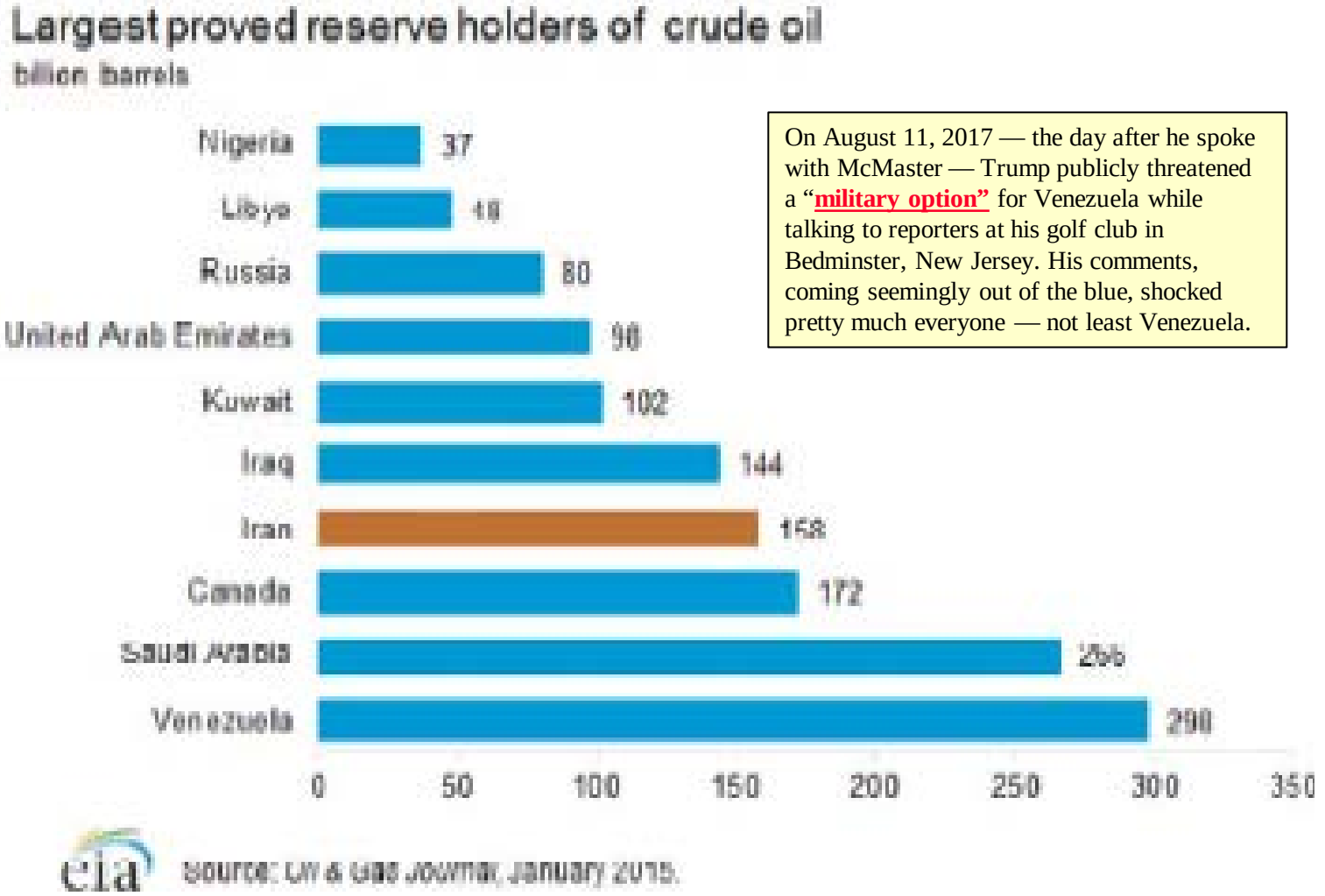
The U.S. is on the 6°C trajectory

EIA 2017 International Energy Outlook
U.S. w/CPP 5.072 Gt
U.S. w/o CPP 5.554 Gt

EIA 2018 International Energy Outlook
U.S. w/ CPP 5.013 Gt
U.S. w/o CPP 5.279 Gt
High Growth 5.815 Gt

Oil Supply/Demand Balance
The Fight for Market Share

Largest Proven Crude Oil Reserves



On August 11, 2017 — the day after he spoke with McMaster — Trump publicly threatened a "**military option**" for Venezuela while talking to reporters at his golf club in Bedminster, New Jersey. His comments, coming seemingly out of the blue, shocked pretty much everyone — not least Venezuela.

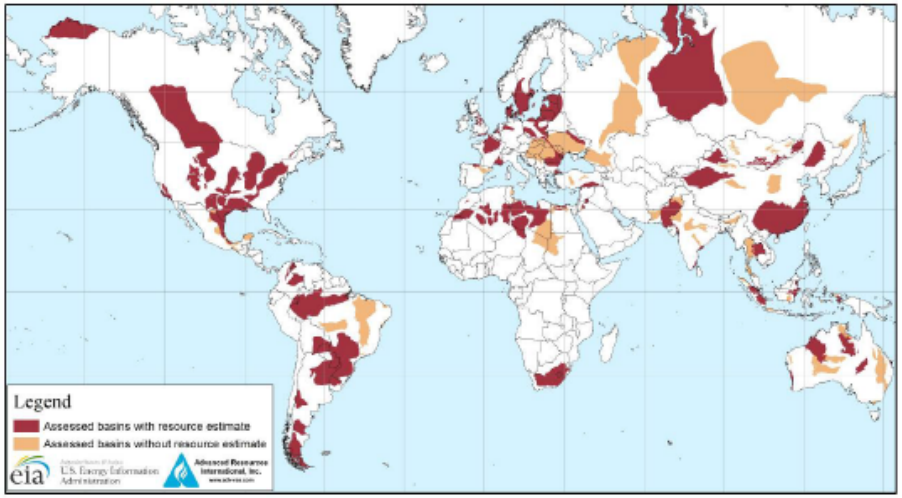
EIA/ARI Technically Recoverable Shale Resources - 2013

Table 1. Comparison of the 2011 and 2013 reports

ARI report coverage	2011 Report	2013 Report
Number of countries	32	41
Number of basins	48	95
Number of formations	69	137
Technically recoverable resources, including U.S.		
Shale gas (trillion cubic feet)	6,622	7,299
Shale / tight oil (billion barrels)	32	345

Note: The 2011 report did not include shale oil; however, the *Annual Energy Outlook 2011* did (for only the U.S.) and is included here for completeness

Figure 1. Map of basins with assessed shale oil and shale gas formations, as of May 2013



Source: United States basins from U.S. Energy Information Administration and United States Geological Survey; other basins from ARI based on data from various published studies.

Table 5. Top 10 countries with technically recoverable shale oil resources

Rank	Country	Shale oil (billion barrels)	
1	Russia	75	
2	U.S.[1]	58	(48)
3	China	32	
4	Argentina	27	
5	Libya	26	
6	Venezuela	13	
7	Mexico	13	
8	Pakistan	9	
9	Canada	9	
10	Indonesia	8	
	World Total	345	(335)

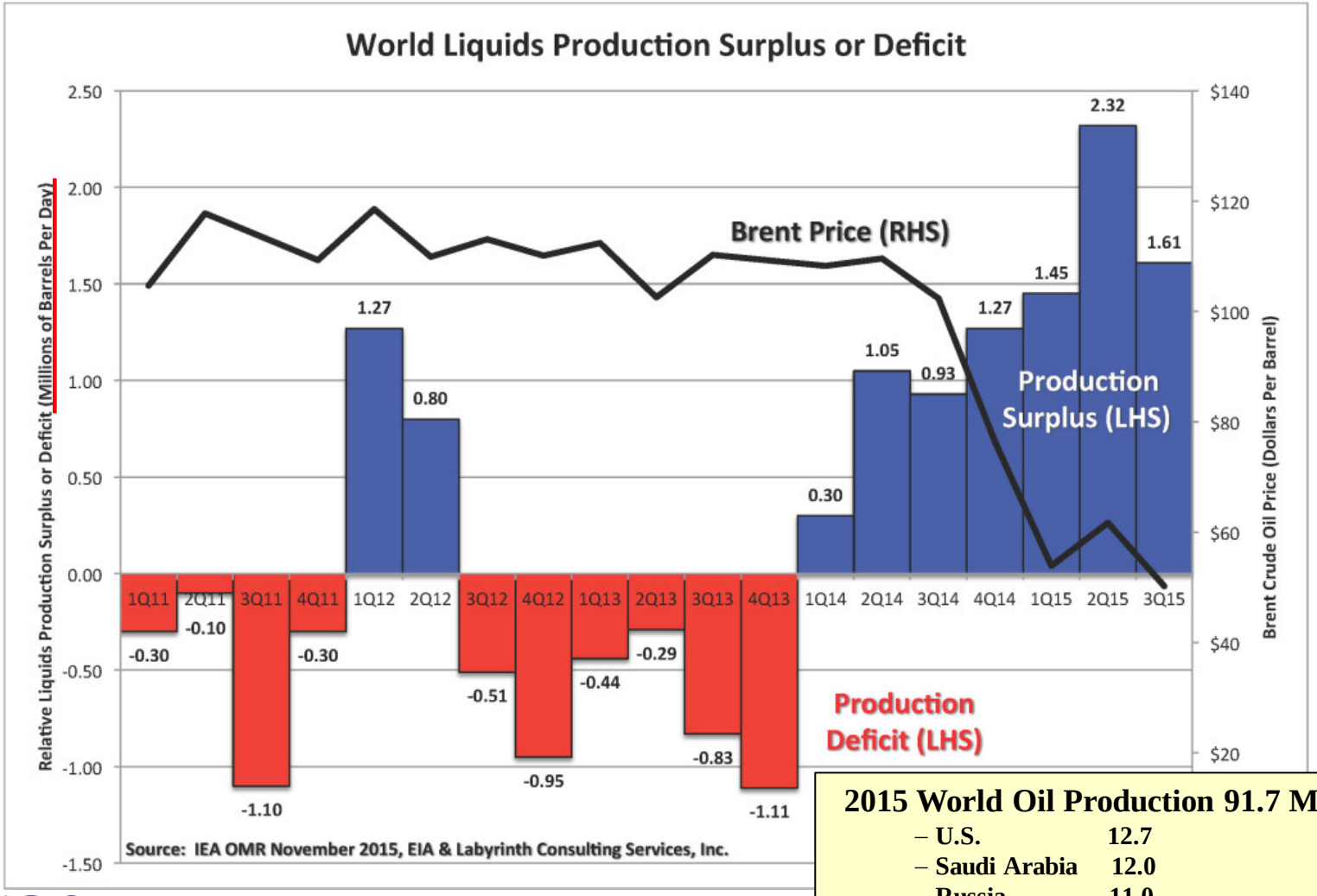
[1] EIA estimates used for ranking order. ARI estimates in parentheses.

Table 6. Top 10 countries with technically recoverable shale gas resources

Rank	Country	Shale gas (trillion cubic feet)	
1	China	1,115	
2	Argentina	802	
3	Algeria	707	
4	U.S.[1]	665	(1,161)
5	Canada	573	
6	Mexico	545	
7	Australia	437	
8	South Africa	390	
9	Russia	285	
10	Brazil	245	
	World Total	7,299	(7,795)

[1] EIA estimates used for ranking order. ARI estimates in parentheses.

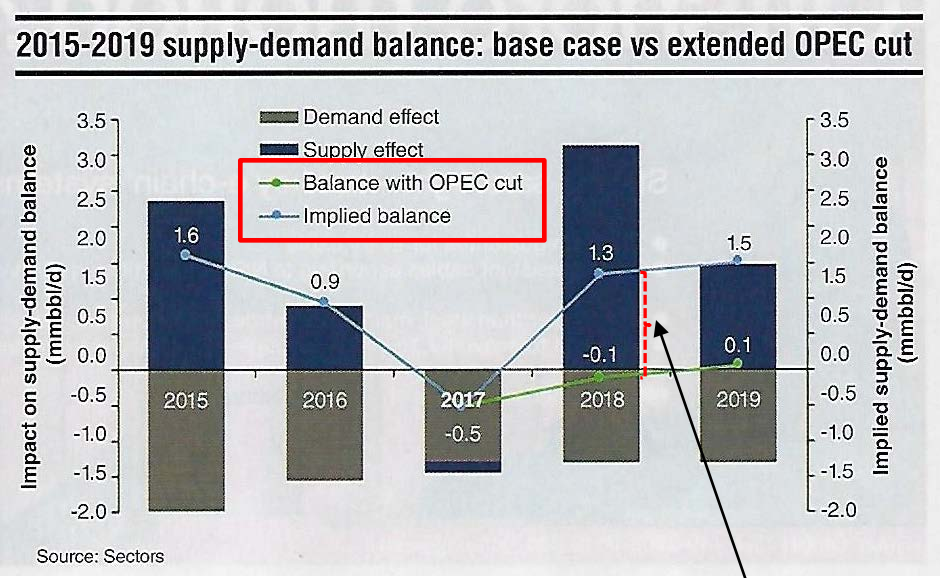
Oil Price – The Supply/Demand Balance



2015 World Oil Production 91.7 MMbbl/d

- U.S. 12.7
- Saudi Arabia 12.0
- Russia 11.0
- Iran 3.9

2015-2019 Supply-Demand Balance



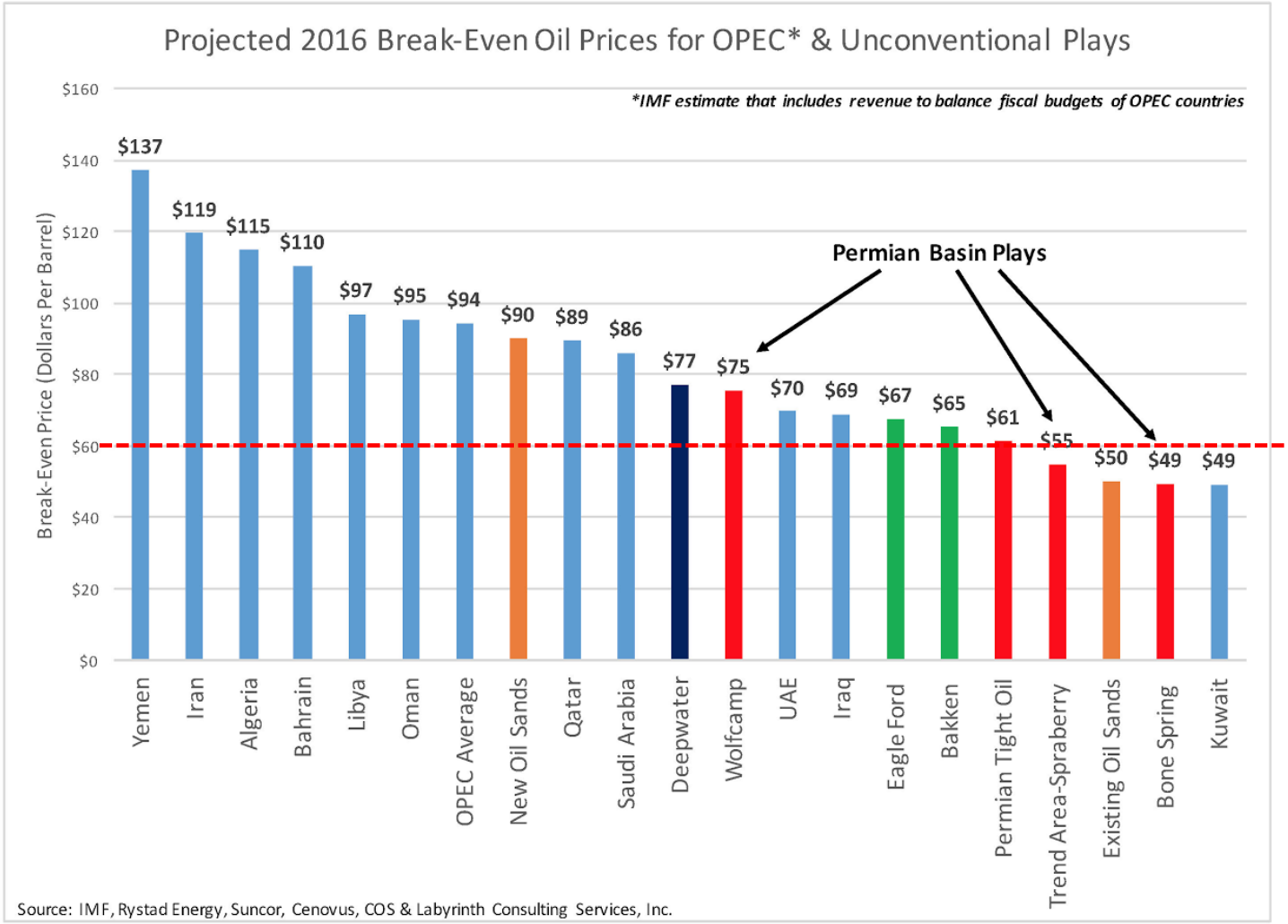
With Base Case, there will be excess supply
With OPEC cut, maintain tight balance
± 1.5 mmbbl/d is a big deal!

WORLDWIDE SUPPLY AND DEMAND

	2017 1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Year	2016 1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Year
	Million b/d									
DEMAND										
OECD										
Americas	24.5	25.0	25.0	25.1	24.9	24.6	24.9	25.3	25.1	25.0
Europe	13.9	14.3	14.7	14.1	14.3	13.8	14.2	14.7	14.3	14.3
Asia Pacific	8.6	7.8	7.9	8.4	8.1	8.5	7.6	7.7	8.2	8.0
Total OECD	**47.0**	**47.0**	**47.6**	**47.5**	**47.3**	**46.9**	**46.8**	**47.7**	**47.6**	**47.3**
Non-OECD										
FSU	4.6	4.7	5.0	4.9	4.8	4.7	4.8	5.1	5.0	4.9
Europe	0.7	0.7	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.8
China	12.5	12.6	12.2	12.4	12.4	12.8	12.9	12.6	13.0	12.8
Other Asia	13.2	13.5	13.2	13.6	13.4	13.8	14.0	13.6	14.3	13.9
Americas	6.4	6.6	6.7	6.6	6.6	6.5	6.7	6.8	6.7	6.7
Middle East	7.9	8.5	8.7	8.1	8.3	8.1	8.5	8.8	8.2	8.4
Africa	4.5	4.3	4.3	4.4	4.4	4.5	4.4	4.3	4.5	4.5
Total Non-OECD	**49.8**	**51.0**	**50.7**	**50.7**	**50.6**	**51.1**	**52.0**	**52.0**	**52.4**	**51.9**
Total Demand	**96.7**	**98.0**	**98.3**	**98.3**	**97.8**	**98.0**	**98.8**	**99.7**	**100.0**	**99.1**
Supply										
OECD										
Americas	19.9	19.8	20.2	20.5	20.1	21.1	21.1	21.5	21.9	21.4
Europe	3.7	3.5	3.4	3.4	3.5	3.6	3.6	3.5	3.6	3.6
Asia Pacific	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4
Total OECD	**24.0**	**23.6**	**23.9**	**24.3**	**24.0**	**25.2**	**25.1**	**25.4**	**25.9**	**25.4**
Non-OECD										
FSU	14.5	14.4	14.3	14.4	14.4	14.4	14.4	14.4	14.5	14.4
Europe	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
China	3.9	3.9	3.8	3.8	3.9	3.8	3.7	3.7	3.7	3.7
Other Asia	3.5	3.5	3.4	3.4	3.5	3.4	3.4	3.4	3.3	3.4
Latin America	4.6	4.5	4.5	4.6	4.6	4.6	4.7	4.7	4.8	4.7
Middle East	1.2	1.2	1.2	1.3	1.2	1.3	1.3	1.3	1.3	1.3
Africa	1.7	1.7	1.8	1.8	1.7	1.8	1.8	1.8	1.8	1.8
Total Non-OECD	**29.5**	**29.3**	**29.2**	**29.3**	**29.4**	**29.3**	**29.4**	**29.4**	**29.6**	**29.4**
Processing gains	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Global biofuels	1.9	2.4	2.8	2.5	2.4	2.0	2.5	2.8	2.5	2.5
Total Non-OPEC	**57.7**	**57.7**	**58.2**	**58.4**	**58.0**	**58.8**	**59.4**	**59.9**	**60.3**	**59.6**
OPEC										
Crude	32.1	32.3	32.7	32.4	32.4	32.4	32.5	32.6	32.6	32.5
NGL	6.8	6.9	7.0	6.9	6.9	7.0	7.0	7.0	7.0	7.0
Total OPEC	**38.9**	**39.2**	**39.6**	**39.3**	**39.3**	**39.4**	**39.5**	**39.6**	**39.6**	**39.5**
Total supply	**96.6**	**96.9**	**97.9**	**97.7**	**97.3**	**98.2**	**98.9**	**99.5**	**99.9**	**99.1**
Stock change	(0.1)	(1.1)	(0.5)	(0.6)	(0.5)	0.2	0.1	(0.2)	(0.1)	0.0

Totals may not add due to rounding.
Source: International Energy Agency; OGJ estimate of OPEC crude supply 4Q 2017 through 2018.

Break-Even Price of Oil Selected Locations



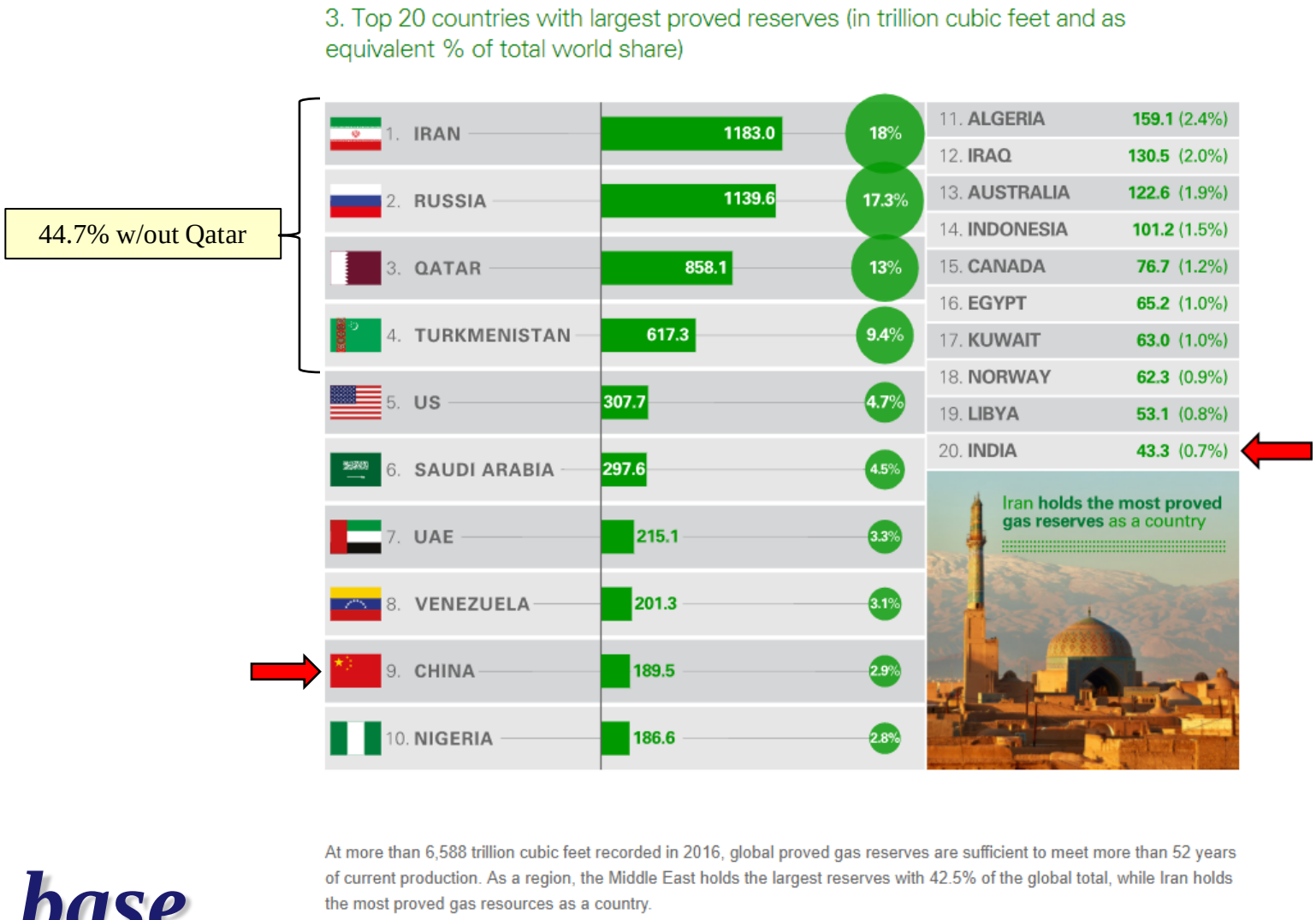
September 25th

- The Brent crude oil price for November jumped by more than $2 on the London market to settle above $81/bbl on Sept. 24, marking the highest Brent settlement since November 2014. For this year, it was the first time since May that Brent broke above $80/bbl.
- US light, sweet crude for November delivery jumped by $1.30 to settle above $72/bbl, marking its highest front-month level since early July.
- Analysts attributed the oil price hikes to comments made during a weekend meeting of members of the Organization of Petroleum Exporting Countries and some non-OPEC members, including Russia.
- Representatives of Saudi Arabia and Russia suggested those countries want to leave production at existing production targets. Meanwhile, some worry that US sanctions against Iran and outages in Venezuela will reduce world oil supply.
- Analysts say that some countries likely would have to increase production to make up for reduced oil supplies on world markets even at the existing production targets.
- The light, sweet crude contract for November delivery on the New York Mercantile Exchange rose $1.30 to $72.08/bbl on Sept. 24. The December contract gained $1.39 to settle at $71.76/bbl.
- The NYMEX natural gas price for October jumped 6¢ to a rounded $3.04/MMbtu. The Henry Hub cash gas dropped 2¢ to settle at $3.04/MMbtu.

HOUSTON, Sept. 25
09/25/2018
By Paula Dittrick
OGJ Upstream Technology Editor

Natural Gas Supply/Demand Balance
The Fight for Market Share

Natural Gas Reserves



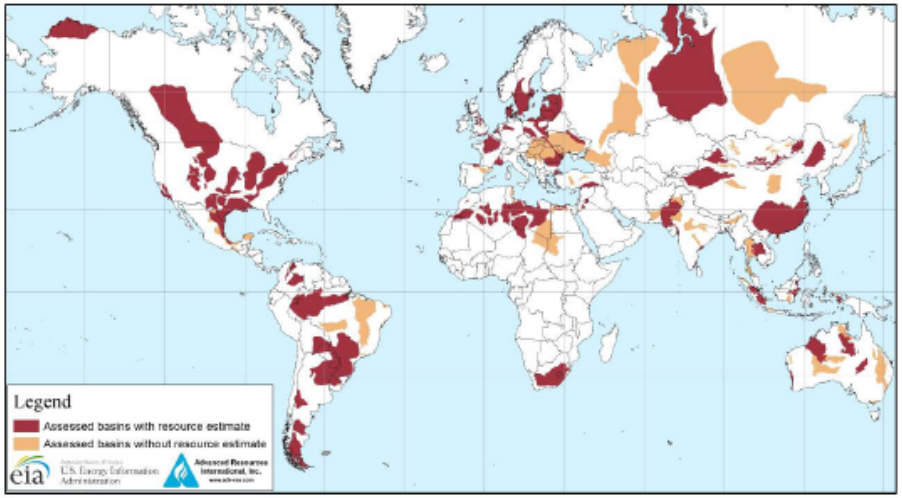
EIA/ARI Technically Recoverable Shale Resources - 2013

Table 1. Comparison of the 2011 and 2013 reports

ARI report coverage	2011 Report	2013 Report
Number of countries	32	41
Number of basins	48	95
Number of formations	69	137
Technically recoverable resources, including U.S.		
Shale gas (trillion cubic feet)	6,622	7,299
Shale / tight oil (billion barrels)	32	345

Note: The 2011 report did not include shale oil; however, the *Annual Energy Outlook 2011* did (for only the U.S.) and is included here for completeness

Figure 1. Map of basins with assessed shale oil and shale gas formations, as of May 2013



Source: United States basins from U.S. Energy Information Administration and United States Geological Survey; other basins from ARI based on data from various published studies.

Table 5. Top 10 countries with technically recoverable shale oil resources

Rank	Country	Shale oil (billion barrels)	
1	Russia	75	
2	U.S.[1]	58	(48)
3	China	32	
4	Argentina	27	
5	Libya	26	
6	Venezuela	13	
7	Mexico	13	
8	Pakistan	9	
9	Canada	9	
10	Indonesia	8	
	World Total	345	(335)

[1] EIA estimates used for ranking order. ARI estimates in parentheses.

Table 6. Top 10 countries with technically recoverable shale gas resources

Rank	Country	Shale gas (trillion cubic feet)	
1	China	1,115	
2	Argentina	802	
3	Algeria	707	
4	U.S.[1]	665	(1,161)
5	Canada	573	
6	Mexico	545	
7	Australia	437	
8	South Africa	390	
9	Russia	285	
10	Brazil	245	
	World Total	7,299	(7,795)

[1] EIA estimates used for ranking order. ARI estimates in parentheses.

Natural Gas Prices – March 2013

Demand:

Japan

- Fukushima = Japan 36% WW LNG
- Oil-price-linked formula

China

- Demand Growth
- Oil-price-linked formula

Europe

- Concern over Russian dependency
- Oil-price-linked formula
- UK declining indigenous supply

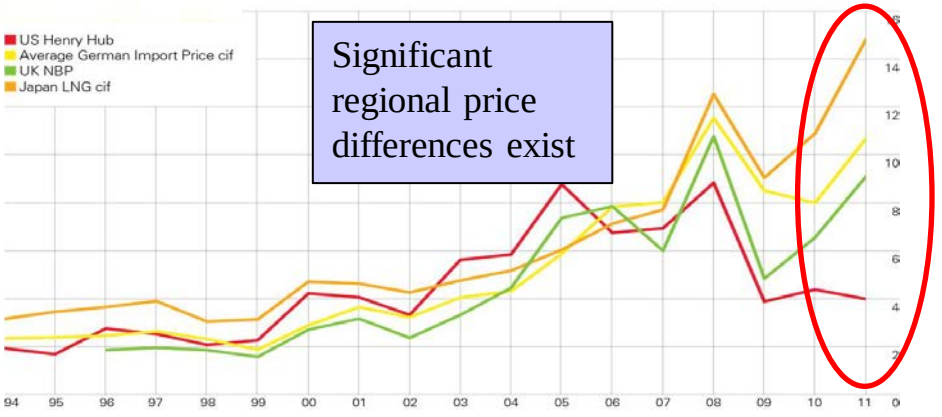
Supply:

North America

- Significant shale resource
- Significant associated gas production

Australia & East Africa

- Project cost/timing uncertainties



base e®

"Practical Strategies for Emerging Energy Technologies"

World LNG Estimated Landed Prices January 2018

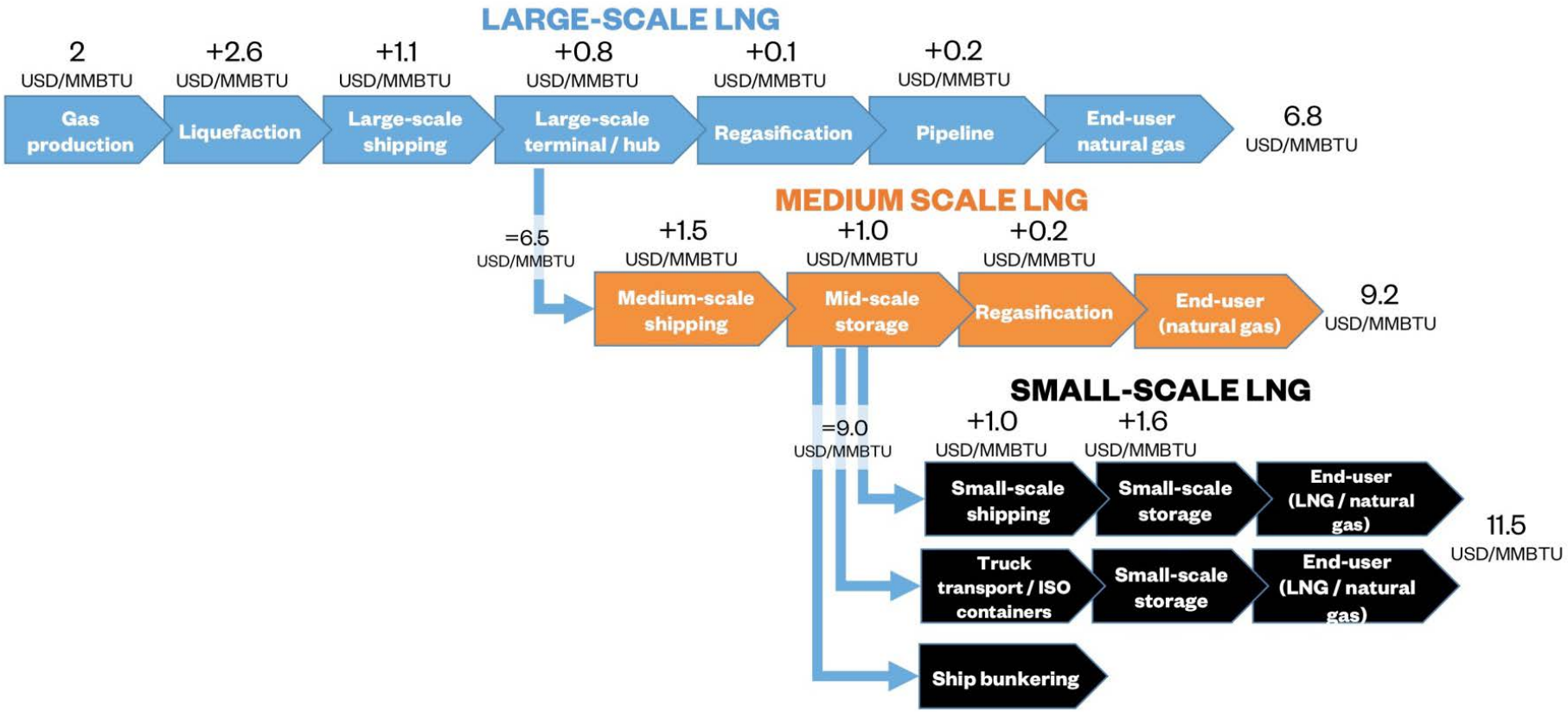
Source: *Waterborne Energy, Inc.* Data in $US/MMBtu.

Note: Includes information and Data supplied by IHS Global Inc. and its affiliates ("IHS"); Copyright (publication year) all rights reserved. Prices are the monthly average of the weekly landed prices for the listed month. Landed prices are based on a netback calculation.

Updated: Feb-18

Pipelines vs. LNG

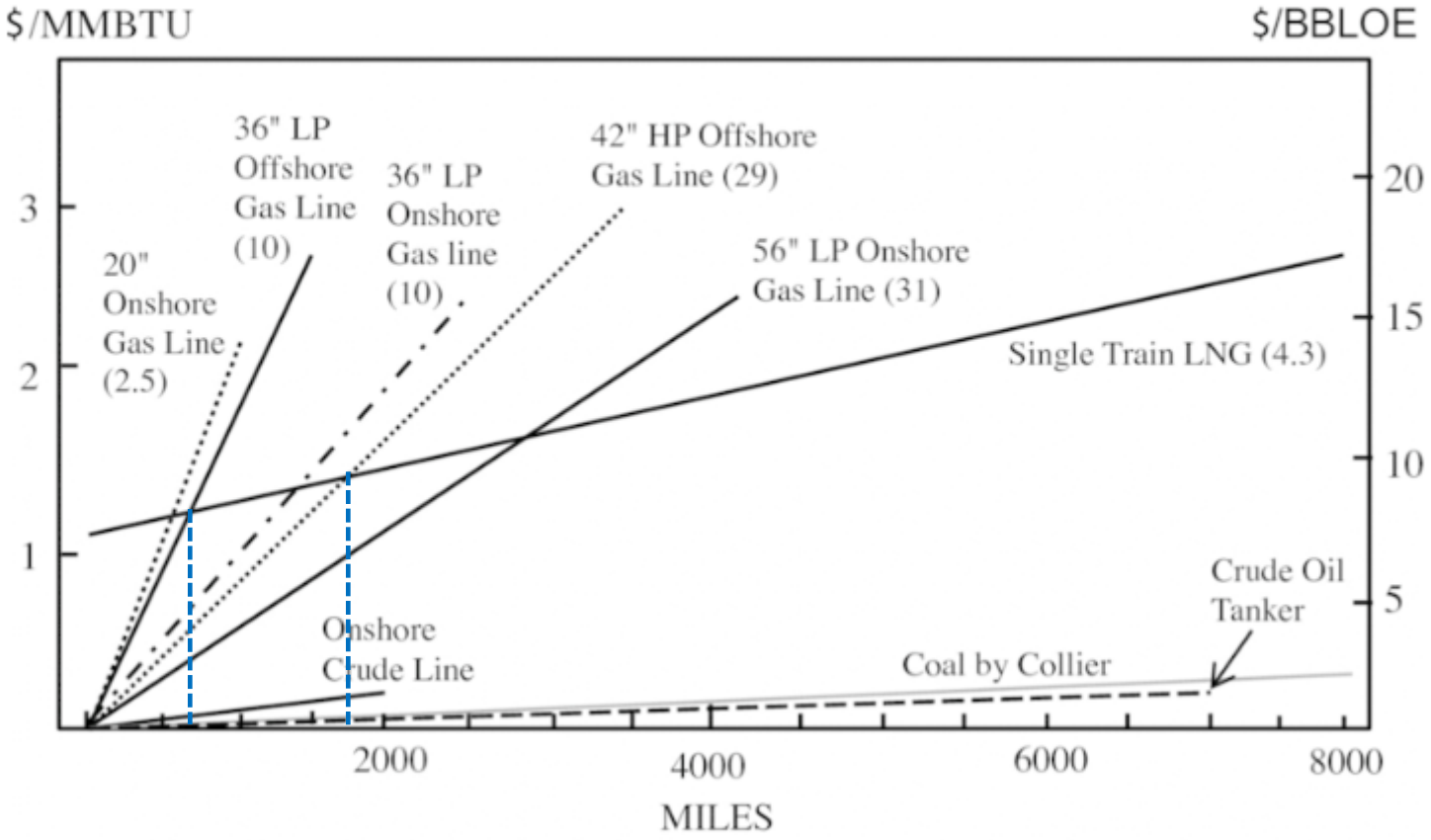
LNG Value Chain



Wärtsilä Technical Journal October 20, 2016

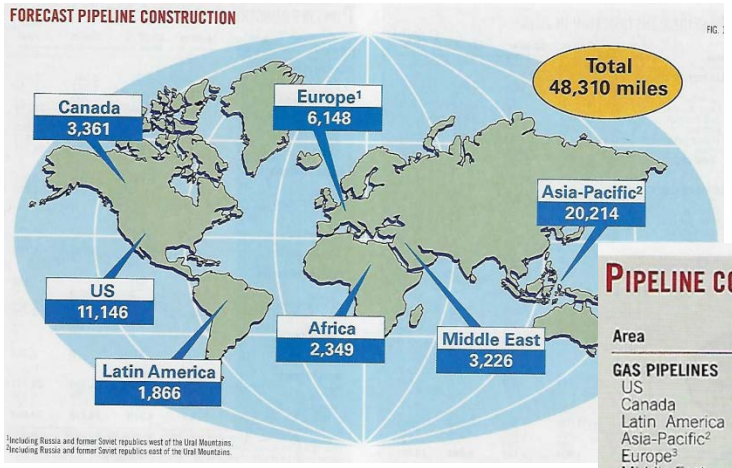
Jensen 2004 Break-even Points

Figure 1 Break-even points. Source of data: [6]6. Jensen , J. 2004. The Development of a Global LNG Market. Is it Likely? If So, When?, Oxford: Oxford Institute for Energy Studies. View all references.



Note: Figures in brackets show gas delivery capability in BCM

Lots of Gas Pipelines



Oil & Gas Journal Feb 5, 2018

PIPELINE CONSTRUCTION IN 2018[1]

Table 1

Area	4-10 in.	12-20 in.	22-30 in.	32+ in.	Total
			Miles		
GAS PIPELINES					
US	30	70	212	2,512	2,824
Canada	0	0	0	0	0
Latin America	0	0	0	879	879
Asia-Pacific[2]	0	848	652	3,658	5,158
Europe[3]	0	111	0	1,141	1,252
Middle East	0	0	16	1,321	1,337
Africa	0	0	465	21	486
Total gas	**30**	**1,029**	**1,345**	**9,532**	**11,936**
CRUDE PIPELINES					
US	34	151	220	0	405
Canada	0	0	0	0	0
Latin America	0	136	0	0	136
Asia-Pacific[2]	0	0	0	0	0
Europe[3]	0	0	0	0	0
Middle East	0	0	0	0	0
Africa	0	0	0	0	0
Total product	**34**	**287**	**220**	**0**	**541**
PRODUCT PIPELINES					
US	34	151	220	0	405
Canada	0	0	0	0	0
Latin America	0	136	0	0	136
Asia-Pacific[2]	0	0	0	0	0
Europe[3]	0	0	0	0	0
Middle East	0	0	0	0	0
Africa	0	0	0	0	0
Total product	**34**	**287**	**220**	**0**	**541**
WORLD TOTALS					
Gas	30	1,029	1,345	9,532	11,936
Crude	65	188	1,570	357	2,180
Product	34	287	220	0	541
Total	**129**	**1,504**	**3,135**	**9,889**	**14,657**

[1]Projects planned to be completed in 2018. [2]Regions east of the Ural Mountains and south of the Caucasus Mountains, excluding the Middle East. [3]Regions west of the Ural Mountains and north of the Caucasus Mountains.

PIPELINE CONSTRUCTION BEYOND 2018[1]

Table 2

Area	4-10 in.	12-20 in.	22-30 in.	30+ in.	Total
			Miles		
GAS PIPELINES					
US	0	0	91	3,541	3,632
Canada	0	85	0	1,989	2,074
Latin America	0	0	15	700	715
Asia-Pacific[2]	0	0	1,884	10,107	11,991
Europe[3]	0	93	832	3,796	4,721
Middle East	0	0	292	373	665
Africa	0	0	0	933	933
Total gas	0	178	3,114	21,439	24,731
CRUDE PIPELINES					
US	0	535	1,795	515	2,845
Canada	0	0	0	1,228	1,228
Latin America	0	0	0	0	0
Asia-Pacific[2]	0	0	0	0	0
Europe[3]	0	0	0	0	0
Middle East	0	0	109	1,043	1,152
Africa	0	0	930	0	930
Total crude	**0**	**535**	**2,834**	**2,786**	**6,155**
PRODUCT PIPELINES					
US	0	561	571	0	1,132
Canada	0	0	0	0	0
Latin America	0	136	0	0	136
Asia-Pacific[2]	0	1,499	0	0	1,499
Europe[3]	0	0	0	0	0
Middle East	0	0	0	0	0
Africa	0	0	0	0	0
Total product	**0**	**2,196**	**571**	**0**	**2,767**
WORLD TOTALS					
Gas	0	178	3,114	21,439	24,731
Crude	0	535	2,834	2,786	6,155
Product	0	2,196	571	0	2,767
Total	**0**	**2,909**	**6,519**	**24,225**	**33,653**

[1]Projects under way at the start of or set to begin in 2018 and be completed after 2018. Includes some probable major projects whose installation will begin in 2018 or later. [2]Regions east of the Ural Mountains and south of the Caucasus Mountains, excluding the Middle East. [3]Regions west of the Ural Mountains and north of the Caucasus Mountains.

Global LNG Growth

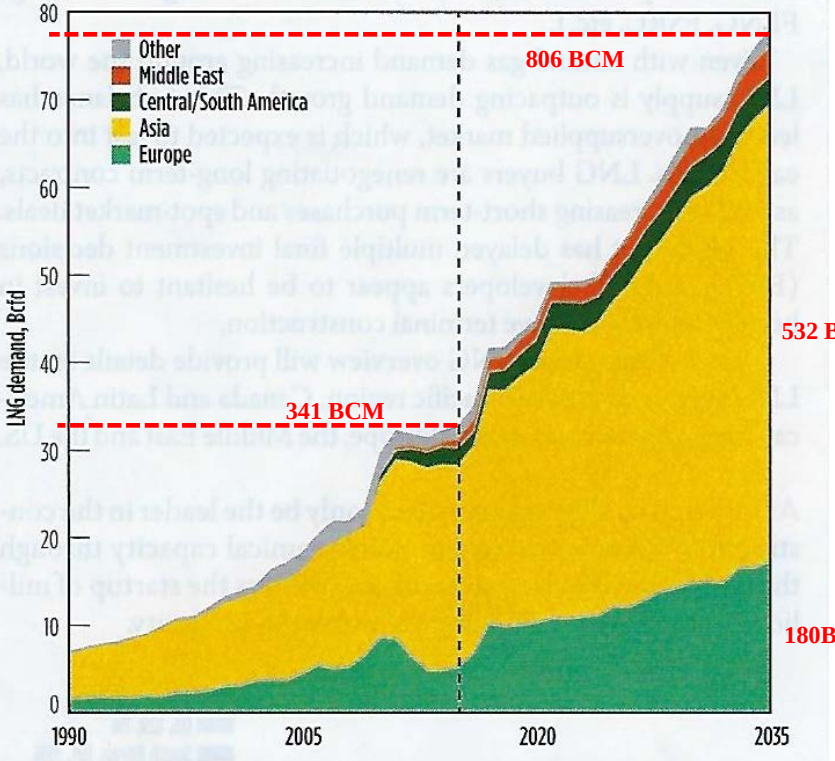


FIG. 3. Global growth in LNG demand to 2035. Source: BP.

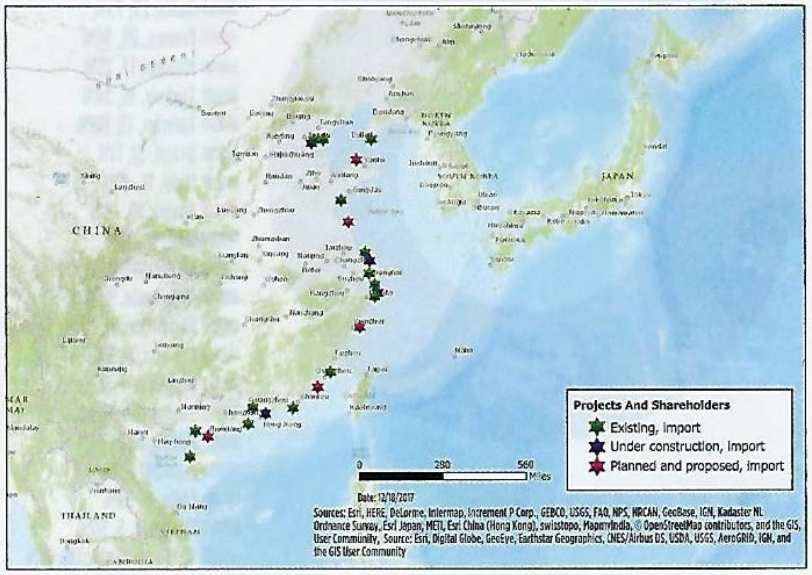


FIG. 4. LNG import terminals in China. Source: Energy Web Atlas.

LNG Market - 2016

Suppliers

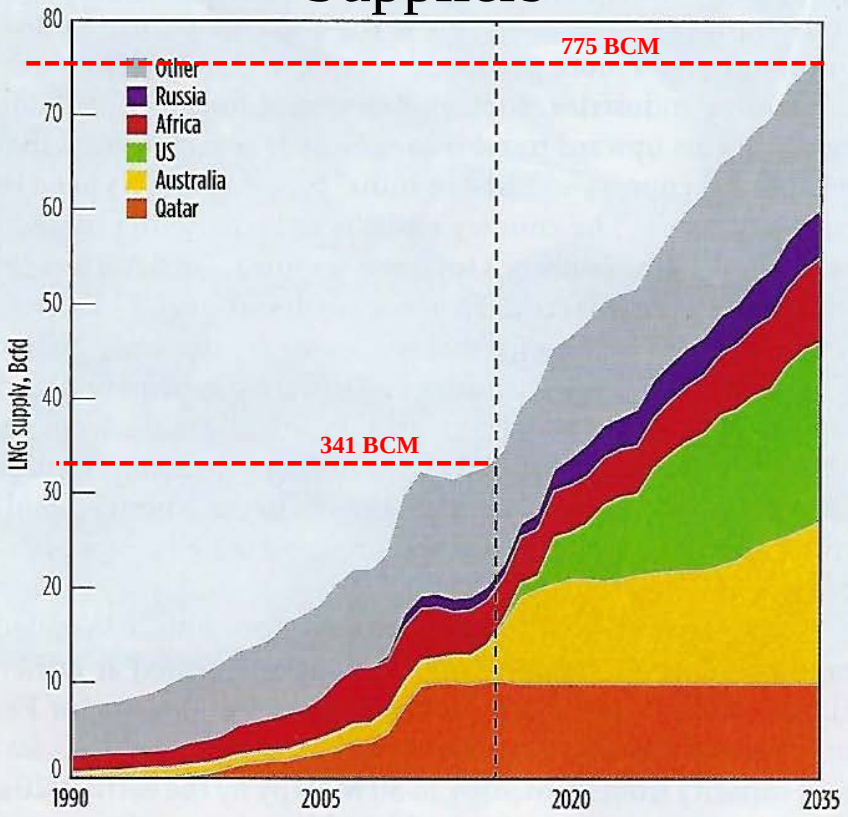


FIG. 1. Global growth in LNG supply to 2035. Source: BP.

Regasification (Users)

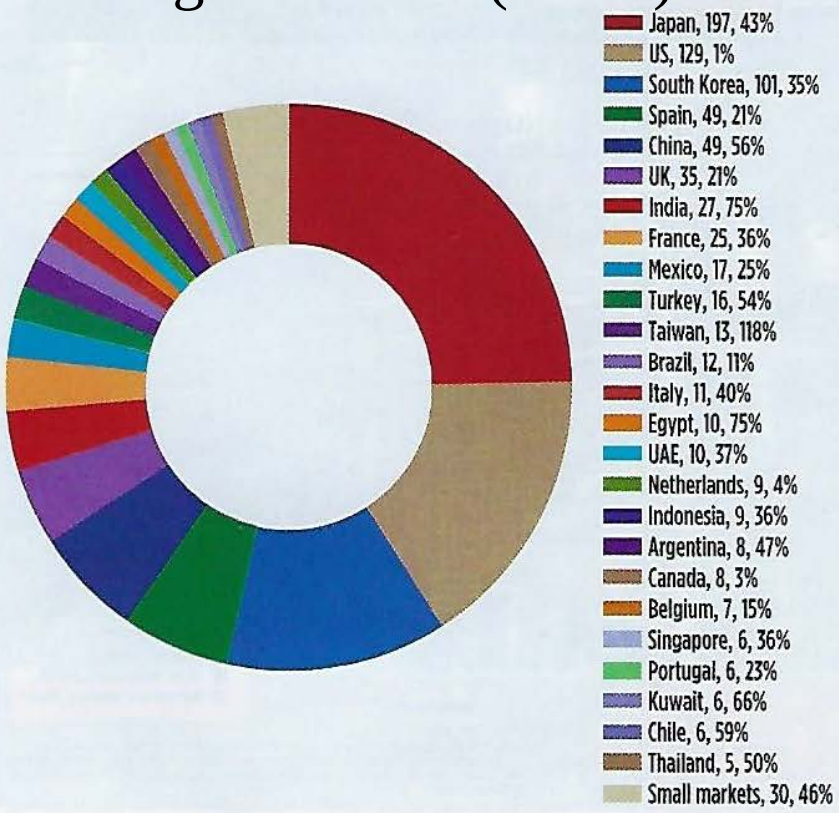
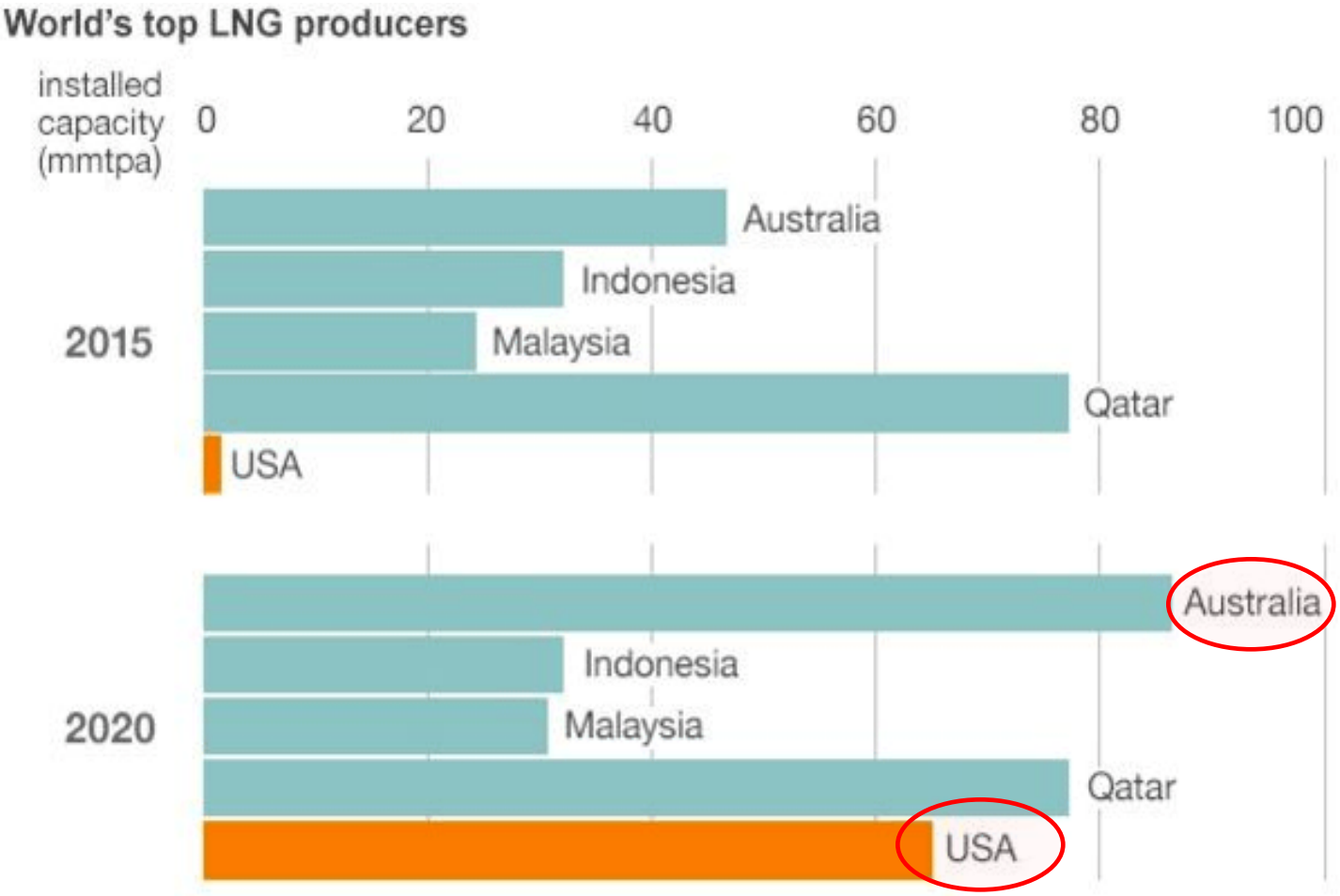


FIG. 2. LNG regasification capacity (MMtpy) by country, 2016. Source: IGU.

Top LNG Producers



Source: Poyry Management Consulting

Australia Supply Strategy

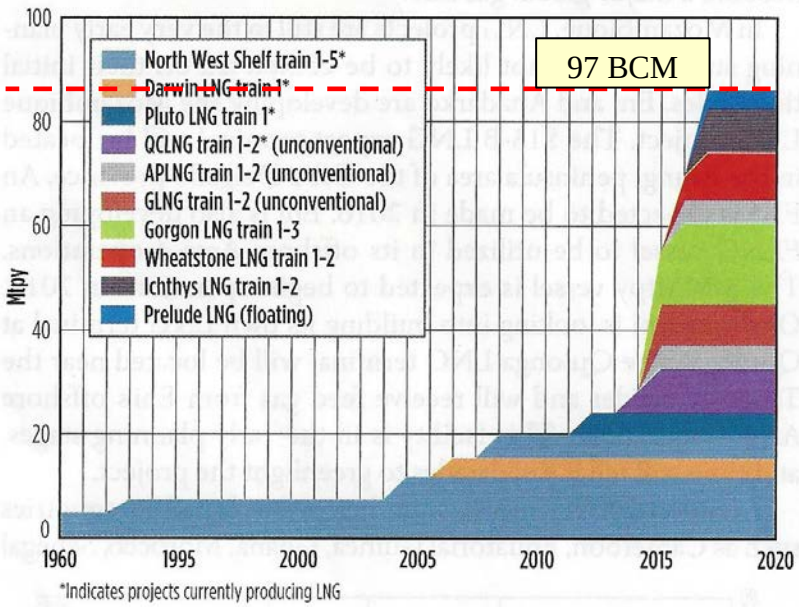
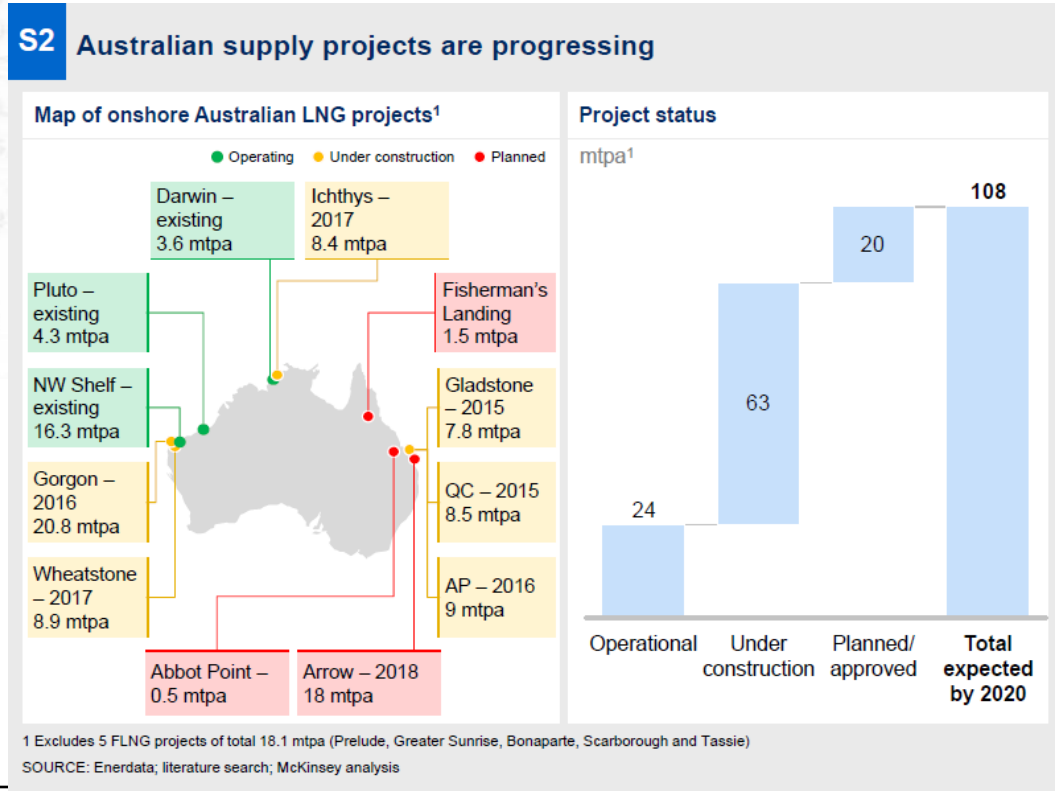


FIG. 2. Australian liquefaction capacity. Source: Australian Department of Industry and Reserve Bank of Australia.

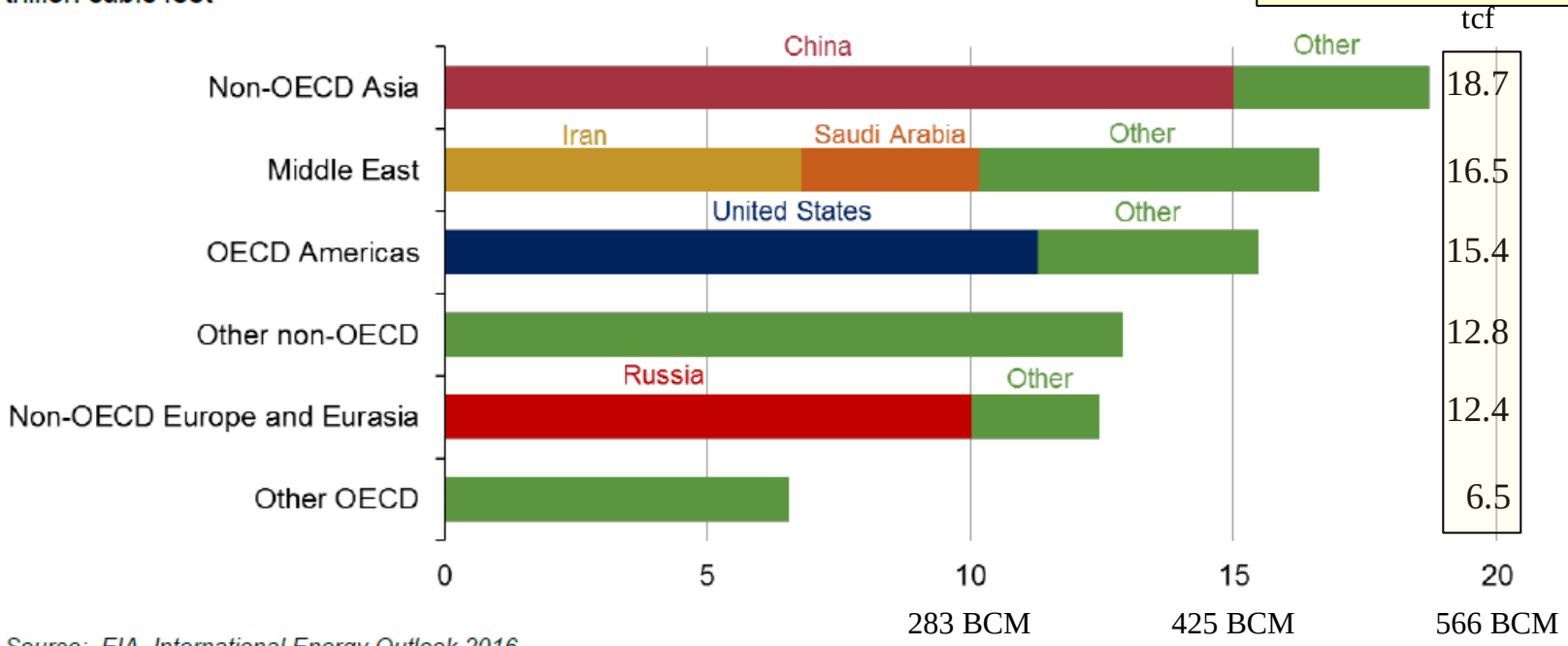


World Change in Gas Production – 2012-2040

Non-OECD Asia, Middle East, and OECD Americas account for the largest increases in natural gas production

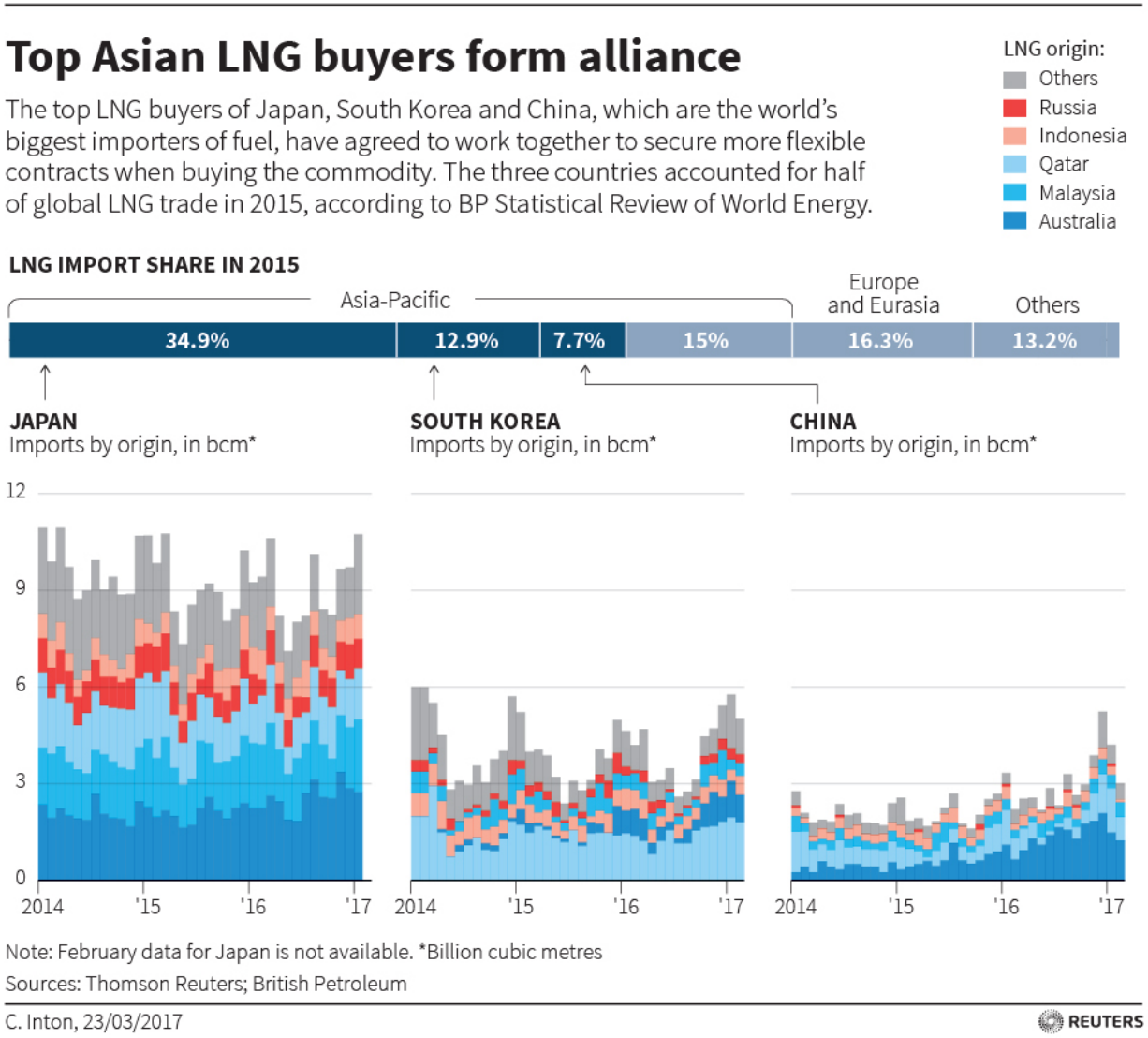
world change in natural gas production, 2012–40
trillion cubic feet

+82.3 tcf = 2330 BCM

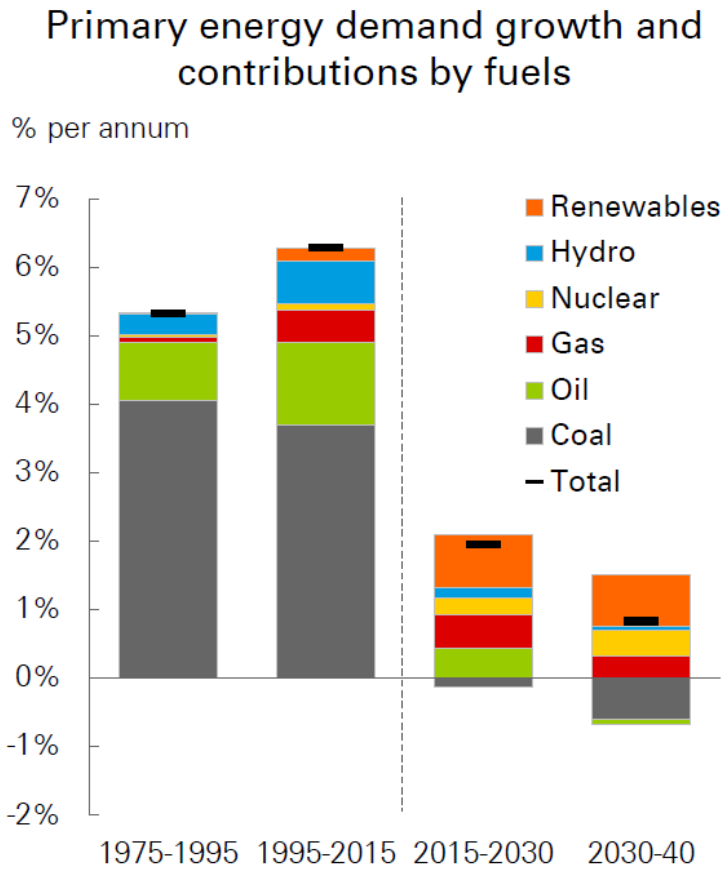


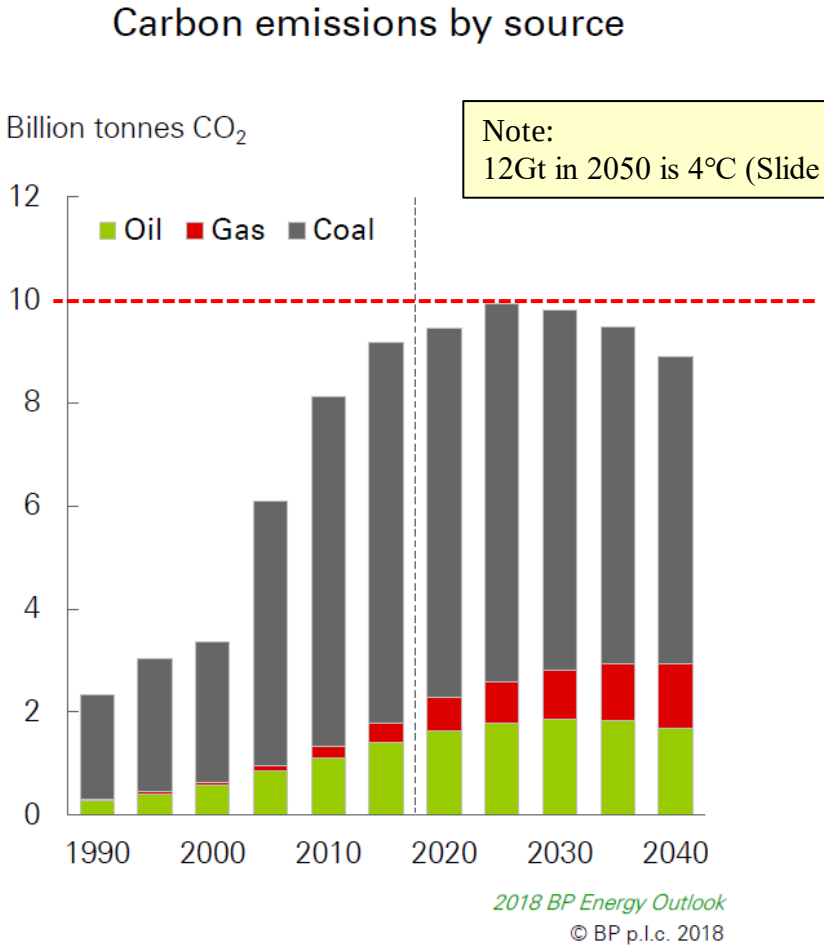
Source: EIA, International Energy Outlook 2016

Changing LNG Contract Terms – More Flex together



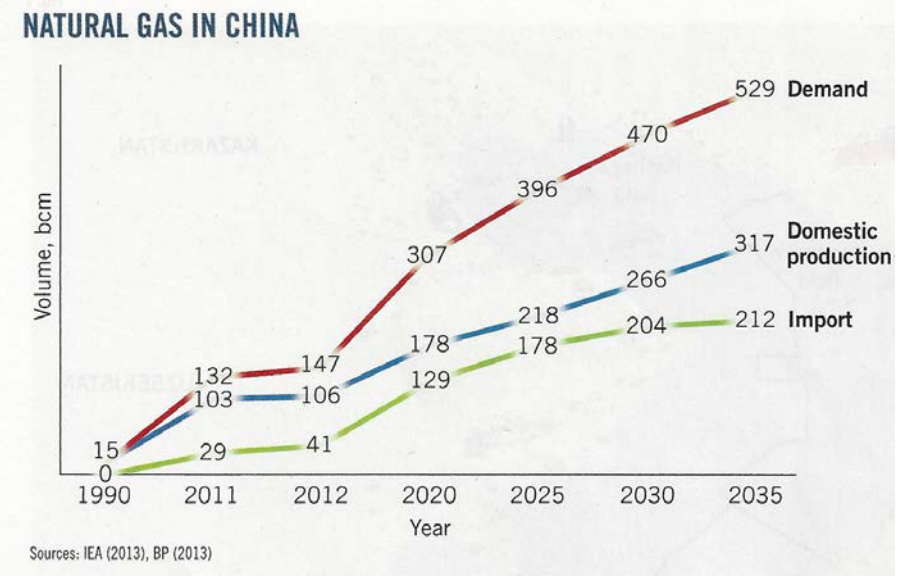
China's Energy Needs Forecast

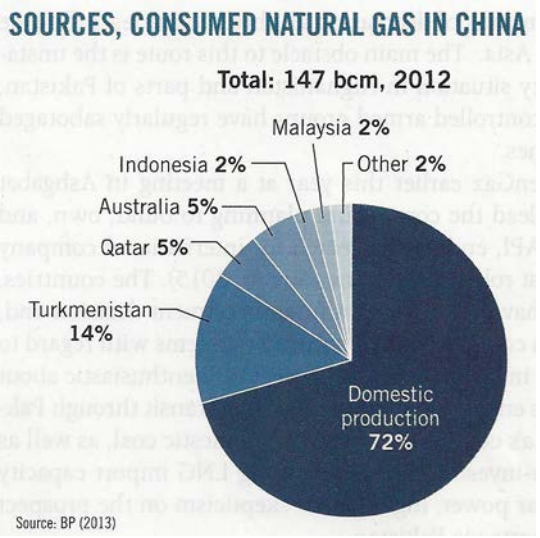




Note:
12Gt in 2050 is 4°C (Slide 14)

China Natural Gas





- 147 in 2012
  - Domestic production
  - Imported

3x @3.5% pa

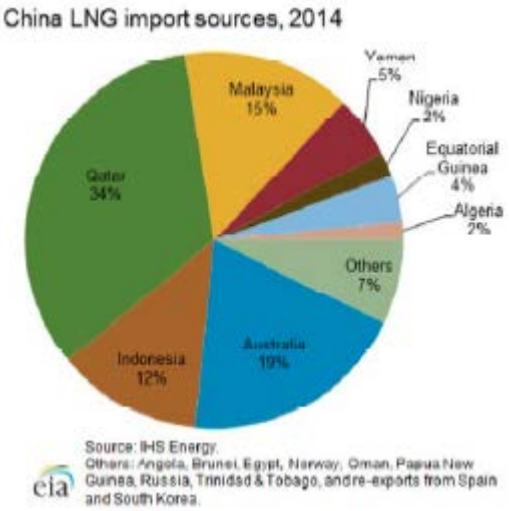
106
41
147

5x @ 12.8% pa

- 529 in 2035
  - Domestic production
  - Imported

317
212
529

$(529/147)^{1/33} = 4.0\%$ per year



LNG vs. U.S./China “Trade War”

Before the discussion of tariffs on LNG

- (Reuters) - China's interest in reducing its trade surplus with the United States through increased energy imports could advance plans for U.S. liquefied natural gas (LNG) plants and ethanol sales
- "China represents an enormous economic opportunity for U.S. LNG and ethanol exports as both products will likely see dramatic demand growth in the coming years”
- Bays estimated that substantial LNG sales commitments could bring in $20 billion to $30 billion annually and ethanol sales could reach $5 billion to $7 billion annually. She noted, however, that the LNG and ethanol markets were not big enough by themselves to meet President Donald Trump's goal of reducing the Chinese trade deficit by $200 billion per year.
- There are more than two dozen proposed U.S. LNG plants waiting for customer commitments to reach a final investment decision, many of them looking to China for deals.
- China overtook South Korea in 2017 as the world's second biggest buyer of LNG behind Japan. The country, which imported 5.6 billion cubic feet per day last year, is looking to buy more low cost sources of energy, like gas, to reduce its use of coal and cut pollution.
- "If you look at some forecasts for 2035, there are really only two places that have significant increases in LNG imports. Europe goes up about 100 mtpa and China goes up about 200 mtpa," Vesey said.
- Texas LNG, which is proposing a 4-mtpa export facility in Brownsville, Texas, and has five early-stage agreements with Chinese customers, hopes to make a final decision next year, about six months behind its original goal.

China LNG Tariff

China keeps LNG off tariff list for now, could be trade weapon later
July 5, 2018

- BEIJING, (Reuters) - China's omission of liquefied natural gas (LNG) from its vast list of U.S. products that face hefty import duties has preserved a potential weapon should the trade war with Washington deepen.
- It also underscores Beijing's desire to ensure supplies of gas as it pushes to switch millions of households and businesses away from using coal as a key part of its 'war on pollution'.
- Although U.S. LNG supplies to China have so far been tiny in volume and value compared with the around $12 billion per year of U.S. crude that arrives in the country, analysts say those levels could be set to shoot up as Beijing forges ahead with its battle to clear its skies.
- Morgan Stanley has estimated annual Chinese imports of U.S. LNG could rise to as much as $9 billion within two or three years, from $1 billion in 2017.
- That would go a long way to helping balance China's trade surplus with the United States, a major bugbear of Washington's in the trade dispute.
- "It is easier for China to switch into other suppliers in the soybean market. Duties on soybeans hurt the U.S. more, but duties on energy products would hurt both sides."
- At a meeting between the government and China's three oil and gas majors ahead of U.S. President's visit to the country last September, the companies underlined that China would have limited alternative sources for LNG imports.
- "The conclusion at that time was that U.S. oil is not competitive," the official said. "In the gas market, we don't have much choice, mainly Qatar, Australia and the U.S."
- Domestic natural gas demand rose 17.6 percent in the first five months of 2018, way above government forecasts of an annual growth rate of 7 or 8 percent, data from National Development and Reform Commission showed.

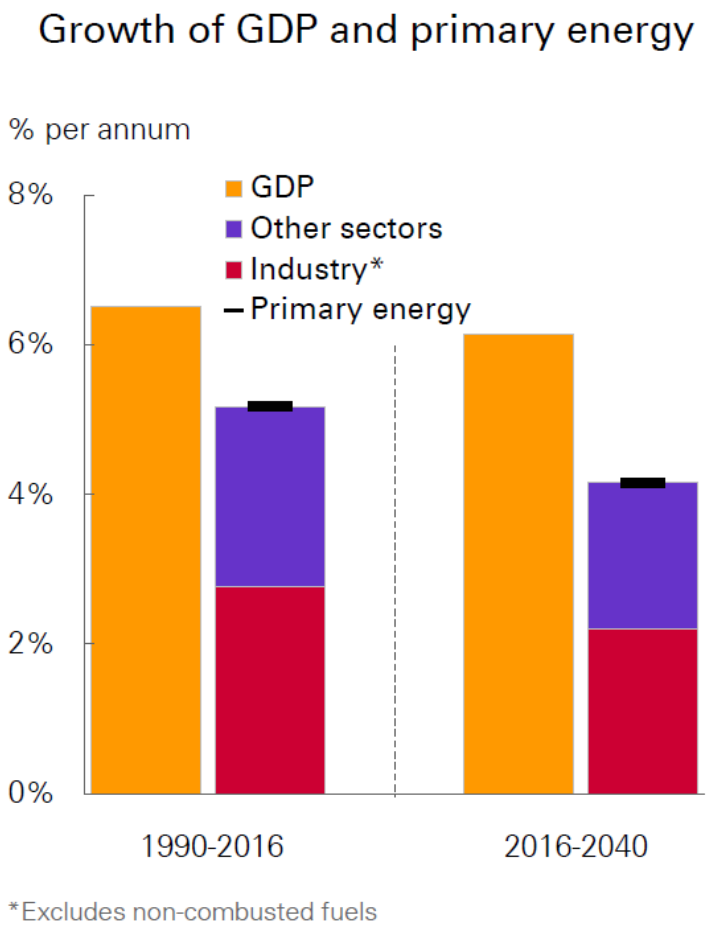
China Goes for Gas in Iran

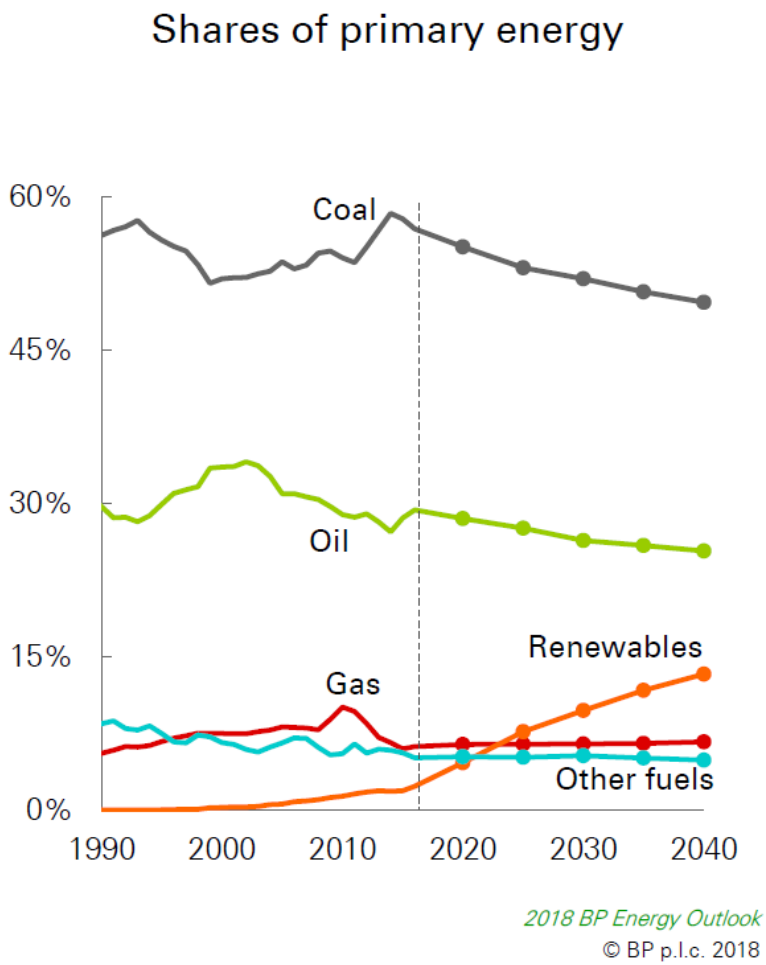
- Beijing glimpses a Middle East energy consolidation, by replacing France's Total in South Pars gas expansion venture
- Total is involved in the Phase 11 development of the huge offshore South Pars gasfield, which is shared with Qatar
- If the US administration does not agree with Total staying in Iran, China will replace this company".
- China National Petroleum Corporation, expecting that Trump would target Iran over the nuclear issue, has been making preparations for several months to step into Total's shoes.
- If CNPC does indeed enter South Pars, then it will be a further and important step along the path of China deepening its energy ties with the Middle East.
- China's domestic crude oil production is in decline, while demand is increasing
  - China produced 3.8m barrels a day in 2017, a fall of 150,000 b/d on 2016—and the third annual decline in succession.
  - Imports rose from 2m b/d in 2004 to 8.4m b/d in 2017
  - China has now overtaken the US as the world's biggest crude importer.
  - Russia is China's largest single supplier of crude oil, with exports soaring from 665,000 b/d in 2014 to 1.2 million b/d last year
  - Russia and China are also doubling the capacity of the East Siberia-Pacific Ocean oil pipeline to 600,000 b/d,
- Three countries of the Gulf Cooperation Council—Kuwait, Saudi Arabia and the United Arab Emirates—remain key suppliers; along with Iran and Iraq.
  - Kuwait's exports to China rose from 208,000 b/d in 2012 to 363,000 b/d in 2017
  - Export rates from Saudi Arabia and the UAE fluctuated slightly over the same period
  - Outside the GCC, Iran's sales to Chinese buyers rose from 438,000 b/d in 2012 to 621,000 b/d last year
  - Iraq's more than doubled from 313,000 b/d to 738,000 b/d.
- Among the small Gulf producers
  - Oman's crude oil exports to China rose from 598,000 b/d in 2014 to 624,000 b/d in 2017
  - Qatar tripled its crude exports to China between 2014 and 2017, recording 21,000 b/d in the latter
  - Chinese companies are also active in Iraq, the Kurdish region of northern Iraq and the UAE, as well as Egypt, South Sudan and Algeria.

Whenever IOCs bow out of potentially rich hydrocarbon regions in the Middle East, or are forced to leave, expect China to be ready and willing to take over.

Gas to India

India Emerges as Largest Energy Growth Market





India Natural Gas

- India plans to dramatically increase its LNG import capacity
  - Indian gas production meets nearly half of domestic demand
  - The country's domestic natural gas production peaked in 2010 at 44.5 Bm^3,
  - Production has declined over the past few years, settling at 29.2 Bm^3 in 2015
  - India must rely on imports to satisfy demand
- India is expanding import capacity at its LNG terminals, as well as building grassroots facilities and utilizing floating storage and regasification unit (FSRU) vessels
  - The country has four operational LNG import terminals with a combined installed capacity of 25 MMtpy
  - India's Ministry of Petroleum and Natural Gas announced that LNG import capacity will increase from 25 MMtpy to 50 MMtpy
  - Nearly 80% of these new LNG supplies will come from Australia and the US.
- India is also planning to utilize LNG as a bunker fuel and transportation fuel.
  - The country has plans to build four LNG barges along the Ganges River.
  - These barges will provide waterway transport vessels with cleaner-burning LNG, as opposed to diesel fuel.
- India is also promoting the use of LNG-fueled vehicles to curb emissions and mitigate its dependence on oil imports
  - India's Petronet is heavily involved in promoting LNG as a transportation fuel
  - Plan includes LNG to be used in vehicles, water vessels and trains
  - Petronet is also in talks with major Indian fuel retailers to install LNG pumps at their fuel locations.
- LNG-fueled vehicles, in combination with new Bharat Stage 6 fuel regulations, could have a dramatic impact on vehicle emissions in the country
  - Air pollution has become such a crucial issue that New Delhi and other cities are requiring drivers to use their vehicles only every other day
  - The government is investing in the construction of compressed natural gas (CNG) fueling stations in the hope that citizens will switch to the cheaper, more fuel-efficient transportation option.

India – Gas Supply

TABLE 1. India's LNG import capacity, MMtpy, 2014–2022

Location	2014	2015	2016	2017	2018	2019	2020	2021	2022
Dahej	10	12.5	15	15	15	15	15	15	15
Hazira	5	5	5	10	10	10	10	10	10
Dabhol	5	5	5	5	5	5	5	5	5
Kochi	5	5	5	5	10	10	10	10	10
Ennore	0	0	5	5	5	5	5	5	5
Mundra	0	0	5	5	10	10	10	10	10
Kakinada (FSRU)	0	2.5	5	5	5	5	5	5	5
Gangavaram	0	3	3	3	3	3	3	3	3
East Coast terminal (1)	0	0	0	2.5	2.5	5	5	5	5
West Coast terminal (1)	0	0	0	0	2.5	5	5	5	5
Total	**25**	**33**	**48**	**55.5**	**68**	**73**	**73**	**73**	**73**

Source: Petroleum & Natural Gas Regulatory Board of India

INDIA'S GAS SUPPLY

	2012-13	2016-17	2021-22	2026-27	2029-30
			MMscmd		
Domestic sources	101.1	156.7	182.0	211.0	230.0
LNG imports	44.6	143.0	188.0	214.0	214.0
Cross border pipeline imports*	—	—	30.0	30.0	30.0
Total	145.7	299.7	400.0	455.0	474.0

*TAPI pipeline projected commissioning 2017-18
Source: "Vision 2030 – Natural Gas Infrastructure in India," PNGRB

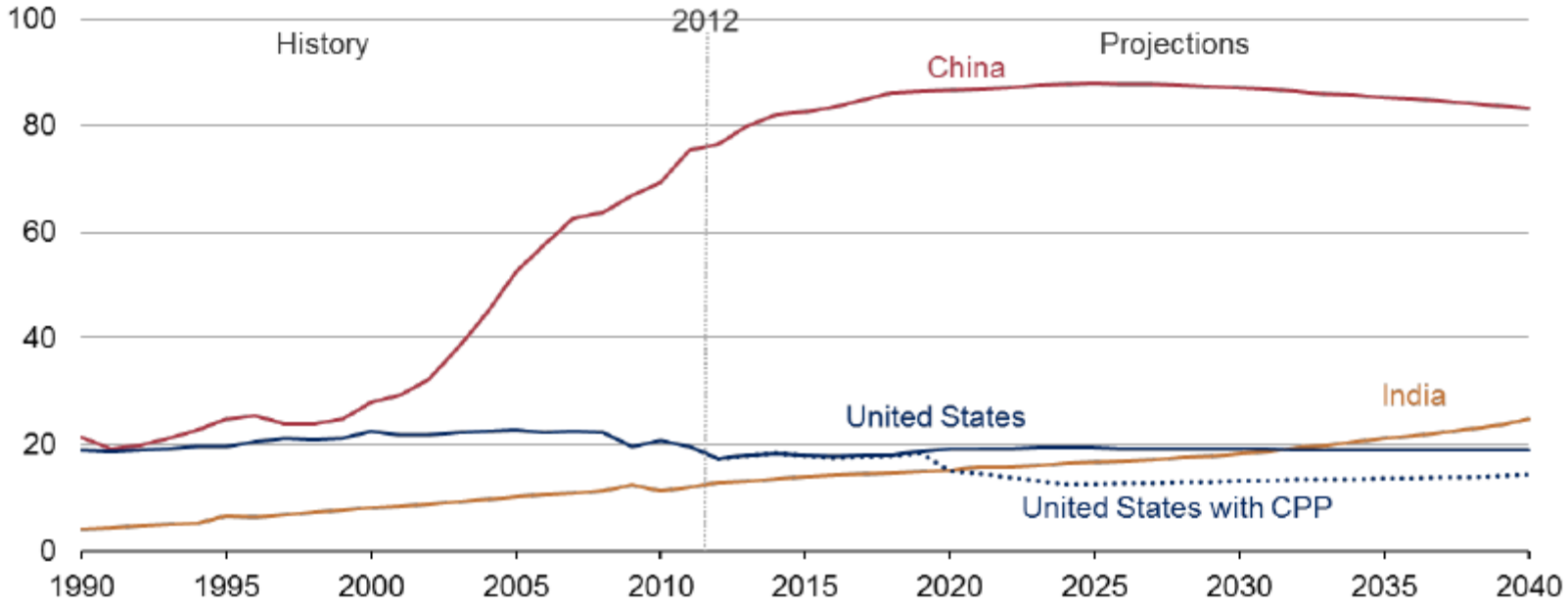
53	110	146	166	173 BCM

India Coal

Of the world's three largest coal consumers, only India is projected to continue to increase throughout the projection

coal consumption in the US, China, and India

quadrillion Btu

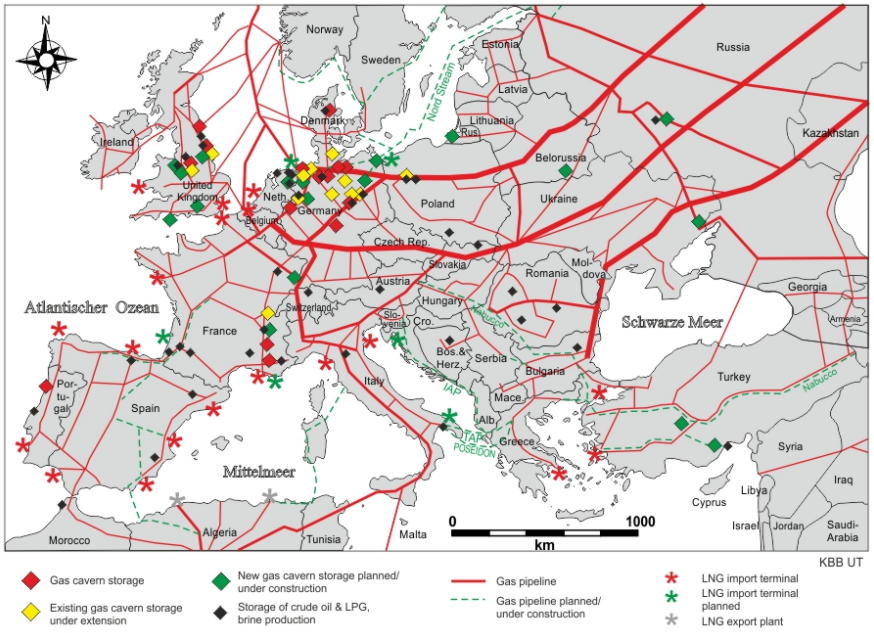


Source: EIA, International Energy Outlook 2016 and EIA, Analysis of the Impacts of the Clean Power Plan (May 2015)

Gas to the EU

Gas to Europe - 1101 BCM Demand

- Europe/Eurasia Pipeline Imports - 470 BCM
  - Russia 208
  - Norway 93
  - The Netherlands 50
  - Algeria 33
- Europe/Eurasia LNG Imports - 91 BCM
  - Qatar 43
  - Algeria 16
  - Nigeria 16



Gas to Europe

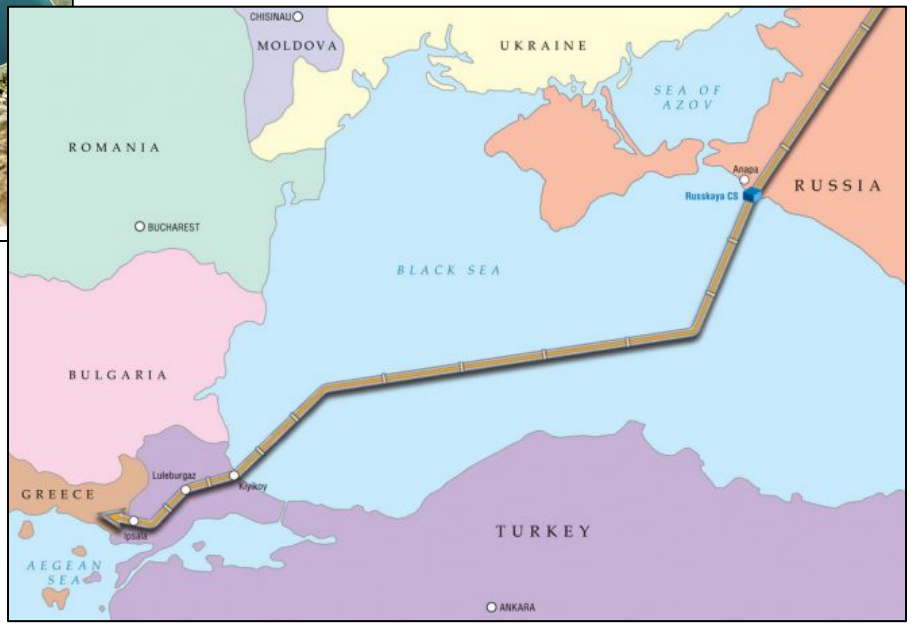
- Most gas arrives by pipelines from Russia and Norway, as well as in LNG tankers from Qatar
- As the region's own fields deplete and nuclear and coal plants are decommissioned, demand for the fuel is rising.
- Europe's demand of almost 550 billion cubic meters last year.
- Russian gas supplies to Europe are also linked to crude, and moves in the commodity affect gas prices at the region's hubs.
- U.S. supplies, in contrast, are tied to low-cost shale gas at the benchmark Henry Hub in Louisiana.
- Europe has also pledged to reduce its increasing dependency on the Russian fuel by supporting the development of new LNG terminals.
- U.S. LNG, the product will still have to compete with lower-cost gas arriving from Siberian fields.
- Europe pledged to import more LNG in a bid to diversify imports, while America is seeking new markets for its expanding production of the fuel.
- Russia is currently Europe's biggest supplier.
- Europe received about 10 percent of total U.S. exports last year, up from 5 percent in 2016
- Since then, Europe has imported more than 40 LNG cargoes from the U.S., or 2.8 billion cubic meters, the Commission said.

Ukraine is key to unlocking Nord Steam 2 Late 2019

- Europe's desire for cheap, stable energy clashes with the political need to maintain cordial US relations and support Ukraine
- East European and Baltic states fear that the Gazprom project, 2x the existing Nord Stream pipeline's annual capacity of 55 BCM, could increase Europe's reliance on Russian gas and make a serious dent in Ukraine's strained federal coffers.
- Germany and France argue that the additional pipeline is necessary because natural gas is as much as 25% cheaper than liquefied natural gas.
- Rather than directly hit Nord Stream 2, US officials said in May that the US may impose sanctions on the European companies involved in the project.
- Gazprom's partners in the consortium, which include Shell, Uniper, Wintershall, OMV and Engie are footing half of the overall required €9.5bn ($11.1bn) capex financing.

TurkStream

- TurkStream is a new export gas pipeline stretching from Russia to Turkey across the Black Sea.
- The first string of the pipeline is intended for Turkish consumers, while the second string will deliver gas to southern and southeastern Europe.
- When fully operational, TurkStream will deliver 31.5 BCM of natural gas annually.



SCP-TANAP-TAP Pipeline

- **The planned capacity of the natural gas pipeline**
  - 2018 16 BCM (0.6 tcf) per year at initial stage
  - 2023 23 BCM(0.8 tcf) by
  - 2026 31 BCM(1.1 tcf)
  - final stage 60 BCM(2.1 tcf) if be able to transport additional gas supplies from Azerbaijan
- SCP – South Caucuses Pipeline
- TANAP - Trans-Anatolian Natural Gas Pipeline
- TAP – Trans Adriatic Pipeline

"Practical Strategies for Emerging Energy Technologies"

EU LNG Imports

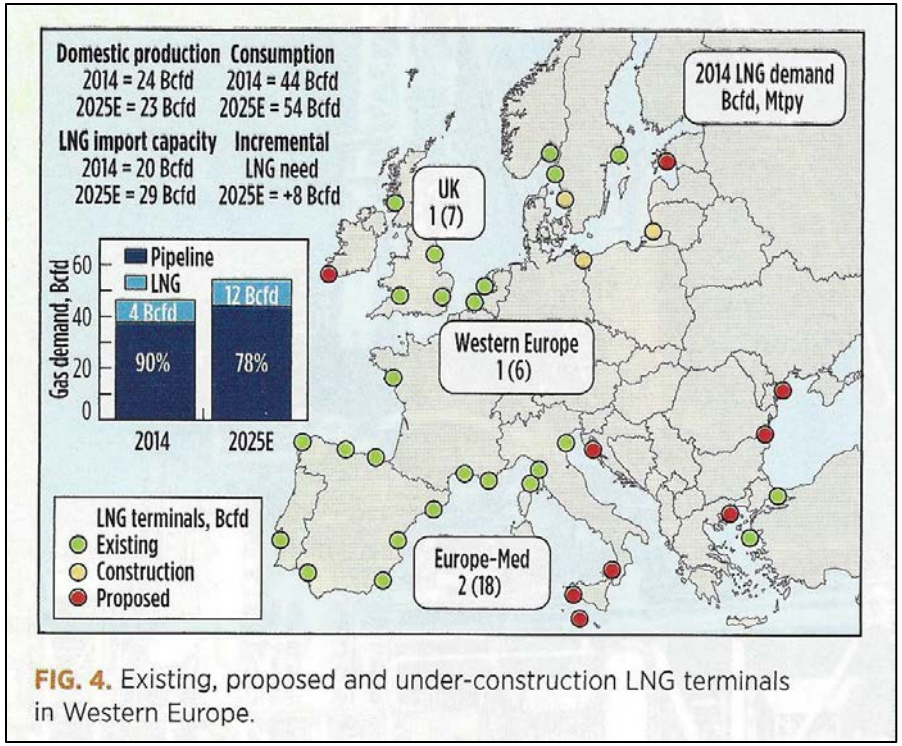
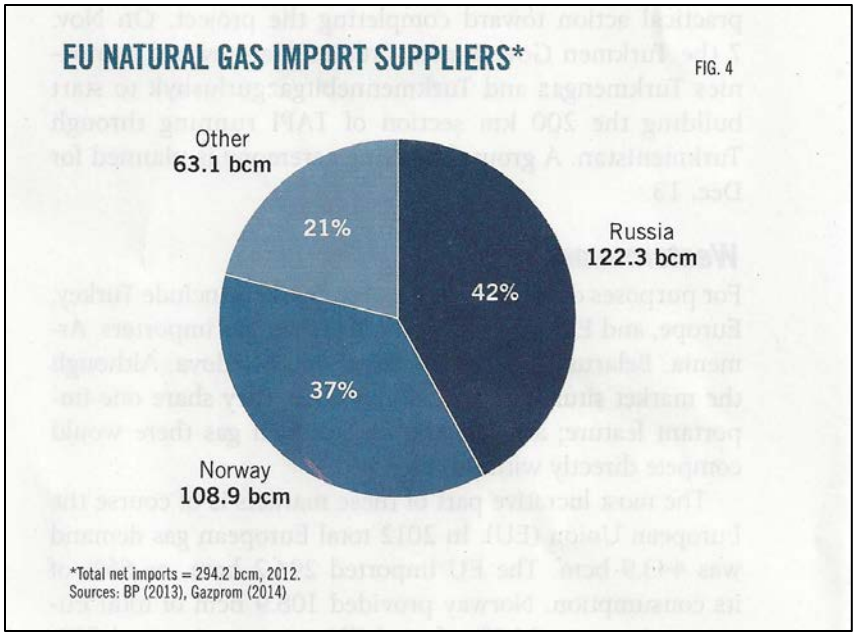


FIG. 4. Existing, proposed and under-construction LNG terminals in Western Europe.

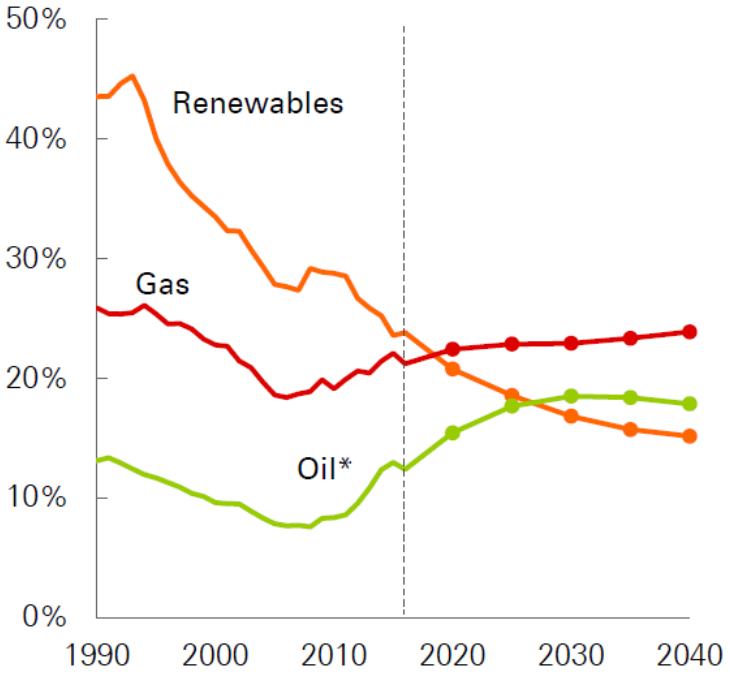


Brexit Effect ???

United States Exports

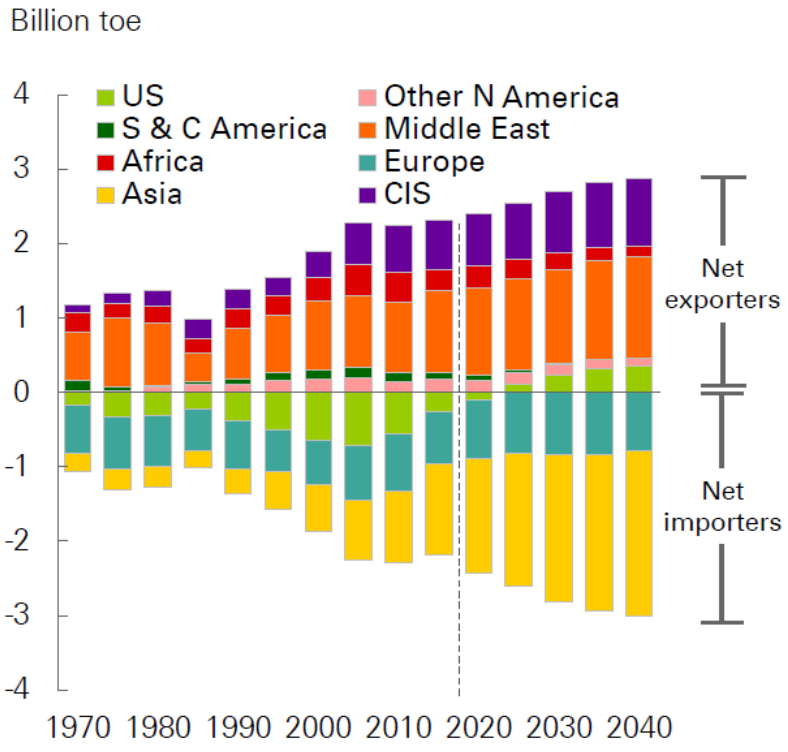
U.S. Extends Leads in O&G Production

US shares of global production



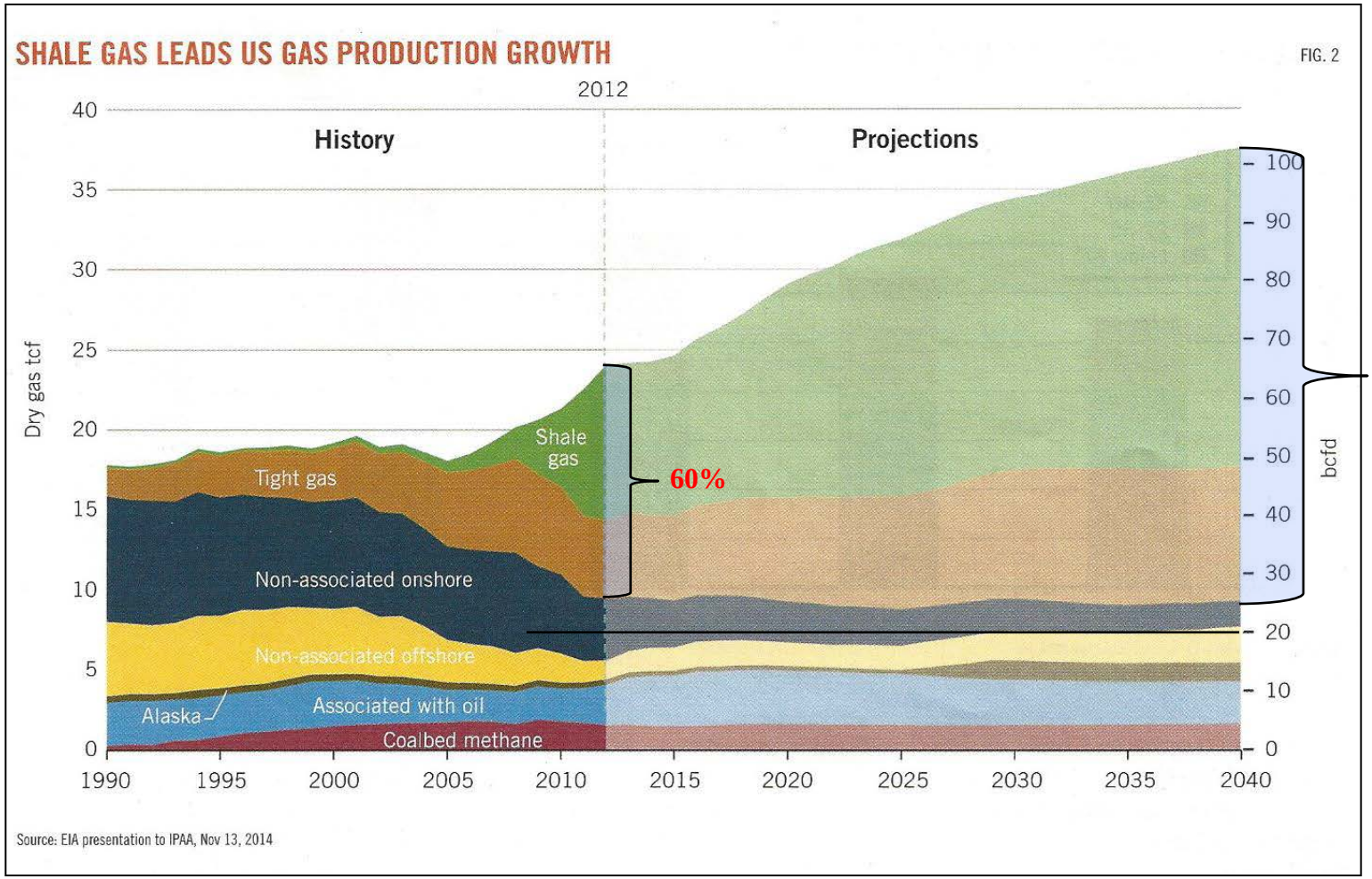
* Includes crude and NGLs

Regional oil/gas imbalances



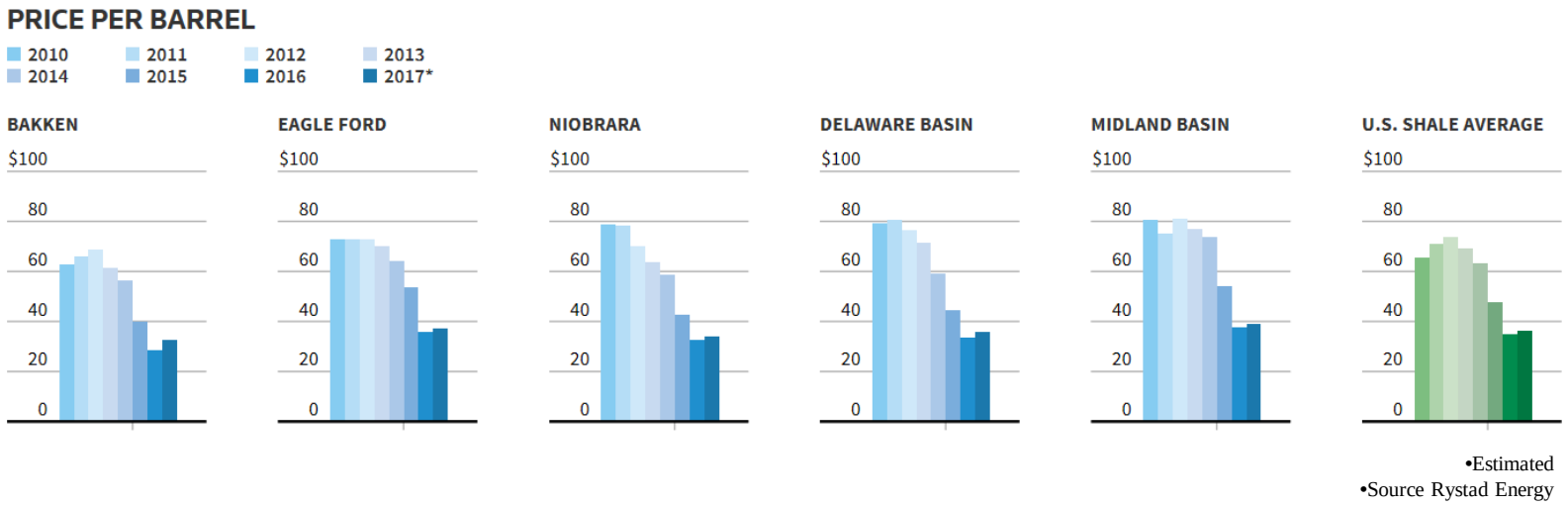
2018 BP Energy Outlook

U.S. Shale Gas


SHALE GAS LEADS US GAS PRODUCTION GROWTH
FIG. 2
2012
History
Projections
Dry gas tcf
bcfd
Shale gas
Tight gas
Non-associated onshore
Non-associated offshore
Alaska
Associated with oil
Coalbed methane
60%
75%
40
35
30
25
20
15
10
5
0
100
90
80
70
60
50
40
30
20
10
0
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
Source: EIA presentation to IPAA, Nov 13, 2014

Reuters Break-even Shale Price

U.S. shale producers' break-even price per barrel is projected to rise in 2017 for first time in five years. The wellhead price required to generate a profit is about half of what it was in 2010.



•Estimated
•Source Rystad Energy

- Drilling innovations over the past decade have generated a dizzying reduction in the cost of pumping oil from shale formations across the United States
- The first time since 2012, shale producers will see a rise in break-even production costs this year
- The per-barrel costs will rise an average of $1.60 across the shale patch to $36.50
- The wellhead price required to generate a profit is about half of what it was in 2010

U.S. Shale Growth to Offset Global Production Problems

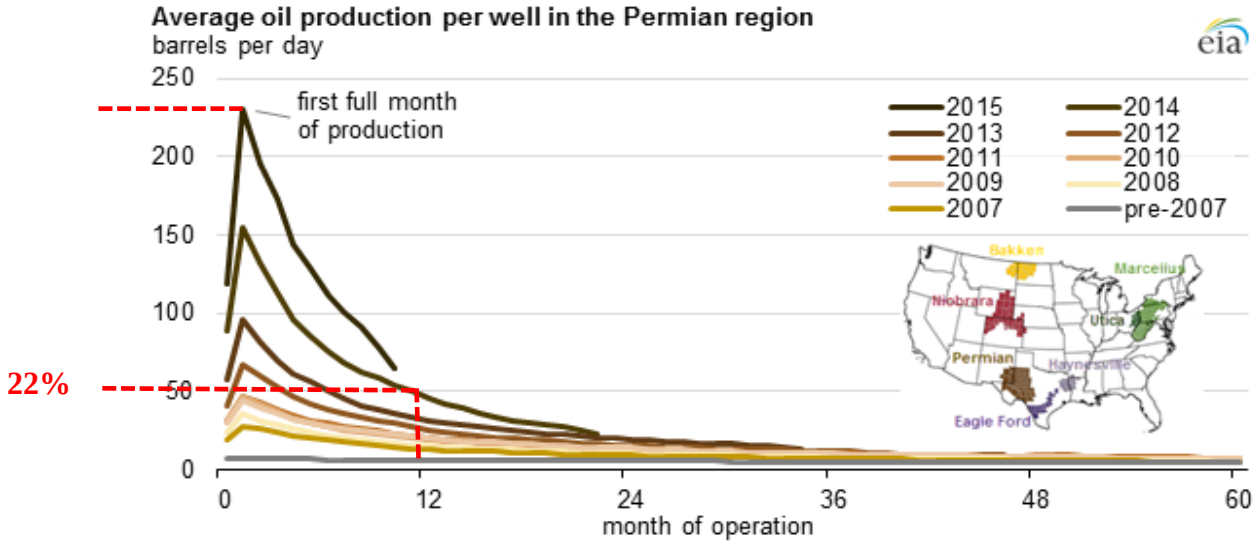
- The energy market has been heavily influenced by a flurry of demand-side developments of late
  - Escalating trade war between the U.S. and China
  - Financial crisis in Turkey
  - Resurgent U.S. dollar.
- Alongside a weakening global economic outlook, the API report appeared to weigh on oil prices on Wednesday afternoon (8/15/18)
  - International benchmark Brent crude trading at around $71.97 — down almost 0.7 percent
  - Meanwhile, U.S. West Texas Intermediate (WTI) stood at $66.38, off nearly 1 percent.
- The price of oil collapsed from near $120 a barrel in June 2014 due to weak demand, a strong dollar and booming U.S. shale production.
  - OPEC's reluctance to cut output was also seen as a key reason behind the fall
  - The oil cartel soon moved to curb production — along with other oil producing nations in late 2016.
- He estimated that without U.S crude production, the world's supply deficit would likely increase by around 5.3 million barrels per day over the next five years.

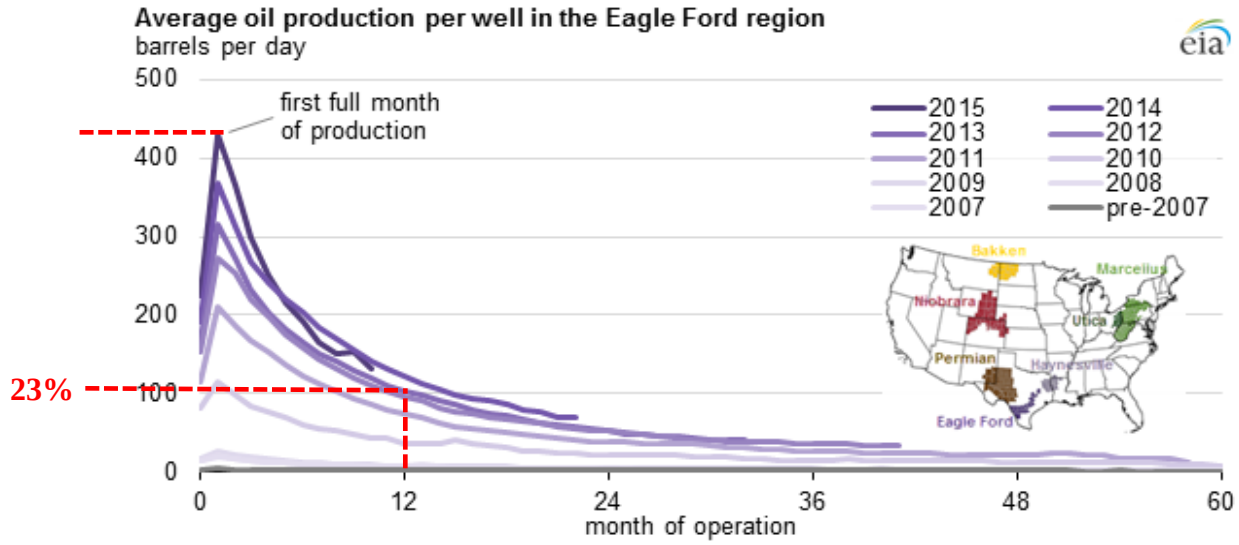
Shale is in 'Better financial shape than ever' before.

"The key medium-term question for the supply side of the oil market is: How much longer can rapid U.S. oil supply growth continue to offset poor production outcomes in the rest of the world?".

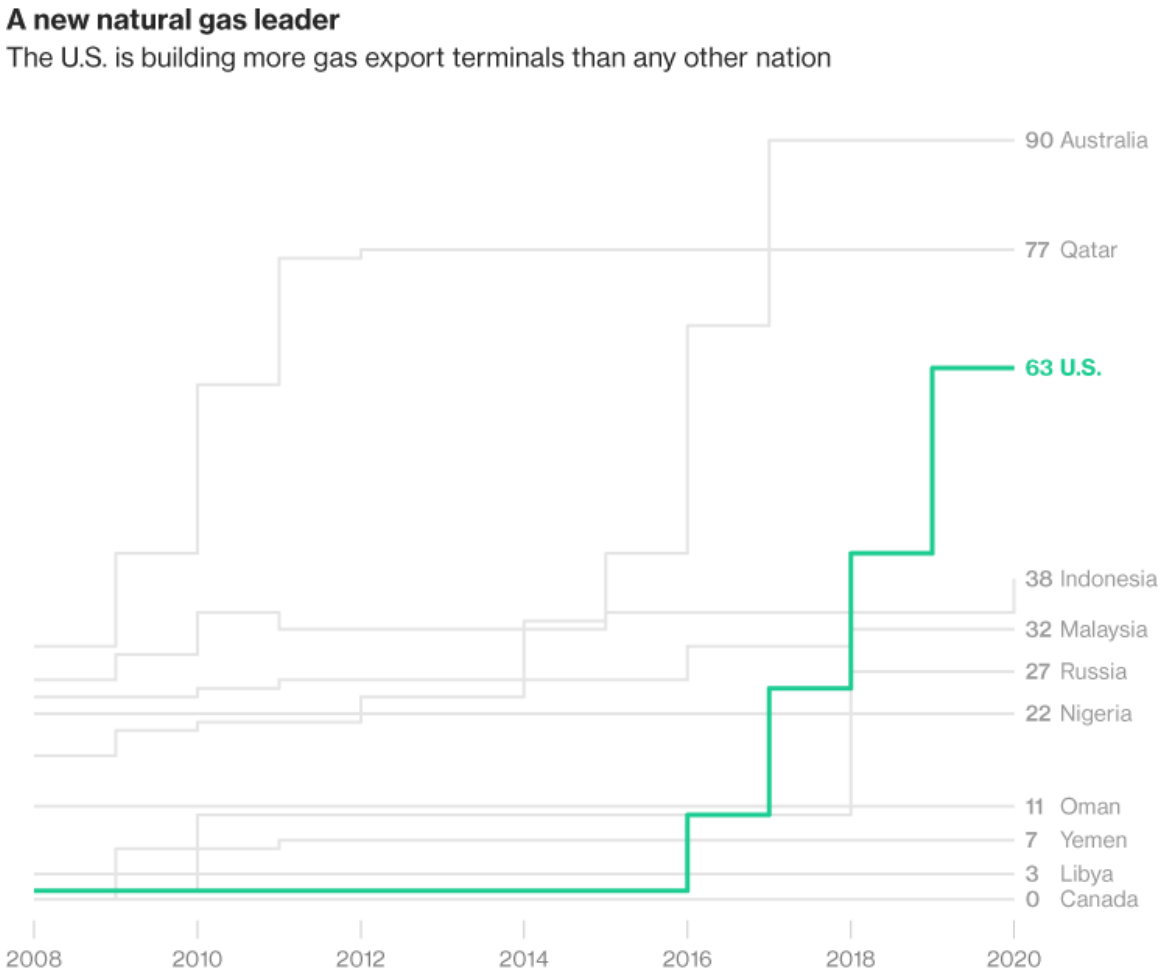
Harry Colvin, director and senior economist at Longview Economics,

Production Well Decline Rate





Gas Exports Terminals



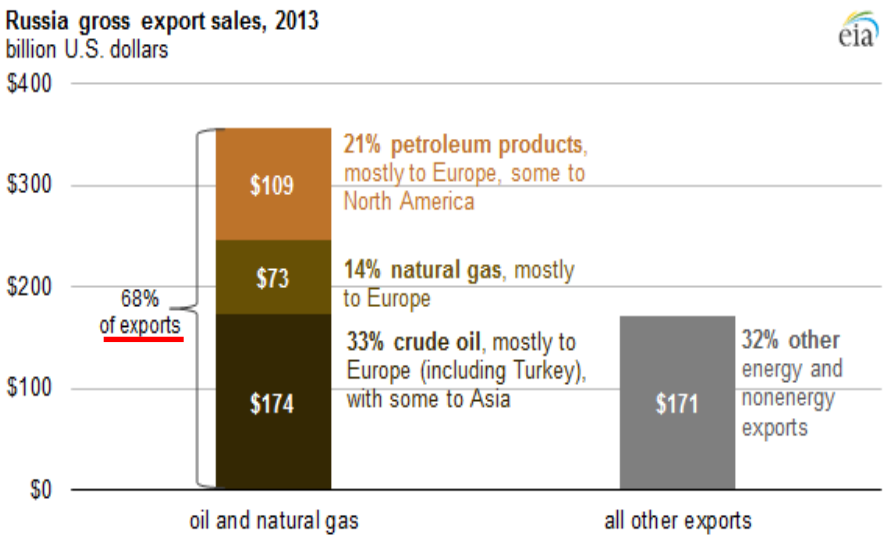
Russia

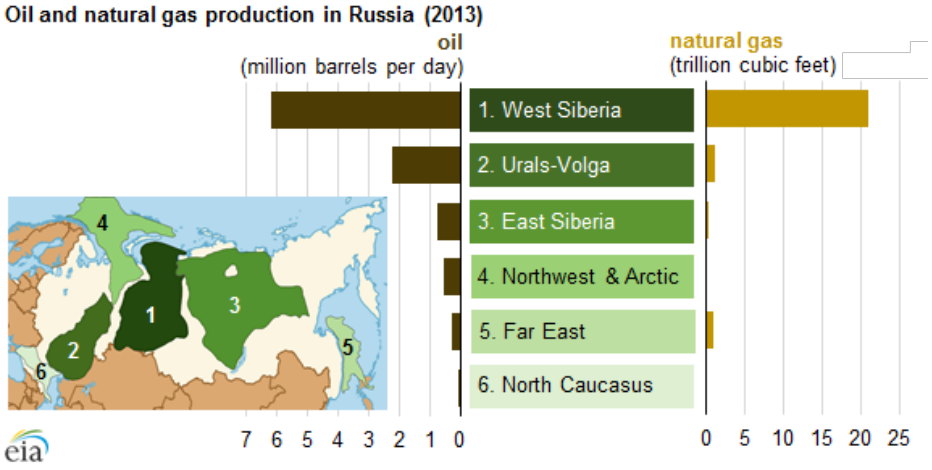
Russia

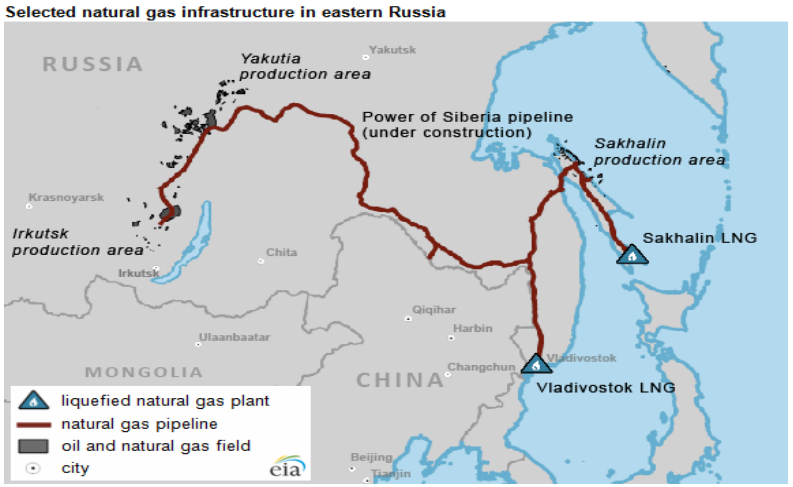
- Gazprom has long been the dominant supplier of natural gas to Europe
  - Last year, it supplied 31% of the Continent's gas needs.
  - Europe accounts for the vast bulk of Gazprom's profits
- Gazprom holds the world's largest natural gas reserves
  - It has most of the spare capacity in the marketplace, about 100 BCM
  - That's equivalent to 25% of its output and about 3% of global production.
- Gazprom is one of the world's lowest-cost gas producers.
  - The cost for Gazprom to deliver natural gas to Germany is $3.5 per million British thermal unit (BTU).
  - The breakeven point For LNG exported from the U.S. will be around $4.3 per million BTU even at the current low gas prices.
- The U.S. LNG industry will have the capacity to export about 0.10 BCM of natural gas per year by 2018
- Australia will be No. 1 in LNG, with the U.S. at No. 2
- Gazprom is defending Europe with everything it has. And it's expanding into Asia
  - Beginning in 2019, it will be sending natural gas through pipelines to China.

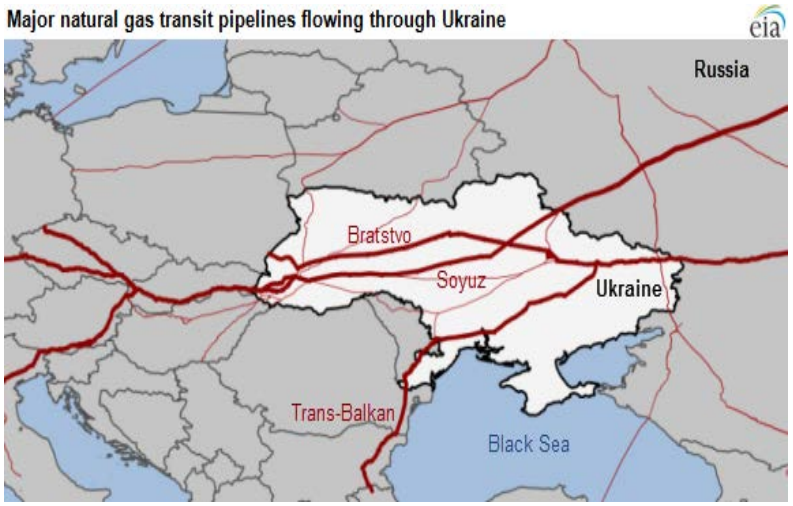
Tim Maverick?

Russia



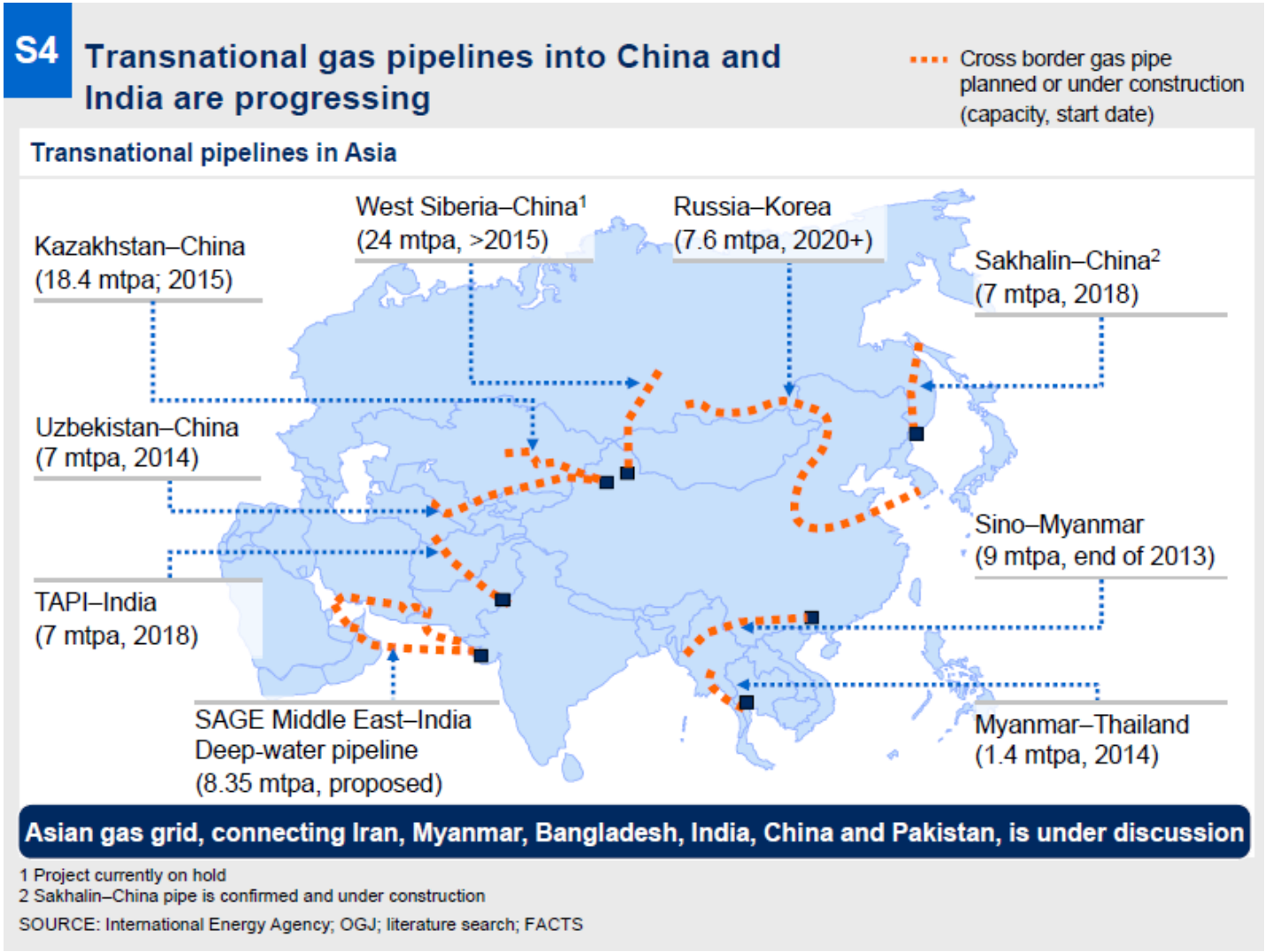






- 16% of European Gas Flows Through Ukraine
- Ukraine to buy gas for $10 per mmBtu

Pipelines to China & India



Russian Gas - 607 BCM Production

44,600 BCM Reserves
Reserves/Production Ratio - 73.5

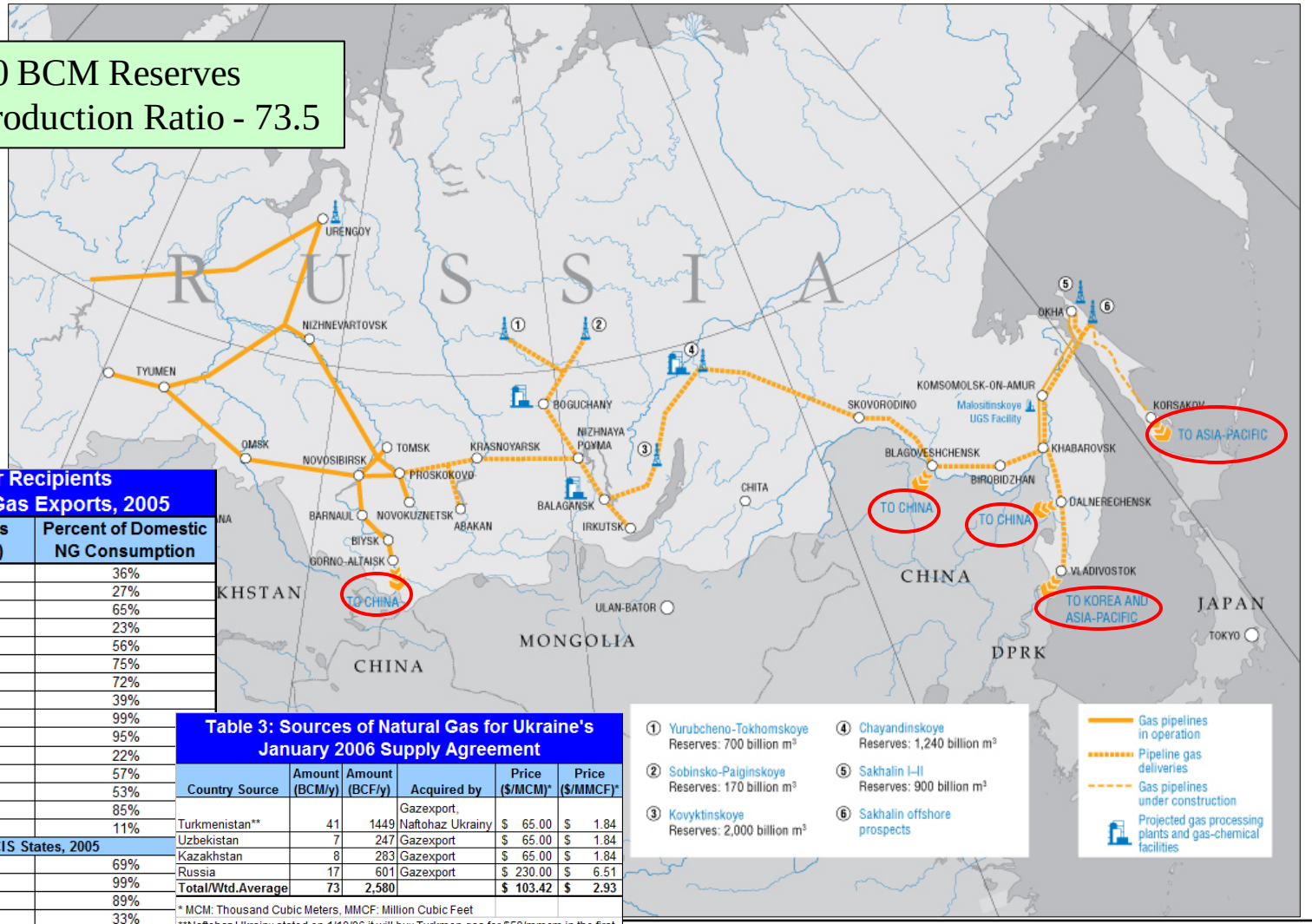


Table 2: Major Recipients of Russian Natural Gas Exports, 2005

Rank	Country	Imports (bcf/y)	Percent of Domestic NG Consumption
1	Germany	1,291	36%
2	Italy	824	27%
3	Turkey	630	65%
4	France	406	23%
5	Hungary	294	56%
6	Czech Republic	252	75%
7	Austria	246	72%
8	Poland	226	39%
9	Slovakia	226	99%
10	Finland	148	95%
11	Romania	140	22%
12	Fmr Yugoslavia	134	57%
13	Bulgaria	101	53%
14	Greece	85	85%
15	Switzerland	13	11%
	Sales to Baltic & CIS States, 2005		
	Ukraine	2,113	69%
	Belarus	710	99%
	Baltic States	205	89%
	Azerbaijan	120	33%
	Georgia	46	88%

Sources: Domestic Consumption: EIA International Energy Annual, 2005; Imports: Cedigaz 2006 and BP Statistical Review 2007.

Table 3: Sources of Natural Gas for Ukraine's January 2006 Supply Agreement

Country Source	Amount (BCM/y)	Amount (BCF/y)	Acquired by	Price ($/MCM)*	Price ($/MMCF)*
Turkmenistan**	41	1449	Gazexport, Naftohaz Ukrainy	$ 65.00	$ 1.84
Uzbekistan	7	247	Gazexport	$ 65.00	$ 1.84
Kazakhstan	8	283	Gazexport	$ 65.00	$ 1.84
Russia	17	601	Gazexport	$ 230.00	$ 6.51
Total/Wtd.Average	**73**	**2,580**		**$ 103.42**	**$ 2.93**

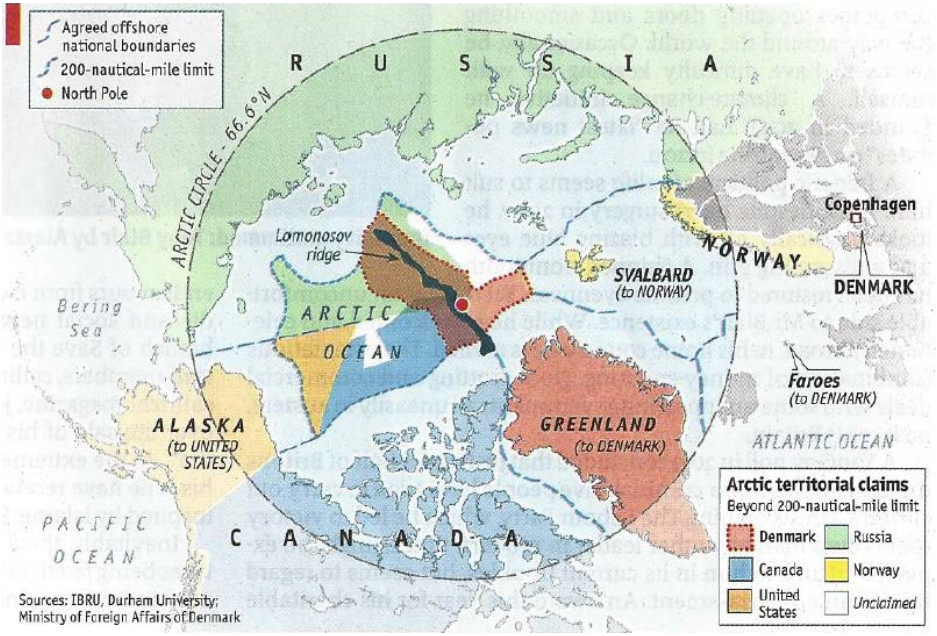
* MCM: Thousand Cubic Meters, MMCF: Million Cubic Feet

**Naftohaz Ukrainy stated on 1/10/06 it will buy Turkmen gas for $50/mmcm in the first half of 2006 and $60 during the second half, but the final agreement's price was higher. Using the lower price for Turkmen gas, the wtd. average price is $97.8/MCM.

Source: Russian Energy Monthly, January 2006

Arctic Oil & Gas

- Estimated 13% (90 billion barrels) of the world's undiscovered conventional oil
- 30% of its undiscovered conventional natural gas
- Costs to develop reserves in the region can be 50-100% more than similar projects undertaken in Texas.
- Profitable development challenging due to the following factors:
  - Equipment needs to be specially designed to withstand the frigid temperatures.
  - On Arctic lands, poor soil conditions
  - Long supply lines
  - Natural gas hydrates can pose operational problems
  - Natural gas development could be impeded by the low market value of natural gas relative to that of oil. and higher transportation costs
  - Environmental issues include the preservation of animal and plant species unique to the Arctic
  - The adequacy of existing technology to manage offshore oil spills in an arctic environment



The Economist 2014

- Overlapping and disputed claims of economic sovereignty.
  - Exclusive Economic Zone (EEZ)- countries have exclusive rights to seabed resources up to 200 miles
  - Beyond the EEZ, assessments of "natural prolongation" of the continental shelf may influence countries' seabed boundaries.

Russian O&G Production

Source: US EIA /O&G Journal Jan 2015

	bbl/d	%	tcf	BCM	%
Northern Caucasus	0.10	1%	0.01	0.3	0%
Urals-Volga	2.20	22%	1.10	31.1	5%
Northwest Arctic	0.50	5%	0.10	2.8	0%
West Siberia	6.20	62%	21.10	597.5	90%
East Siberia	0.60	6%	0.20	5.7	1%
Far East	0.40	4%	1.00	28.3	4%
Total	10.00	100%	23.51	665.7	100%

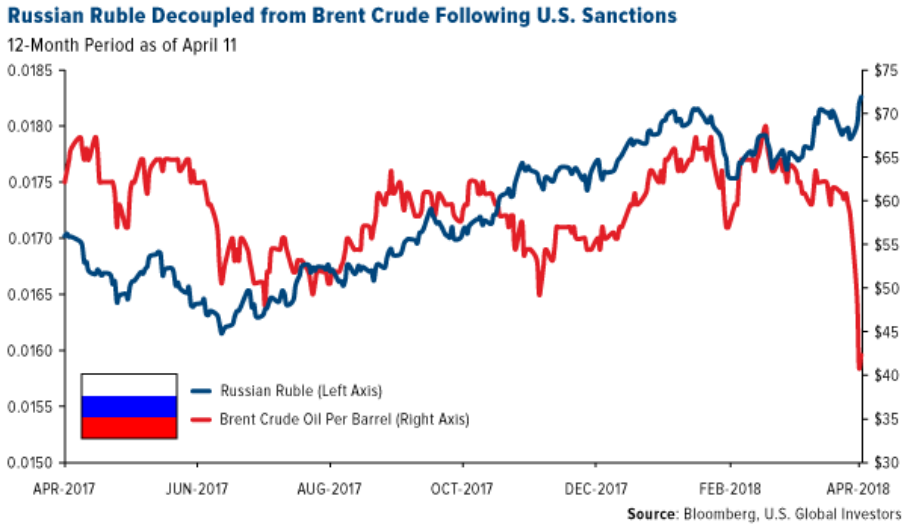
- Arctic is Russia's priority resource base for the 21st century
- Capability & knowledge unmatched by Arctic Council
- Governance of the AC inconsistent with NATO
- The UN Convention on the Law of the Seal (UNCLOS) may be replaced by a sovereignty rights
- U.S. failure to ratify UNCLOS will be an issue
- Russian sanction complicate things
- Potential for Russia/China alliance

Source: US Central Intelligence Agency, World Factbook

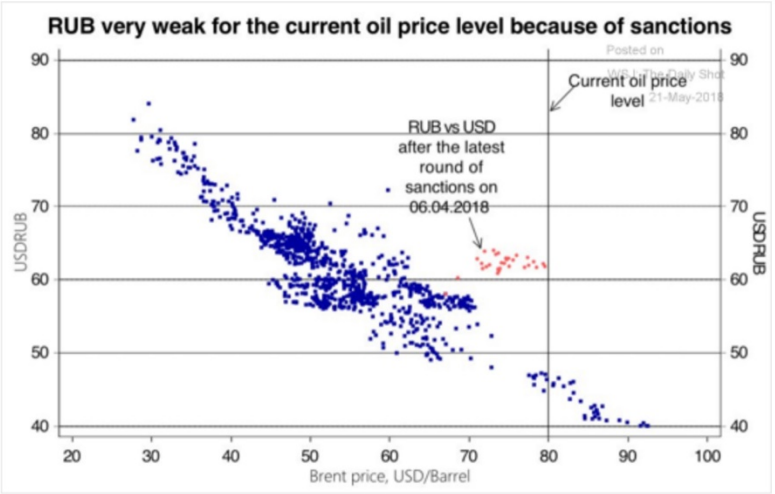
Russian Sanctions

- The U.S. sanctions on Russia have affected investment in Russian oil and gas exploration projects.
- Congress is considering further sanctions on the energy and banking sectors to punish Moscow for the threat it poses to the United States.
- U.S. sanctions have curtailed investment in Russian oil and gas exploration projects necessary to grow Russia's production.
- Since January 2017, the current U.S. Administration has sanctioned 217 Russian-related individuals and entities for a broad range of activities,
- The Administration has also introduced prohibitions on the provision of goods, services, and technology in support of certain energy projects in Russia.
- Sanctions have limited important investment in exploratory energy projects needed to help grow Russia's oil and gas production capacity.

Russian Oil Price vs. Ruble Devaluation



9. The Russian ruble should be much stronger given the current oil price.



Source: @Tatiana_Evd

Russia's Novatek Ships First LNG Cargo to Brazil

Russian natural gas producer Novatek has shipped its first LNG cargo to the Brazilian market with LNG produced from the Yamal LNG project.

The cargo was delivered to the Bahia Regasification Terminal owned by Petrobras.

“Our LNG marketing strategy aims to diversify our supply geography and customer base,” noted Leonid Mikhelson, Novatek’s Chairman of the Management Board.

Leonid added: “This shipment represents our first LNG cargo produced by our own production to the Latin American market, and confirms the viability of our logistical model and unique geographical location of the Yamal LNG project to deliver competitively priced LNG to any part of the world.”

PAO Novatek is one of the largest independent natural gas producers in Russia, and in 2017, entered the global gas market by successfully launching the Yamal LNG project.

The $27 billion Yamal LNG project began operations last December and has already shipped two million tons of the liquefied fuel. The LNG plant is expected to have three trains with an annual capacity of 16.5 million tons per year when fully operational.

Besides Novatek, Yamal LNG’s shareholders include France’s Total, China’s CNPC and Silk Road Fund.

Natural Gas Trade 2017 – 1134.1 BCM

Pipeline trade grew 3.7%
LNG trade grew 10.3%
Consumption grew 5.9%

Gas Trade in 2016 and 2017

Billion cubic metres	2016				2017				2017 vs. 2016			
	Pipeline imports	LNG imports	Pipeline exports	LNG exports	Pipeline imports	LNG imports	Pipeline exports	LNG exports	Pipeline imports	LNG imports	Pipeline exports	LNG exports
US	79.5	2.4	58.6	4.3	80.7	2.2	66.1	17.4	1.2	(0.3)	7.4	13.1
Canada	21.1	0.3	79.5	†	24.0	0.4	80.7	†	2.9	0.1	1.2	0.0
Mexico	37.5	5.9	†	-	42.1	6.6	†	-	4.5	0.7	0.0	0.0
Trinidad and Tobago	-	-	-	14.3	-	-	-	13.4	0.0	0.0	0.0	(0.9)
Other S. & Cent. America	16.2	15.6	16.2	6.4	15.4	13.8	15.4	5.8	(0.8)	(1.8)	(0.8)	(0.6)
France	32.2	9.1	-	1.5	33.5	10.8	-	1.0	1.4	1.7	0.0	(0.5)
Germany	95.6	-	9.1	-	94.8	-	7.1	-	(0.8)	0.0	(2.0)	0.0
Italy	60.5	5.9	-	-	53.8	8.4	-	-	(6.7)	2.5	0.0	0.0
Netherlands	36.8	1.3	46.8	0.9	40.9	1.6	43.3	0.8	4.1	0.3	(3.6)	(0.0)
Norway	†	-	109.4	6.0	†	-	109.2	5.8	0.0	0.0	(0.2)	(0.3)
Spain	15.5	13.8	0.6	0.2	14.4	16.6	0.1	0.1	(1.1)	2.8	(0.5)	(0.0)
Turkey	36.9	7.8	0.6	-	42.8	10.9	0.6	-	5.9	3.1	(0.0)	0.0
United Kingdom	35.2	11.0	9.7	0.6	39.4	7.2	10.8	0.3	4.2	(3.9)	1.2	(0.3)
Other Europe	94.8	7.9	13.9	1.3	103.7	10.2	21.6	0.2	8.9	2.3	7.8	(1.1)
Russian Federation	18.1	-	200.1	14.6	18.9	-	215.4	15.5	0.8	0.0	15.4	0.9
Ukraine	10.5	-	-	-	13.3	-	-	-	2.8	0.0	0.0	0.0
Other CIS	29.3	-	68.5	-	30.1	-	67.5	-	0.8	0.0	(0.9)	0.0
Qatar	-	-	18.5	107.2	-	-	18.4	103.4	0.0	0.0	(0.1)	(3.8)
Other Middle East	25.8	13.7	8.0	18.8	22.2	13.0	12.5	19.1	(3.6)	(0.6)	4.5	0.3
Algeria	-	-	38.1	15.8	-	-	36.4	16.6	0.0	0.0	(1.7)	0.8
Other Africa	8.3	10.7	8.6	30.0	7.6	8.2	8.7	38.9	(0.7)	(2.5)	0.1	9.0
Australia	6.4	0.1	-	59.2	5.8	-	-	75.9	(0.6)	(0.1)	0.0	16.7
China	36.0	35.9	-	-	39.4	52.6	-	-	3.4	16.7	0.0	0.0
India	-	23.6	-	0.1	-	25.7	-	-	0.0	2.1	0.0	(0.1)
Japan	-	113.6	-	-	-	113.9	-	-	0.0	0.4	0.0	0.0
Indonesia	-	-	8.2	22.2	-	-	8.0	21.7	0.0	0.0	(0.2)	(0.5)
South Korea	-	45.7	-	0.1	-	51.3	-	0.1	0.0	5.6	0.0	(0.0)
Other Asia Pacific	18.1	32.5	20.0	53.4	17.7	40.0	18.8	57.2	(0.4)	7.4	(1.2)	3.8
Total World	**714.4**	**356.7**	**714.4**	**356.7**	**740.7**	**393.4**	**740.7**	**393.4**	26.3	36.7	26.3	36.7

Source: Includes data from FGE MENAgas service, IHS.

Trade represents approximately 30% of the consumption
Japan, China & Korea represent almost 55% of all LNG Imports

Source: BP Statistical Review of World Energy 2018

Transportation

World Oil Choke Points

Table 1. Volume of crude oil and petroleum products transported through world chokepoints, 2009-13

Location	2009	2010	2011	2012	2013
Strait of Hormuz	15.7	15.9	17.0	16.9	17.0
Strait of Malacca	13.5	14.5	14.6	15.1	15.2
Suez Canal and SUMED Pipeline	3.0	3.1	3.8	4.5	4.6
Bab el-Mandab	2.9	2.7	3.4	3.7	3.8
Danish Straits	3.0	3.2	3.3	3.1	3.3
Turkish Straits	2.8	2.8	3.0	2.9	2.9
Panama Canal	0.8	0.7	0.8	0.8	0.8
World maritime oil trade	53.9	55.5	55.6	56.7	56.5
World total oil supply	84.9	87.5	87.8	89.7	90.1

- 36% of World Oil Supply
- 57% of World Maritime Oil Trade

Figure 2. Map of the Strait of Hormuz

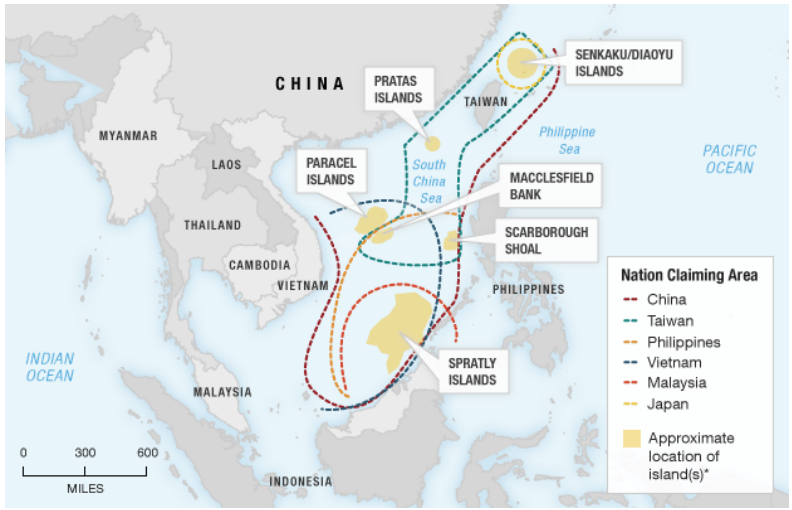
Source: U.S. Government (See full map for alternate routes)

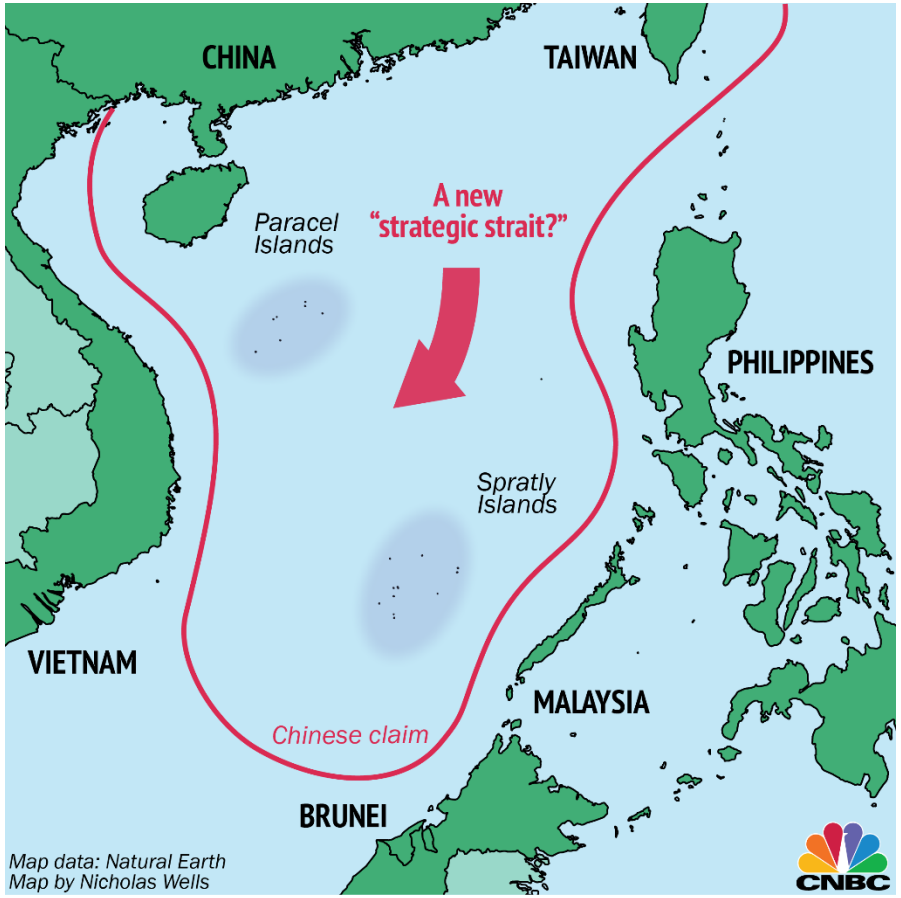
Figure 3. Map of the Strait of Malacca

Source: CIA Factbook (See closer view of Strait of Malacca)

China – South China Sea

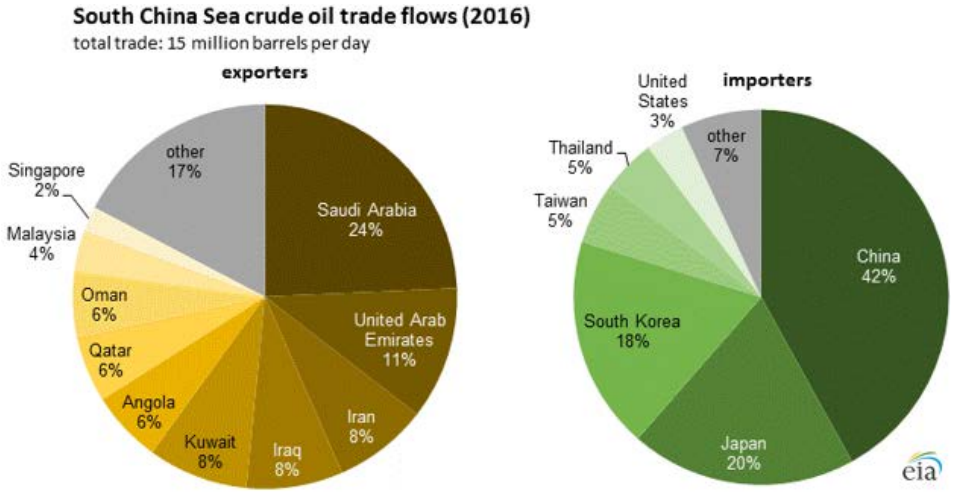
South China Sea Islands





South China Sea 2016

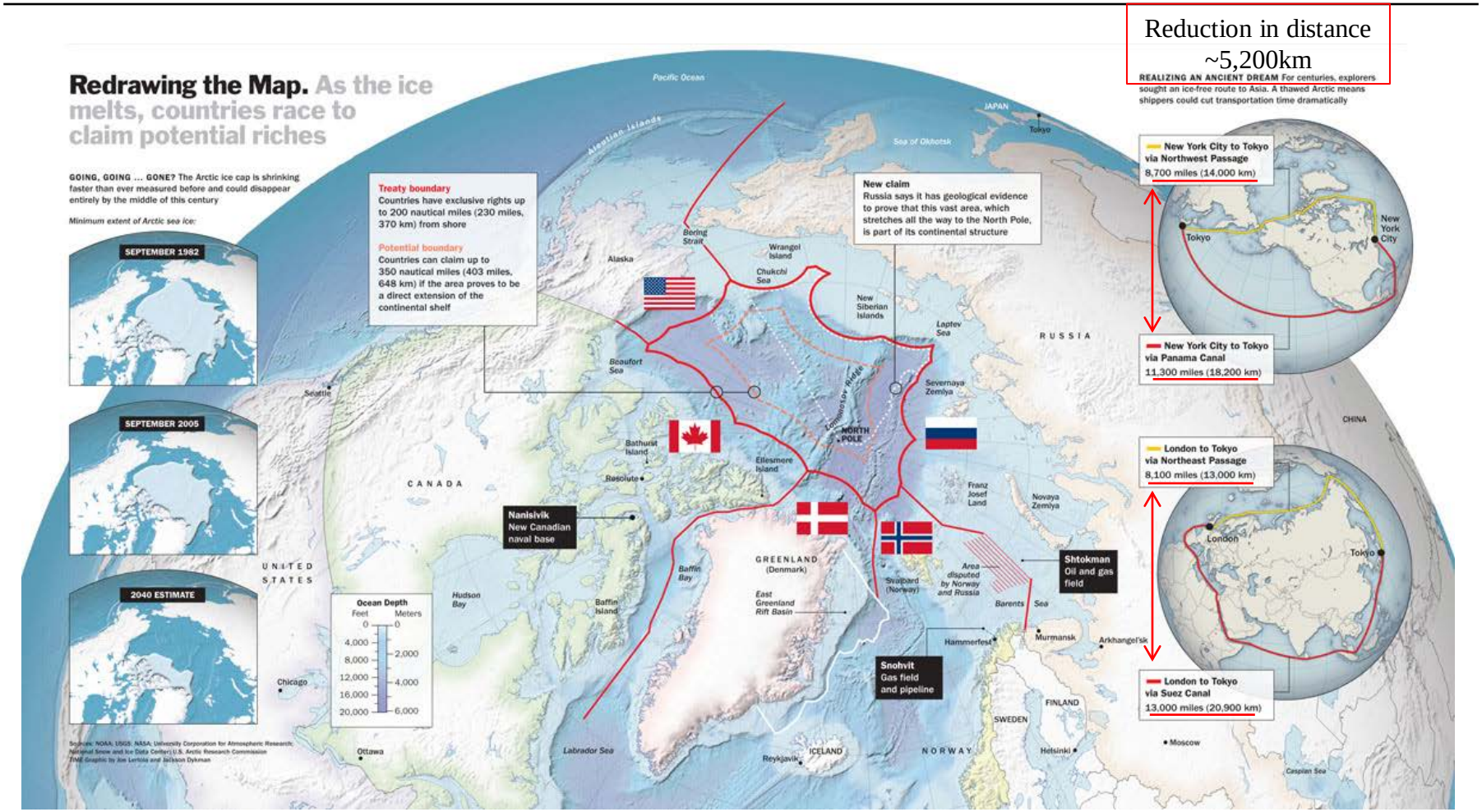
- More than 30% of global maritime crude oil trade, or about 15 million barrels per day (b/d), passed through the South China Sea.
- More than 90% of crude oil volumes flowing through the South China Sea in 2016 transited the Strait of Malacca.
- The South China Sea is a major trade route for the Middle East, which accounted for more than 70% of total South China Sea crude oil shipments in 2016.
- The South China Sea route accounted for 52% of Iran's crude oil exports in 2016.
- China, Japan, and South Korea—collectively accounted for 80% of total crude oil volumes transiting the South China Sea in 2016.
- About 90% of China's 2016 maritime crude oil shipments were transported through the South China Sea.
- About 90% of the crude oil imported by Japan and South Korea was shipped through the South China Sea in 2016. Most of Japan's and South Korea's imports are from Middle Eastern suppliers and are transported through the Strait of Malacca and then the South China Sea.



China denied request for U.S. warship visit Hong Kong

- U.S. consulate in the Chinese city amid rising tension between Beijing and Washington over trade and a U.S. decision to sanction the Asian nation's military.
- The amphibious assault ship Wasp had been due to make a port call in the former British colony of Hong Kong in October, diplomatic sources said.
- "The Chinese Government did not approve a request for a U.S. port visit to Hong Kong by the USS Wasp," a consulate spokeswoman said.
- "We have a long track record of successful port visits to Hong Kong, and we expect that to continue," she added.
- In Beijing, Foreign Ministry spokesman Geng Shuang did not directly answer a question on whether China had denied the request.
- "For requests for U.S. military ships to visit Hong Kong, China has always carried out approvals case by case, in accordance with the principle of sovereignty and the detailed situation," he told reporters, without elaborating.
- In 2016, at a time of heightened tension over its territorial claims in the disputed South China Sea, China denied a request for a U.S. carrier strike group led by the John C. Stennis to visit Hong Kong.
- On Saturday, China summoned the U.S. ambassador in Beijing and postponed joint military talks in protest against a U.S. decision to sanction a Chinese military agency and its director for buying Russian fighter jets and a surface-to-air missile system.
- China and the United States are also embroiled in an increasingly bitter trade war.

The Arctic



Reduction in distance
~5,200km

baseₑ®

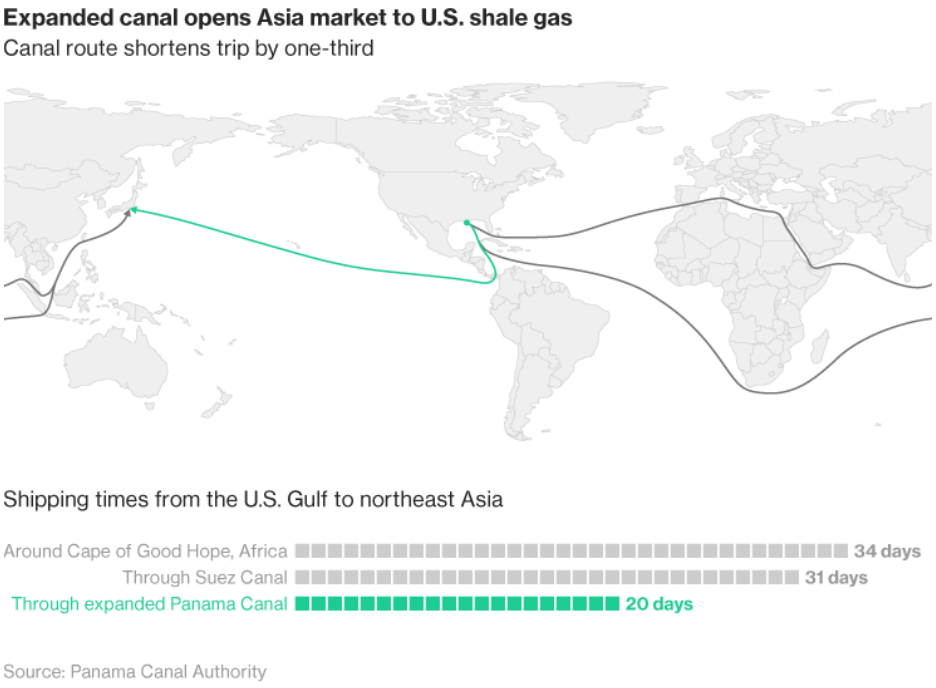
"Practical Strategies for Emerging Energy Technologies"

A New Choke Point

Bering Strait 51 miles

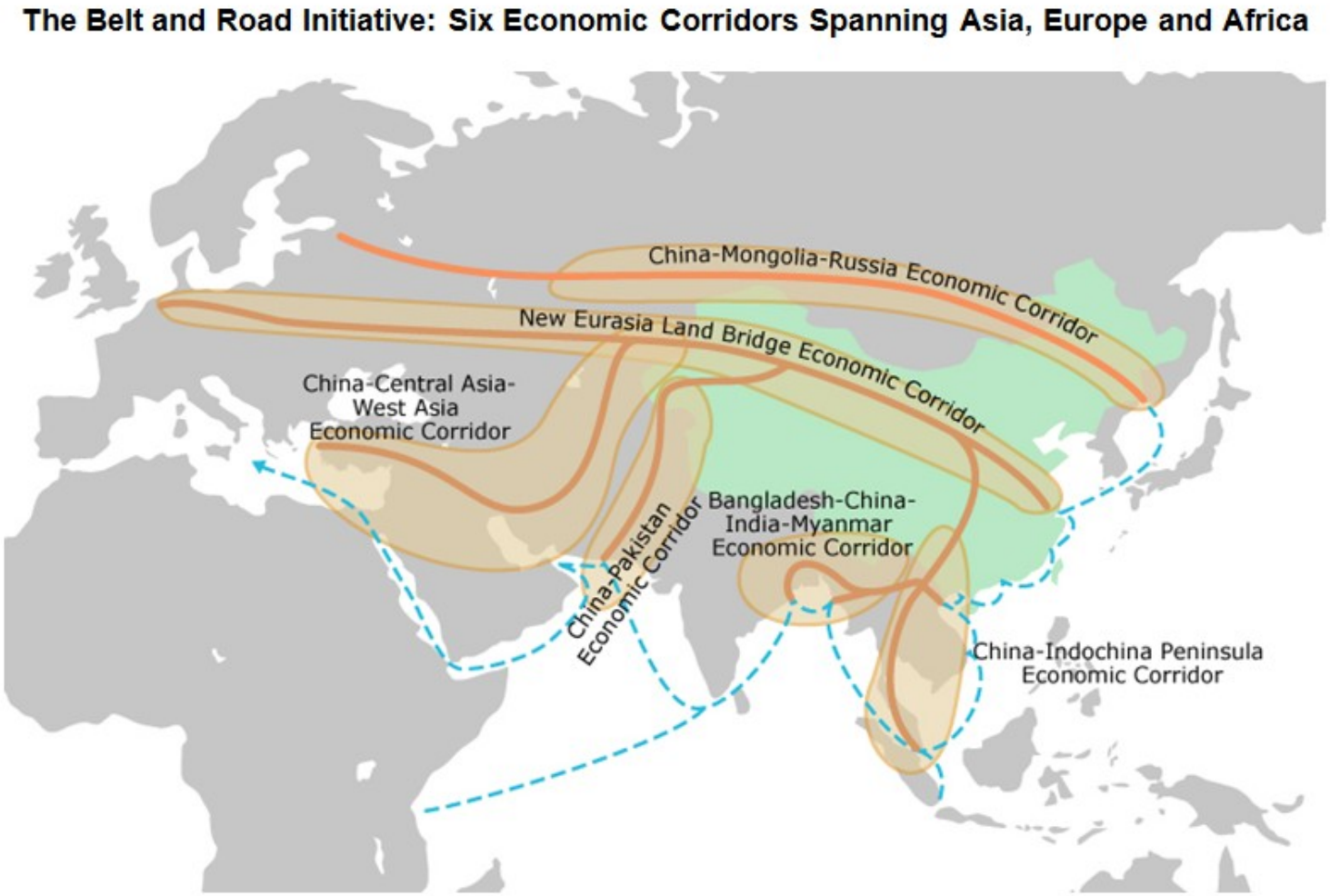
The New Panama Canal

- **Current locks are too small for most natural-gas carriers**
  - 90 percent of the world fleet will be able to use the new canal
  - Able to accommodate the kind of tankers that transport liquefied natural gas
  - Shaving eleven days and a third of the cost off the typical round trip to the Far East
- **Nine years of construction work, at a cost of more than $5 billion**
  - A third set of locks and deeper navigation channels
  - Crucial improvements that will double the isthmus's capacity for carrying cargo between the Atlantic and Pacific oceans.
- **The debut coincides with a surge in U.S. natural-gas production**
  - Markets from Chile to China will also become more accessible for oil drillers across the Americas

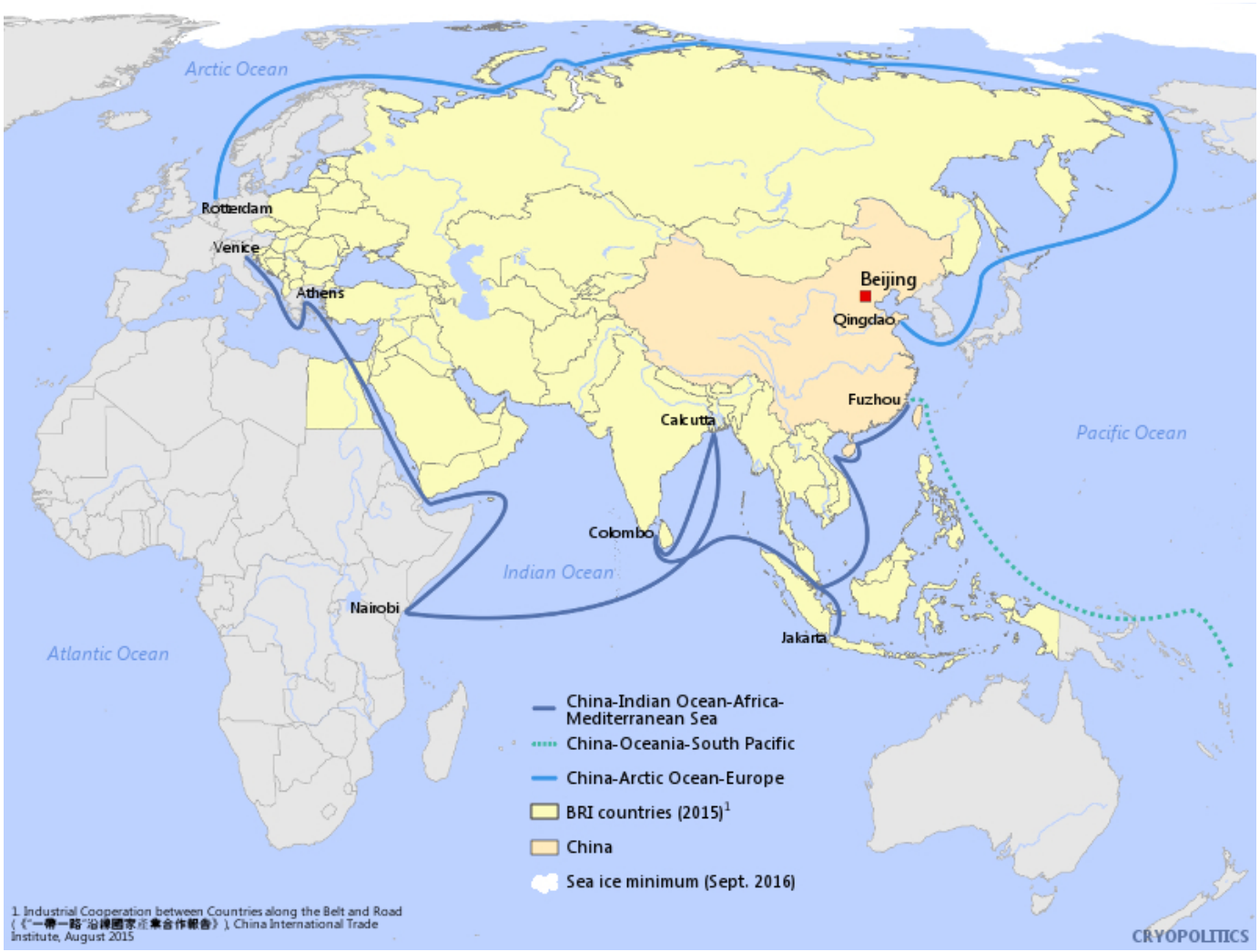


Source: Alex Nussbaum and Naureen Malik May 2016

The New Silk Road (Belt & Road)

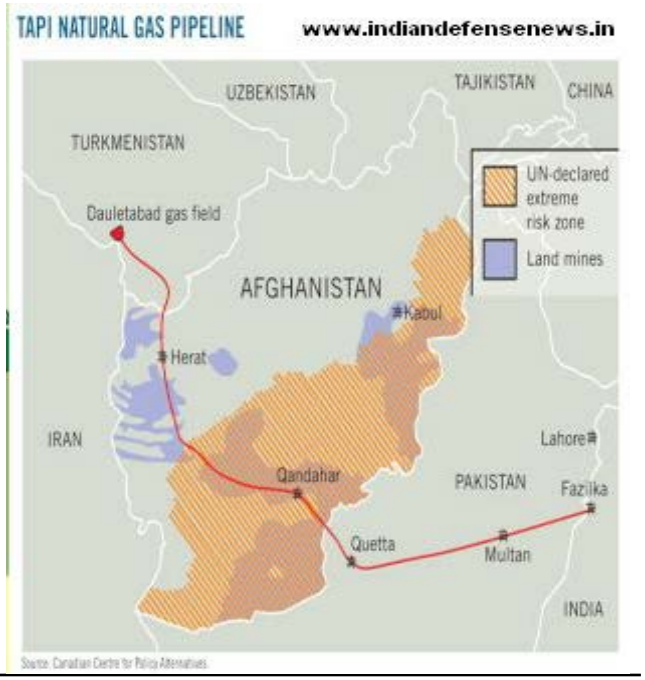


China Blue Economic Route



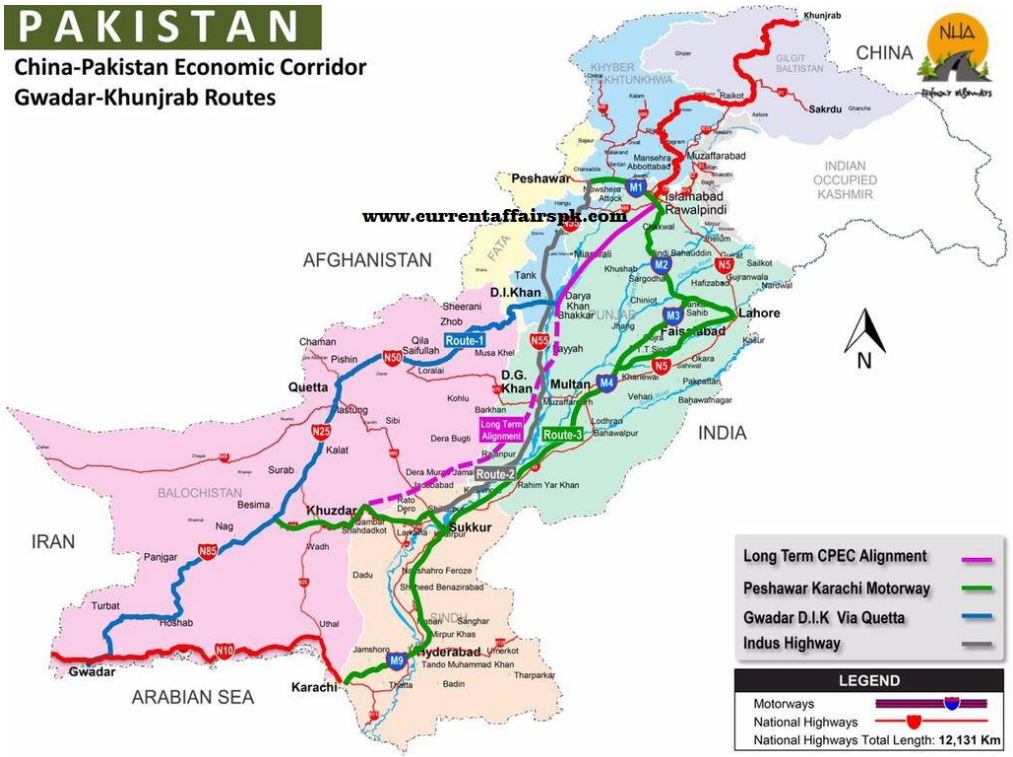
TAPI Natural Gas Pipeline

- **Turkmenistan–Afghanistan–Pakistan–India Pipeline (TAPI)**
  - A natural gas pipeline being developed by the Asian Development Bank.
  - The pipeline will transport Caspian Sea natural gas from Turkmenistan through Afghanistan into Pakistan and then to India.
    - Progress, but future uncertain
    - Construction on the project started in Turkmenistan on December 13th, 2015.
    - The pipeline is expected to be operational by 2019.
  - The abbreviation TAPI comes from the first letters of those countries
  - Proponents of the project see it as a modern continuation of the Silk Road.



China-Pakistan Economic Corridor

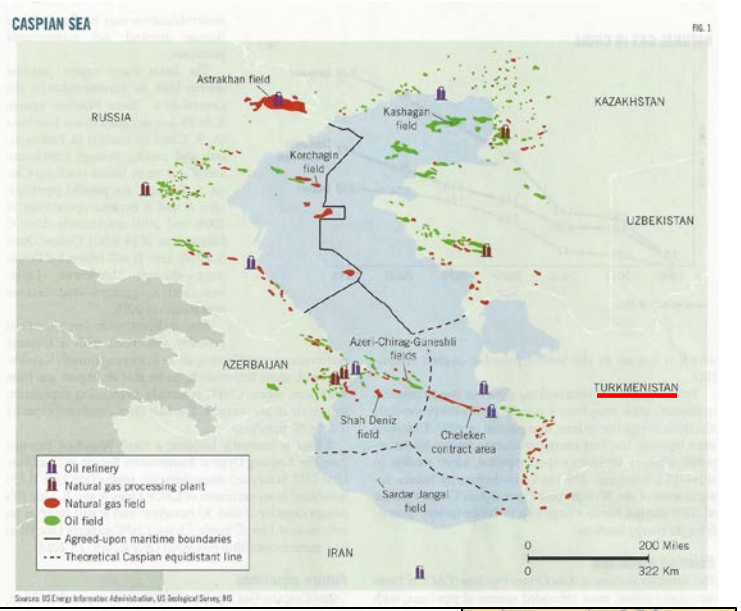
- The project includes coal-fired, solar and wind power stations and a network of highways running 3,000 kilometers down the length of the country, from the freezing passes of the Karakoram Highway to the Arabian Sea.
- Frequent power blackouts have driven traditional industries like textiles to countries such as Bangladesh and Vietnam.
- Of the $46 billion planned investment in the China-Pakistan Economic Corridor, $35 billion is earmarked for energy.
- For China, CPEC offers a shorter route to the Indian Ocean, without going through the congested and strategically sensitive Strait of Malacca.
- It strengthens the bond with Pakistan, an ally that bridges South Asia and the Middle East. And it gives China a port in the Indian Ocean that could one day become a naval base.

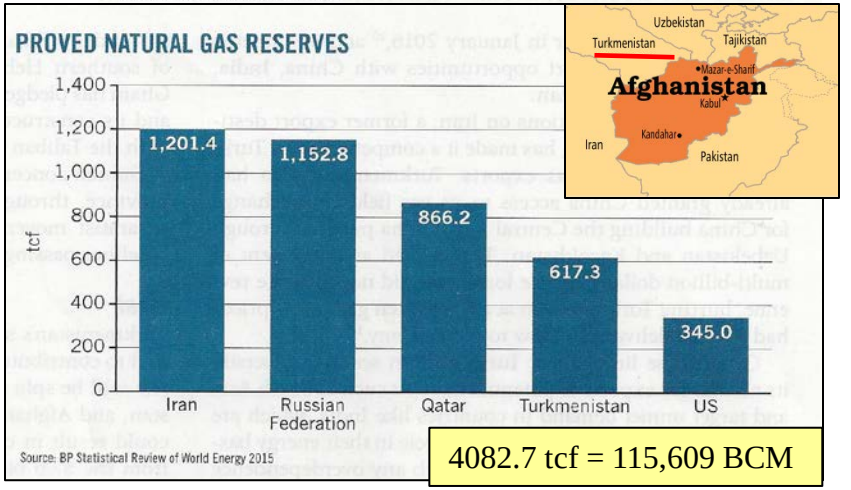


- For Pakistan, it brings soft loans to build power stations, roads and a deep-sea port and free-trade zone modeled on

Turkmenistan – Serving Eurasia?

- 17,500 BCM proven natural gas reserves
- 9.3% of world total
- Russian Gas Pipeline Access/Use
  - 1989 – 81 BCM
  - 1998 – 12 BCM
- 74% in Galkynysh field near Afghan border
- China National Petroleum Corp. (CNPC)
  - CNPC controls 82% of Proven gas reserves
  - Produced 13 BCM (20%) in 2012
  - Export 30 BCM/year for 30 years
  - Expected to bring annual gas deliveries to 65 BCM/year
- Turkmengaz largest producer
  - Produced 51 BCM (80%) in 2012
- Does not directly border with Europe, China, or India and depends on transiting thru other countries.
- Trans-Caspian Gas Pipeline (300km) proposed but far from guaranteed





4082.7 tcf = 115,609 BCM

base e

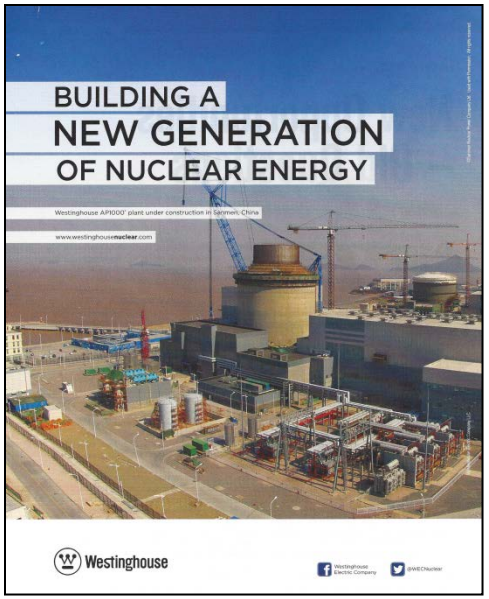
"Practical Strategies for Emerging Energy Technologies"

Source: O&G Journal December 7, 2015

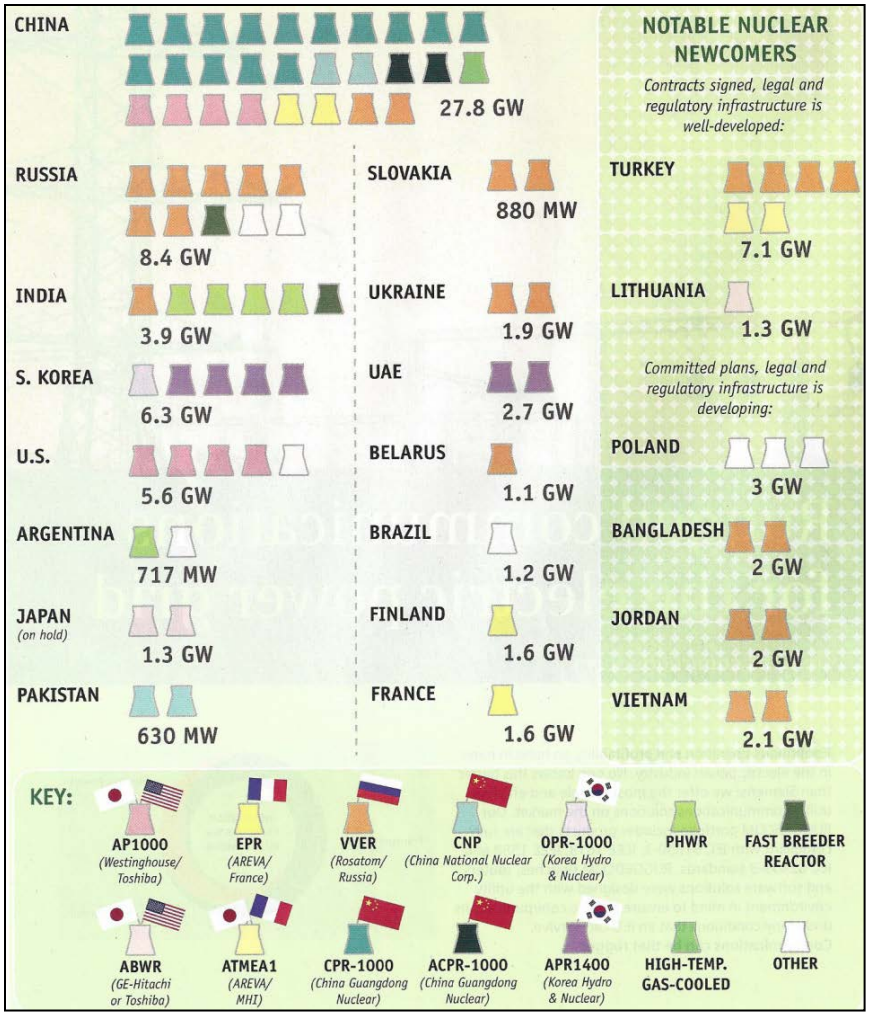
Nuclear Power

“The Big Picture: Next-Gen Nuclear”

- Compliments of Power magazine April 2014
- 72 mostly advanced nuclear reactions under construction
- A total of 68GW (12% of installed base)
- China represents 40% of the total
- France will cap nuclear capacity at the current 63.2GW, forcing closures w/capacity additions
  - Currently at 75% share of generation
  - Goal is 50% by 2025



Westinghouse AP1000® plant under construction in Sanmen, China



Installed Generating Capacity (2012) = 5,550 GW

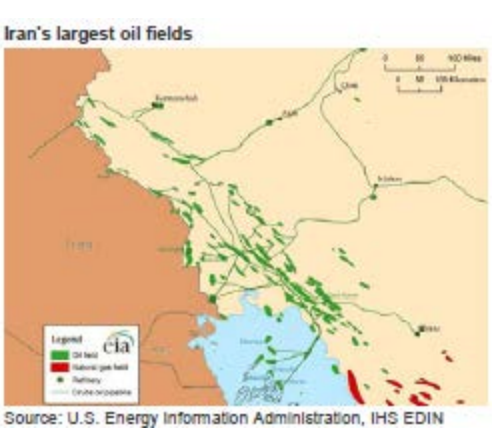
Other Issues & Countries to Watch

- Argentina
- Methane Hydrates
- Russia to be dominant fuel supplier to Asia
- International Maritime Organization (IMO) 3.5% to 0.5% marine fuel sulphur content in 2020
- Russian Plans to dominate fuel supply to Asia
- LNG Supply Demand Balancing
- North American Shale
- Panama Canal
- Mexico
- East Mediterranean Resource
- Qatar
- China-Pakistan Economic Corridor
- Canadian Resources
- Arctic
- Turkmenistan–Afghanistan–Pakistan–India Pipeline (TAPI)

Iran

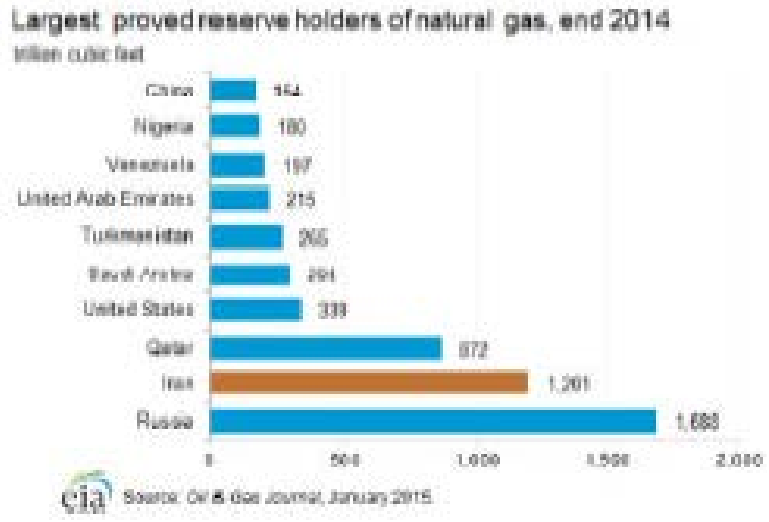
Iran

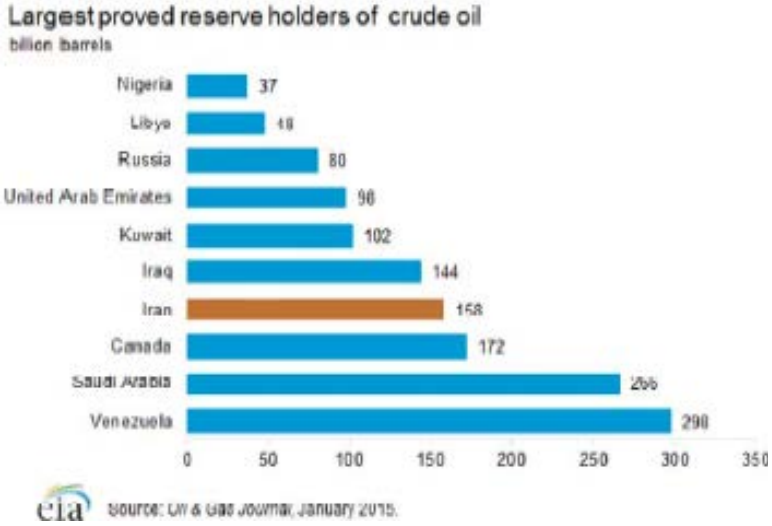
- Iran holds the world's fourth-largest proved crude oil reserves and the world's second-largest natural gas reserves
- Iran Petroleum Ministry reserves 1201tcf/33,988 BCM
- Iran may have more success with LNG rather than pipeline to Europe
- Target export of 11 MMtpy (15.2 BCM)
- LNG Foreign investment opportunities
  - LNG Plant near Tombak 25 MMtpy/35 BCM
  - Kish Island recoverable reserves 63.6 tcf/1,800 BCM



Source: U.S. Energy Information Administration, IHS EDIN

Source: U.S. Energy Information Administration, IHS EDIN





Iran Deal Effect

- HOUSTON, May 9 (Reuters) - U.S. shale producers will **not** boost output to offset any global oil squeeze after President Donald Trump abandoned the Iran nuclear deal, one of the industry's most prominent executives said on Wednesday.

- The withdrawal, alongside Trump's decision to impose the "highest level" of sanctions on Iran, sent Brent and U.S. benchmark oil prices up more than 3 percent on Wednesday.

- **Iran**, the third-largest oil producer in the Organization of the Petroleum Exporting Countries, pumps **3.8 million barrels per day (bpd).**

- **U.S. shale producers**, which in the past year have increased output by nearly 2 million bpd, to about 7 million bpd, **are not likely to act to fill that void** should Iranian exports slip, said Mark Papa, chief executive of Centennial Resource Development Inc.

- "I don't think it's going to change what U.S. producers do at all," Papa told Reuters in Houston after a meeting with the board of directors of national oil company Saudi Aramco, which is holding a regularly scheduled gathering this week in Houston.

- Many U.S. shale producers have set their 2018 spending budgets and are wary of boosting spending to pump more as their shareholders call for **higher dividends and share buyback**s.

India Cutting Iranian Oil Imports to Zero in November

- India is not planning to buy any crude oil from Iran in November, raising the prospect that Tehran will lose another major customer as U.S. sanctions hit.
  - Indian Oil Corp. and Bharat Petroleum Corp. haven't asked for any Iranian cargoes for loading in November
  - Nayara Energy also doesn't plan any purchases, said an industry executive.
  - Mangalore Refinery and Petrochemicals Ltd. hasn't made any nominations for that month, but may do so later, a company official said.
- The rapid drop in Iranian exports has helped to push Brent crude to a four-year high above $80/bbl
- Only Saudi Arabia and, and to a lesser extent, United Arab Emirates and Russia, have the capacity to pump more.
- India is the second-largest buyer of Iranian oil, having imported an average of 577,000 barrels a day this year, or about 27 percent of the Middle Eastern country's exports
- With South Korea, Japan and European nations also cutting imports to zero, the loss of the Indian refiners, even if temporarily, is a major blow for the Islamic republic.
- At the same time, the U.S. sanctions that are due to go into effect in early November are creating a major gap in the global oil market just as Brent crude hits a four-year high above $80 a barrel.
- Mercuria Energy Group Ltd. and Trafigura Group, among the world's biggest trading houses, are predicting the loss of Iran's supply will boost prices to $100 a barrel for the first time since 2014.
- That risk has been echoed by some of the world's biggest oil companies.

•Debjit Chakraborty
•Dhwani Pandya
•Javier Blas
September 25 2018, 12:43 PMSeptember 25 2018, 3:56 PM

Vogtle Nuke Deadline Extended Again to 11:30 P.M.

- The fate of the only nuclear plant under construction in the United States was supposed to be decided yesterday, but is still up in the air as owners debate how to manage cost overruns.
- Oglethorpe Power voted Monday night to continue construction of the Vogtle nuclear project in Georgia, but attached conditions that must also be accepted by other owners of the plant. The exit of one major owner would mean the project would be canceled.
- Oglethorpe, which owns 30% of the project, wants a cap on the project's costs to its ratepayers and a guarantee that future cost overruns would be borne by Southern Co., a co-owner in the plant. The owners faced a 5 p.m. (EDT) deadline Tuesday to reach an agreement, but twice extended their negotiation period, first to 7 p.m. and then to 11:30 p.m.

U.S. - Gulf Summit September 2018?

- The US president's idea - six nations of the Gulf Cooperation Council meet at Camp David in September.
  - Find a solution to the dispute between Saudi Arabia and the UAE on the one side, and Qatar on the other.
  - Since June 2017, a Saudi-led group of states has imposed an economic and diplomatic blockade on Qatar.
- A fairly safe assumption is that there won't have been a solution by September
  - It's hard to imagine Saudi and UAE leaders being willing to sit down with the emir of Qatar.
  - Qatar has said it's happy to open talks on the issue
  - Two sides in the dispute are continuing to wage a vicious media war.
- Then there's the issue of the oil price
  - Trump would like to woo mid-term voters with lower gasoline prices
  - He's already made known his displeasure at Opec's failure to take steps to bring prices down.
- Saudi output down
  - Saudi Arabia responded by pushing for production increases in June, and the price fell accordingly.
  - Saudi production has actually decreased from 10.3m barrels a day last month, to 10.1m b/d in August.
  - Saudi Arabia seems to be hinting that while it's happy to back the US Iran policy, it's not prepared to see the oil price collapse
  - It needs all the revenue it can get to finance its ambitious economic reform programme
- On the issue of Iran
  - Both Saudi Arabia and the UAE line up squarely behind the US-but Qatar definitely doesn’t
  - Even if the Saudi-UAE blockade of Qatar was lifted, the two sides would be at issue on the Iran question.
  - Kuwait has been trying to mediate in the Qatar crisis and, along with Oman, doesn't want to get involved in any action over Iran.

Team Trump's Iran Pipe Dream

Despite John Bolton's suggestion to the contrary, new US sanctions on Iran are clearly about regime change, Fred Kaplan writes in Slate. They probably won't work—and even if they do, what comes next will be worse.

"One could make a case that it would be in the best interest…if the Iranian regime folded and was replaced by more peaceful and democratic leaders.

But this…isn't likely to happen. More to the point, Trump's policies—the withdrawal from the nuclear deal and the stiffening of sanctions—are weakening Iran's moderate factions and strengthening its hardliners," Kaplan writes.

"[W]ith this one move, Trump has irritated the allies, opened a new avenue for Russian and Chinese influence in the Middle East, strengthened the hard-liners in Iran, and heightened the chances that they'll revive Iran's nuclear program—all for the sake of killing a deal that blocked this program for the next two decades, and in pursuit of the pipe dream, which has been punctured in so many other dark escapades in US foreign policy, that ousting an unfriendly regime will bring to power a much friendlier one."

"One is Yemen, where Iran provides military support to the Houthi rebels in their war against Saudi Arabia and the UAE," Rome writes. "A second, often overlooked area for confrontation is in cyberspace, where Iran retains advanced capabilities to attack US or allied computer networks. Under these circumstances, US allies in the region, especially Israel and Saudi Arabia, would likely be more emboldened to take aggressive action against Iranian threats—raising the temperature in an already volatile region."

CNN Global Briefing Fareed Zakaria
August 7, 2017

An Alliance the West Ignores at Its Peril

Russia has **dismissed new US sanctions** over the poisoning in Britain of Sergei Skripal and his daughter as “the theater of absurd” and Washington as an “unpredictable” power. **Jamil Anderlini suggests in the *Financial Times*** that Moscow may already have found an ally more to its liking. It’s an alliance the West ignores at its peril.

“While heavily lopsided—Russia’s economy is about one-tenth the size of China’s—the countries’ economic relationship is critical for both sides,” Anderlini writes.

“But even more significant than their economic entanglement is the military relationship between the neighbors. On his first trip abroad in his new role in April, Wei Fenghe, China’s defense minister, visited Moscow with a very direct message: ‘The Chinese side has come to show Americans the close ties between the armed forces of China and Russia,’ he told his counterpart…”

“Again, this is not just friendly rhetoric. Until recently, Chinese naval vessels had not strayed from the country’s coastline for centuries, but today its warships conduct regular joint exercises with Russia from the Sea of Japan to the Mediterranean.”

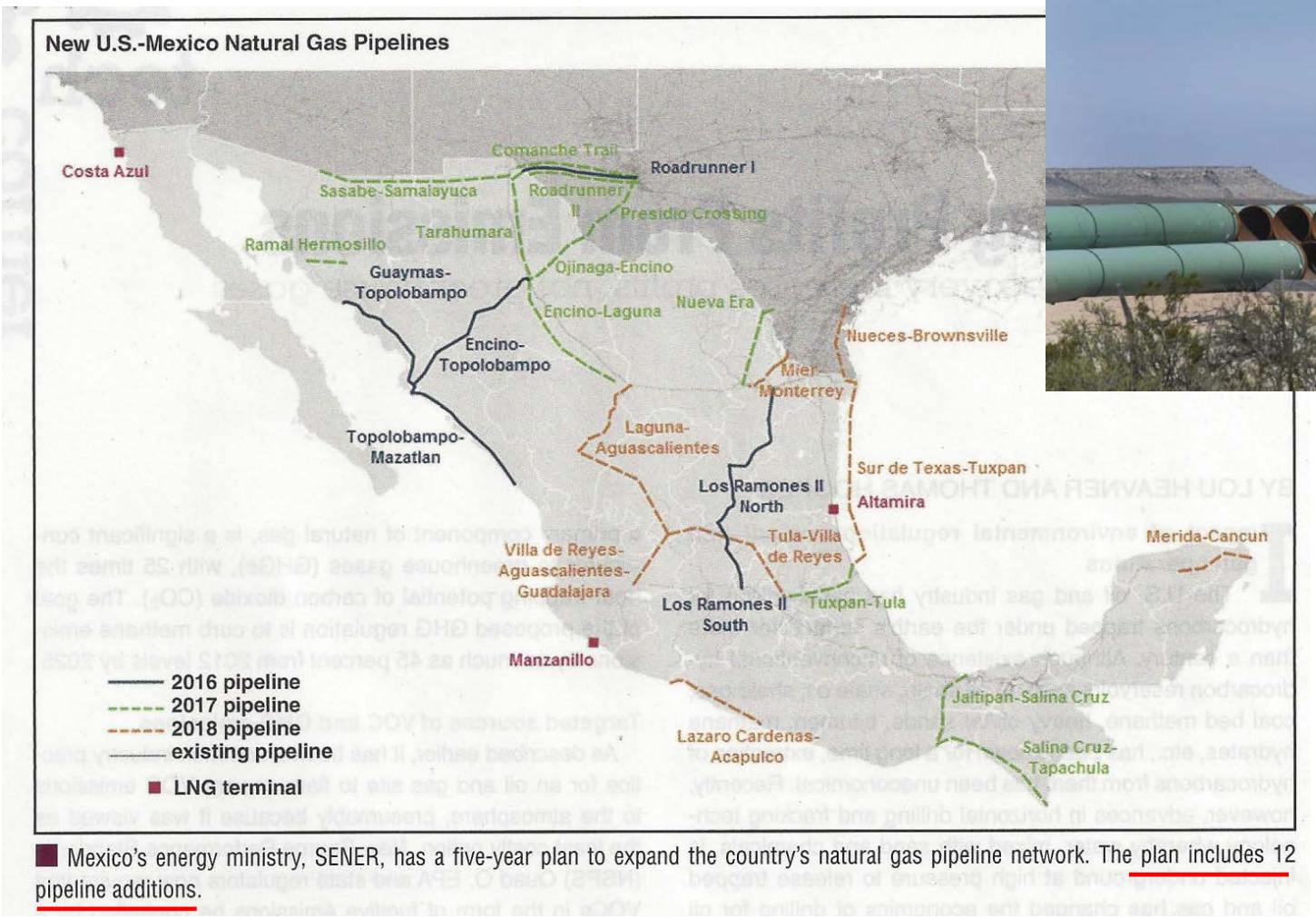
Fareed Zakarian – August 9, 2018

NAFTA

Texas Natural Gas To Mexico Depends On NAFTA

- The U.S. Energy Department reported that four major pipelines are scheduled to begin commercial operations by the end of the year to supply Mexico's power generation and industrial sectors.
- Mexico has emerged as one of the largest customers of U.S. natural gas after overhauling its energy policies five years ago.
- The pipelines, which include Enbridge's Nueces-Brownsville project in the Rio Grande Valley and three projects in Mexico, are expected to start up in October and November.
- They'll help bring gas from West Texas, where there is a pipeline shortage, and elsewhere in the state to central and western Mexico.
- Natural gas shipments to Mexico by pipeline exceeded 5 billion cubic feet per day for the first time last month, up from an average of 4.2 billion cubic feet per day in 2017.
- U.S. natural gas exports to Mexico surged after 2013 and 2014, when Mexico opened its energy market to foreign investment and intensified its focus on using cleaner-burning fuel sources such as natural gas.
- Mexico sought to buy gas from the U.S., where the shale boom in West Texas and elsewhere had unleashed a cheap and plentiful supply, and pushed to expand its pipeline network as its own oil and gas production declined.

Gas to Mexico



Mexico's energy ministry, SENER, has a five-year plan to expand the country's natural gas pipeline network. The plan includes 12 pipeline additions.

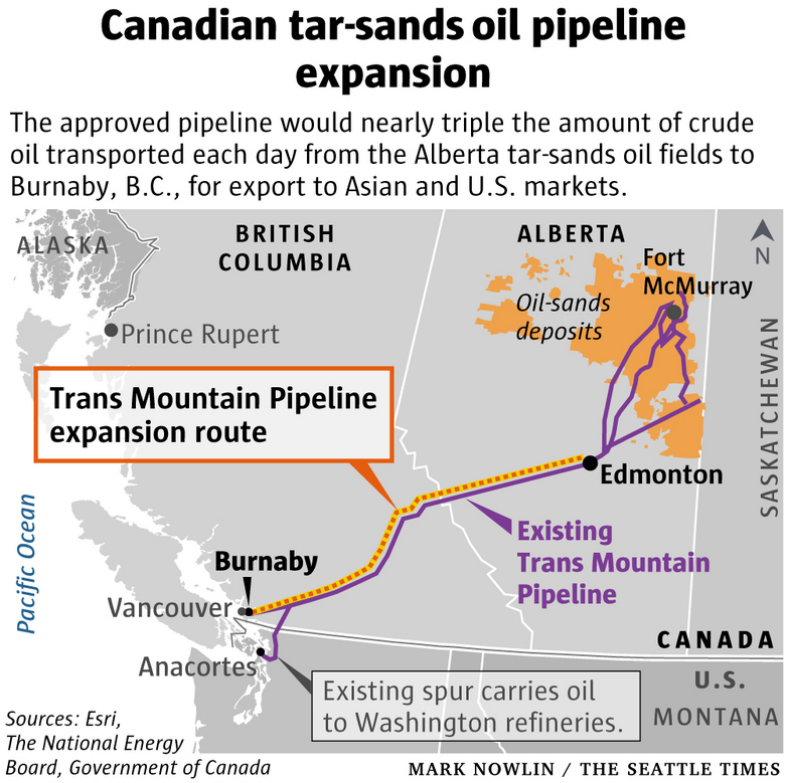
Source: CompressorTech2 May 2017

Canadian Oil Sands

- Canadian Natural purchased the oil sands business of Royal Dutch Shell PLC and Marathon Oil Corp. in February, boosting its overall production to one million barrels a day.
  - It's one of a handful of Canadian operators that took advantage of the foreign selloff to grow their oil sands holdings.
  - Statoil ASA, Murphy Oil Corp. and ConocoPhillips have also exited, while other international companies have cut spending on their oil sands plays.
  - Suncor is integrating its operations with those of Syncrude and looking at all aspects to reduce costs, from greater automation to changing how it uses suppliers.
  - If oil prices stay in the US$50 a barrel range, Suncor would generate a lot of free cash flow after completing its Fort Hills oil sands and Hebron offshore oil projects and would look at further dividend increases
- Before the oil crash, the oil sands struggled
  - Rising costs due to competition for staff and services
  - The international spotlight attracted capital, but also negative attention that delayed pipeline approvals and fuelled concern about high greenhouse gas emissions.
  - Differentials — the discount applied to heavy oil — have shrunk amid higher demand for Canadian production by refineries in the U.S. Gulf because of the continuing decline in imports from Mexico and Venezuela, Rogers said.

Canada's Trans Mountain Oil Pipeline

- Canada's energy regulator has given the go-ahead for the construction of a large portion of the Trans Mountain expansion project, which will nearly triple capacity on the oil pipeline from Alberta to a Vancouver area port.(8/16/18)
- Canadian Prime Minister Justin Trudeau has backed the project, which faces intense environmental and political opposition but would bring much needed relief to Canadian oil producers who are struggling to get their crude to market.
- The Trans Mountain expansion, which would nearly triple capacity on the line to 890,000 barrels per day, is one of three major Canadian crude export pipeline projects in the works.
- The National Energy Board (NEB) said all conditions had been met for construction to go ahead on Segments 1-4, which cover a vast swath of land from Edmonton, Alberta to Kamloops, British Columbia.
- Kinder Morgan Canada, which announced a deal to sell the project to the Canadian government in May, separately said in a blog post that preliminary work was under way in Alberta ahead of the arrival of pipeline construction crews in the spring of 2019.
- It did not provide an update on when construction would be completed. There are concerns the project could cost more than its C$7.4 billion ($5.6 billion) budget, and be delayed past its current in-service date of December 2020.
- The discount on Canada's heavy crude hit a near five-year high earlier this month as rising production continued to outstrip space on congested pipelines.



Canada LNG

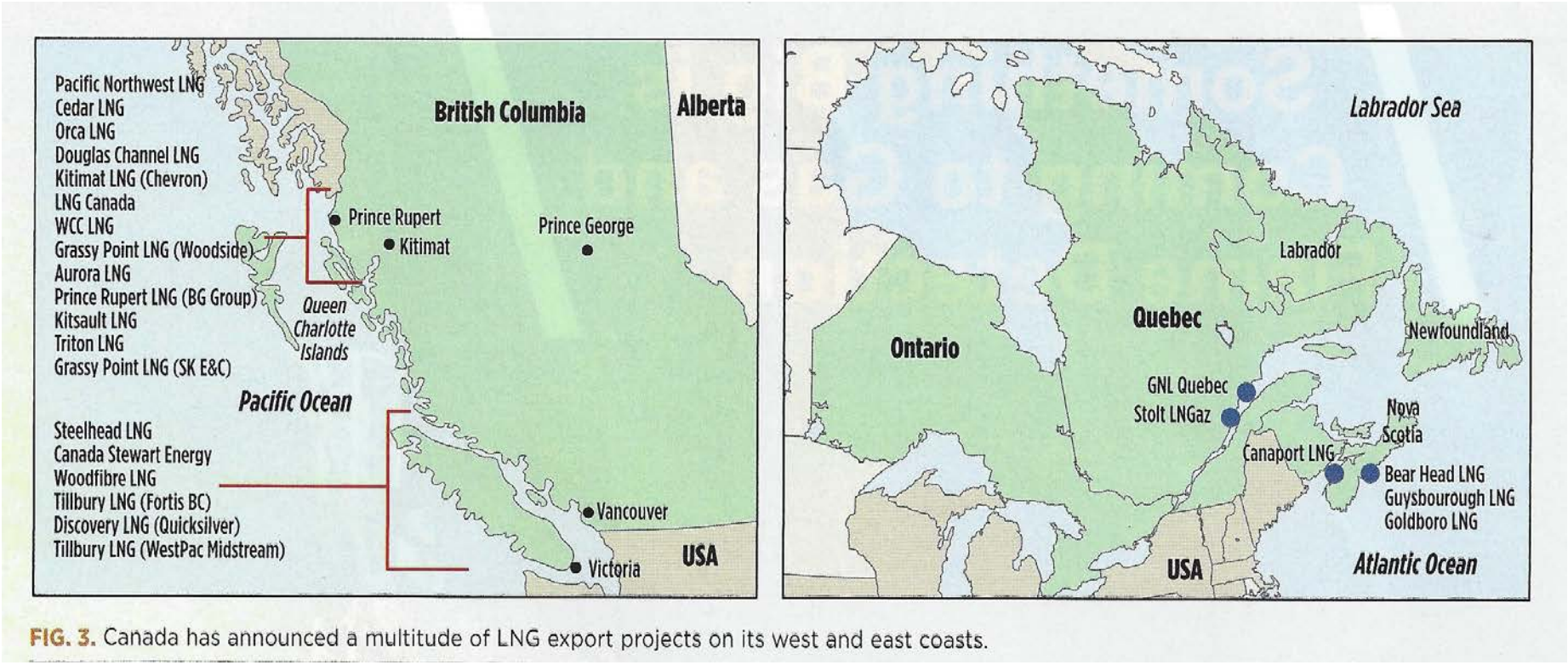


FIG. 3. Canada has announced a multitude of LNG export projects on its west and east coasts.

Canada Wet Gas Alliance Pipeline

- The Alliance pipeline is unique because it carries unprocessed natural gas
  - Unprocessed, or wet, natural gas contains ethane, propane, butanes, and natural gasoline, as well as methane, the primary component of natural gas
  - Alliance is the only pipeline of its kind that transports wet natural gas prior to processing over long distances at high pressure
  - It accomplishes this feat by modulating pipeline pressure up to nearly 2,000 psig to ensure that the mix of methane and NGPL does not separate while in the pipeline
- The Alliance pipeline currently has the capacity to carry up to 1.6 billion cubic feet per day (Bcf/d) of wet natural gas from production sites in Alberta and British Columbia along 2,391 miles of pipeline to the Aux Sable natural gas plant liquids (NGPL) extraction and fractionation facility near Chicago
- 2020

- The expansion would add up to 0.5 Bcf/d of capacity, for a total throughput of more than 2.0 Bcf/d (20BCM/y), potentially starting November 2020

Eastern Canada

PGS has in partnership with TGS commenced a new 3D MultiClient project in East Canada. The new Tablelands 3D GeoStreamer® survey will cover approximately 8,000 km² in an active Newfoundland area of the Flemish Pass and Orphan Basins. Acquisition is expected to complete in late Q3 2018.

Following this eighth consecutive season of data acquisition offshore East Canada, the jointly owned library will have more than 175,000 km of 2D GeoStreamer data and approximately 36,500 km2 of 3D GeoStreamer data. An expansive well log library is also available in the region, along with advanced MultiClient interpretation products that will improve play, trend and prospect delineation.

"Tablelands 3D will expand PGS data coverage offshore East Canada with high quality seismic data to an area that is highly relevant for exploration in the attractive Newfoundland basins. The area has proven reservoirs of excellent quality, combined with transparent fiscal terms and a predictable land tenure system," said Rune Olav Pedersen, President & CEO of PGS.

South America

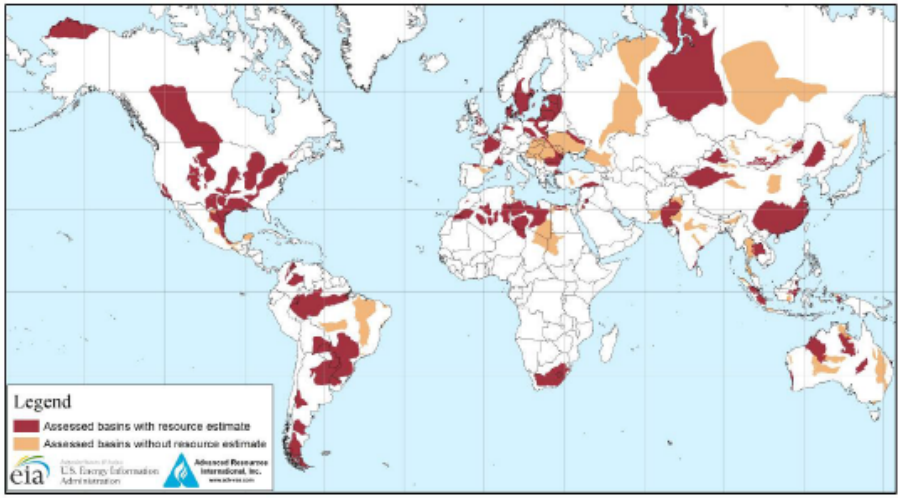
EIA/ARI Technically Recoverable Shale Resources - 2013

Table 1. Comparison of the 2011 and 2013 reports

ARI report coverage	2011 Report	2013 Report
Number of countries	32	41
Number of basins	48	95
Number of formations	69	137
Technically recoverable resources, including U.S.		
Shale gas (trillion cubic feet)	6,622	7,299
Shale / tight oil (billion barrels)	32	345

Note: The 2011 report did not include shale oil; however, the *Annual Energy Outlook 2011* did (for only the U.S.) and is included here for completeness

Figure 1. Map of basins with assessed shale oil and shale gas formations, as of May 2013



Source: United States basins from U.S. Energy Information Administration and United States Geological Survey; other basins from ARI based on data from various published studies.

Table 5. Top 10 countries with technically recoverable shale oil resources

Rank	Country	Shale oil (billion barrels)	
1	Russia	75	
2	U.S.[1]	58	(48)
3	China	32	
4	Argentina	27	
5	Libya	26	
6	Venezuela	13	
7	Mexico	13	
8	Pakistan	9	
9	Canada	9	
10	Indonesia	8	
	World Total	345	(335)

[1] EIA estimates used for ranking order. ARI estimates in parentheses.

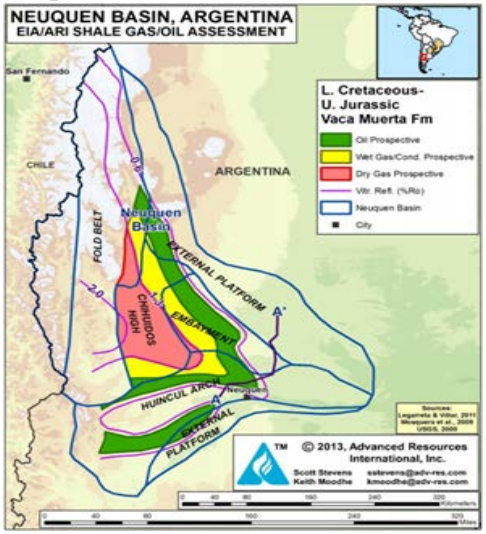
Table 6. Top 10 countries with technically recoverable shale gas resources

Rank	Country	Shale gas (trillion cubic feet)	
1	China	1,115	
2	Argentina	802	
3	Algeria	707	
4	U.S.[1]	665	(1,161)
5	Canada	573	
6	Mexico	545	
7	Australia	437	
8	South Africa	390	
9	Russia	285	
10	Brazil	245	
	World Total	7,299	(7,795)

[1] EIA estimates used for ranking order. ARI estimates in parentheses.

Argentina Shale Gas

- EIA recent update of global shale resources ranked Argentina's potential second in the world
  - 802 TCF/22,700 BCM
- Argentina rates their shale prospects at:
  - 1181 TCF/33,400 BCM
- Vaca Muerta's geologic properties have been compared to the Eagle Ford in terms of its depth, thickness, pressure, and mineral composition.

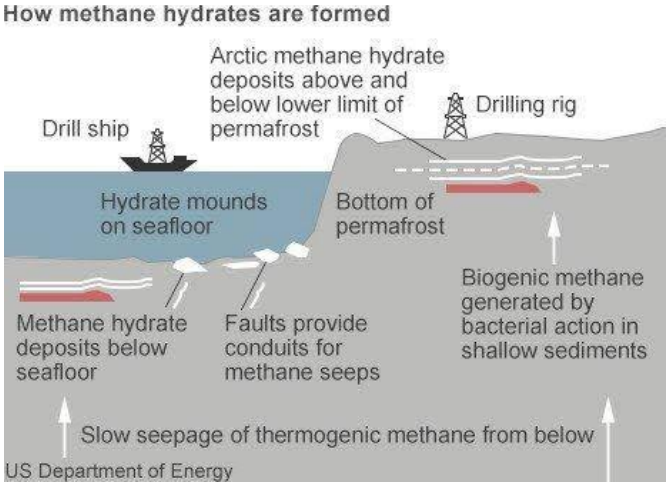


Methane Hydrates – 280,000 to 2,800,000 BCM?

- **For the first time, China has extracted gas from methane Hydrates under the South China Sea**
- Considered key to (their?) future global energy supply
- Officially known as methane clathrates, or hydrates
- Methane hydrates, also called "flammable ice", hold vast reserves of natural gas
- Many countries including the US and Japan are working on how to tap those reserves
- Mining and extracting are extremely difficult
  - They are formed at very low temperatures and under high pressure
  - They can be found in sediments under the ocean floor as well as underneath permafrost on land.

• Methane hydrates could be key to future energy needs

Likely the world's last great source of carbon-based fuel



Rural Electrification

Power – "Still in the Dark"

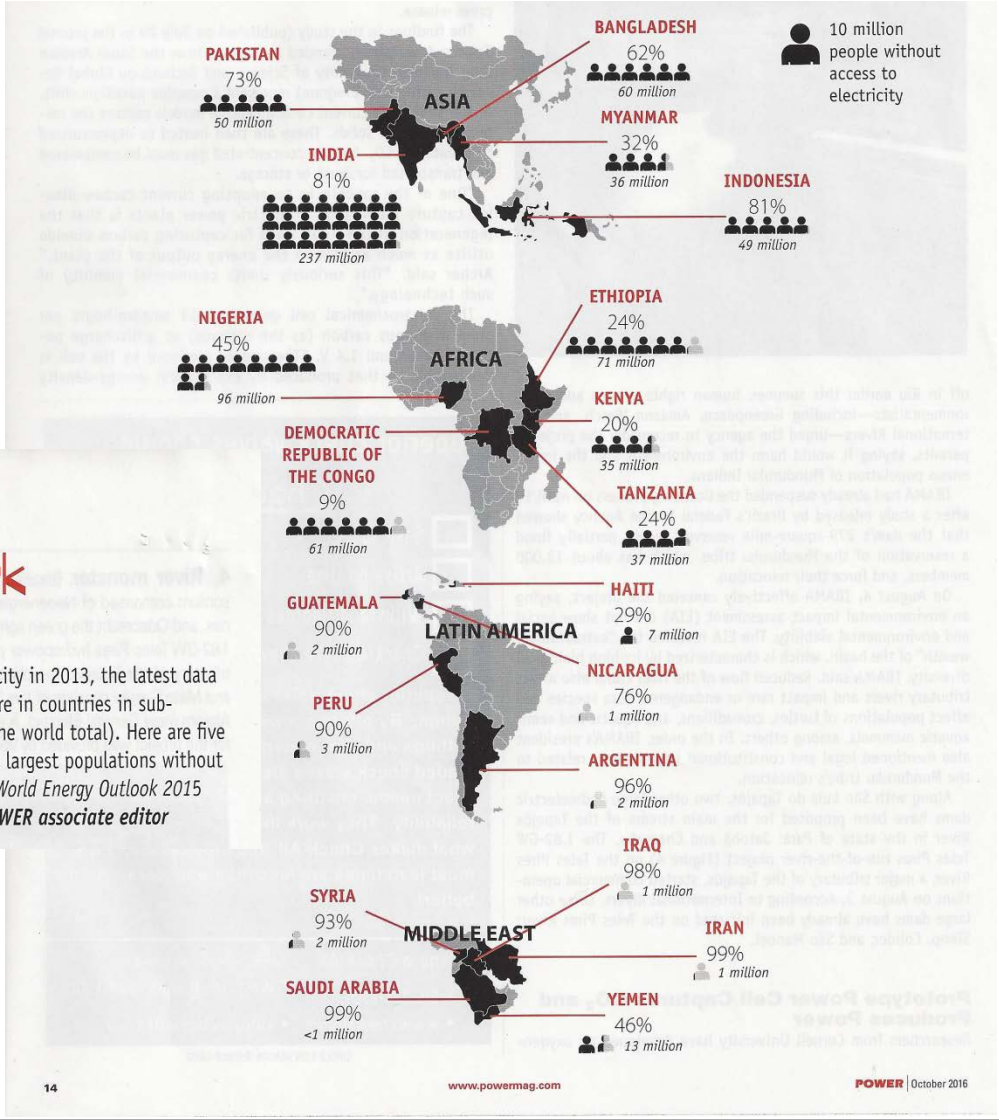
1.2 billion people
17% of Global
Population do not
have access to
electricity

GLOBAL MONITOR

THE BIG PICTURE: Still in the Dark

An estimated 1.2 billion people—17% of the global population—did not have access to electricity in 2013, the latest data from the International Energy Agency show. More than 95% of those living without electricity are in countries in sub-Saharan Africa and developing Asia, and they are predominantly in rural areas (around 80% of the world total). Here are five countries per region (developing Asia, Africa, Latin America, and the Middle East) that have the largest populations without access to electricity. Also noted is that country's national electrification rate (%). *Source: IEA, World Energy Outlook 2015*

—Copy and artwork by Sonal Patel, a POWER associate editor



Rural Electrification Opportunity

MA H4857 Energy Compromise Bill

The final H4857 released by the House and Senate Conference Committee as an energy compromise bill contains:

- Boosts the Renewable Portfolio Standard (RPS) annual increase to 2 percent from the current 1 percent starting in 2020, but declines back to 1 percent in 2030;
- Authorizes 1,000 megawatt-hours of energy storage
- Authorizes 1,600 megawatts of offshore wind by 2035
- Expands energy efficiency offerings within the MassSave program
- "clean peak" standard which incentivizes waste incineration (class 2 renewables):
  - Could potentially slow retirement of existing incinerators like Springfield and Saugus
  - Fairly convinced that gas is not a concern
- Gas leaks: quantifying how much is leaking! Requires DPU to do that.
- Demand charge language raises questions (Senate version was a compromise, what ended up in was a watered-down Senate version)
  - Monthly minimum reliability contribution

Excludes the following:

- Solar net metering cap removal or lifting
- Solar access for all/equity
- 2030/2040 targets
- Environmental Justice
- Pipeline tax ban

U.S. Regional Retail Electricity Prices – Cents/kWh

Table 7c. U.S. Regional Retail Electricity Prices (Cents per Kilowatthour

U.S. Energy Information Administration | Short-Term Energy Outlook - August 2018

	2017				2018				2019				Year		
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	2017	2018	2019
Residential Sector															
New England	18.57	18.92	18.97	19.28	20.42	20.09	18.92	19.69	21.03	20.86	19.90	20.45	18.93	19.74	20.54
Middle Atlantic	15.55	16.27	16.43	15.87	15.61	16.36	16.51	16.14	15.94	16.79	16.94	16.47	16.04	16.16	16.53
E. N. Central	12.90	13.58	13.28	13.19	12.94	13.65	13.53	13.63	13.45	14.28	14.00	14.00	13.23	13.43	13.92
W. N. Central	10.94	12.66	13.16	11.51	10.91	12.41	13.27	11.79	11.31	13.02	13.62	12.02	12.07	12.10	12.49
S. Atlantic	11.69	12.01	12.26	11.81	11.61	11.86	12.26	11.94	11.82	12.22	12.52	12.13	11.96	11.93	12.18
E. S. Central	11.08	11.44	11.32	11.20	10.86	11.29	11.25	11.42	11.27	11.84	11.47	11.53	11.26	11.19	11.51
W. S. Central	10.54	10.93	10.87	10.76	10.54	10.88	10.71	10.74	10.65	11.19	10.91	10.87	10.79	10.71	10.90
Mountain	11.28	12.16	12.31	11.82	11.57	12.39	12.54	12.06	11.84	12.71	12.84	12.32	11.94	12.19	12.47
Pacific	14.51	14.69	16.50	14.37	14.86	15.48	16.99	14.59	15.14	16.07	17.63	15.06	15.07	15.53	16.00
U.S. Average	12.59	12.99	13.19	12.75	12.57	13.01	13.27	12.95	12.88	13.54	13.58	13.21	12.90	12.96	13.31
Commercial Sector															
New England	14.64	14.65	15.30	15.20	16.56	15.78	15.54	15.41	16.30	15.16	15.10	15.18	14.95	15.81	15.43
Middle Atlantic	12.07	12.75	13.34	12.08	12.07	12.43	13.27	12.10	12.01	12.37	13.25	12.25	12.58	12.49	12.49
E. N. Central	10.02	10.24	10.05	9.99	10.10	10.28	10.19	10.19	10.31	10.50	10.31	10.28	10.08	10.19	10.35
W. N. Central	9.12	10.11	10.57	9.26	9.17	10.04	10.75	9.50	9.36	10.32	10.99	9.76	9.79	9.89	10.13
S. Atlantic	9.44	9.38	9.55	9.53	9.56	9.35	9.61	9.66	9.88	9.54	9.68	9.70	9.48	9.55	9.69
E. S. Central	10.58	10.56	10.62	10.57	10.51	10.58	10.84	10.95	10.63	10.78	10.82	10.93	10.58	10.72	10.79
W. S. Central	8.37	8.40	8.38	8.28	8.38	8.11	8.13	8.17	8.00	7.74	7.80	8.11	8.36	8.19	7.91
Mountain	9.14	9.92	10.04	9.49	9.25	10.04	10.22	9.73	9.28	10.08	10.27	9.81	9.67	9.84	9.88
Pacific	12.53	13.56	15.36	13.61	12.86	14.36	16.03	14.29	13.67	14.95	16.60	14.43	13.82	14.45	14.96
U.S. Average	10.39	10.68	11.03	10.56	10.51	10.71	11.13	10.75	10.66	10.81	11.13	10.78	10.68	10.79	10.86
Industrial Sector															
New England	12.38	12.19	12.55	12.37	13.49	12.76	13.08	12.83	14.12	13.16	13.35	13.01	12.37	13.03	13.39
Middle Atlantic	6.94	6.94	6.88	6.81	7.20	6.72	6.90	6.87	7.00	6.64	6.84	6.84	6.89	6.92	6.83
E. N. Central	7.03	7.05	7.04	6.96	7.08	7.09	7.20	7.16	7.14	7.16	7.25	7.21	7.02	7.13	7.19
W. N. Central	6.89	7.35	8.07	6.87	7.05	7.27	8.19	7.04	7.16	7.37	8.30	7.12	7.31	7.40	7.50
S. Atlantic	6.31	6.39	6.79	6.34	6.45	6.40	6.95	6.53	6.44	6.44	6.97	6.56	6.46	6.59	6.61
E. S. Central	5.90	5.96	6.18	5.89	5.74	5.86	6.29	6.06	5.85	5.98	6.37	6.15	5.98	5.99	6.09
W. S. Central	5.28	5.55	5.72	5.41	5.43	5.35	5.71	5.46	5.31	5.36	5.72	5.53	5.50	5.49	5.49
Mountain	6.08	6.54	7.12	6.13	6.10	6.62	7.24	6.25	6.28	6.82	7.44	6.43	6.50	6.59	6.78
Pacific	8.23	9.35	10.73	9.73	8.63	9.94	11.11	9.99	8.80	10.04	11.19	10.04	9.57	10.00	10.10
U.S. Average	6.64	6.89	7.27	6.79	6.79	6.91	7.43	6.95	6.83	6.99	7.49	7.02	6.91	7.03	7.09
All Sectors (a)															
New England	15.93	15.87	16.35	16.35	17.79	16.98	16.63	16.71	18.05	16.99	16.84	16.99	16.13	17.02	17.22
Middle Atlantic	12.35	12.68	13.26	12.29	12.48	12.59	13.33	12.38	12.52	12.60	13.37	12.55	12.67	12.72	12.78
E. N. Central	10.00	10.13	10.16	10.01	10.13	10.29	10.38	10.27	10.37	10.43	10.54	10.43	10.08	10.27	10.45
W. N. Central	9.15	10.06	10.75	9.29	9.26	10.04	10.93	9.52	9.47	10.21	11.15	9.71	9.84	9.96	10.16
S. Atlantic	9.86	9.93	10.35	9.93	10.00	9.93	10.42	10.09	10.22	10.09	10.57	10.20	10.04	10.12	10.29
E. S. Central	9.20	9.27	9.55	9.23	9.23	9.33	9.68	9.51	9.48	9.52	9.77	9.59	9.32	9.45	9.60
W. S. Central	8.10	8.35	8.67	8.21	8.34	8.26	8.56	8.18	8.20	8.13	8.49	8.23	8.35	8.35	8.28
Mountain	8.97	9.67	10.12	9.25	9.10	9.83	10.31	9.45	9.26	9.95	10.45	9.61	9.55	9.73	9.87
Pacific	12.48	12.98	14.79	13.06	12.78	13.73	15.28	13.47	13.25	14.16	15.70	13.71	13.38	13.87	14.25
U.S. Average	10.26	10.47	10.98	10.37	10.42	10.56	11.11	10.55	10.60	10.72	11.20	10.68	10.54	10.68	10.82

Regional Natural Gas Prices - $/1000ft^3

U.S. Energy Information Administration | Short-Term Energy Outlook - August 2018

	2017				2018				2019				Year		
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	2017	2018	2019
Wholesale/Spot															
Henry Hub Spot Price	3.12	3.19	3.06	3.01	3.13	2.96	2.99	3.20	3.30	3.08	3.15	3.32	3.10	3.07	3.21
Residential Retail															
New England	12.85	14.08	18.12	13.57	14.56	17.32	17.79	13.58	13.04	13.93	17.15	13.61	13.60	14.93	13.62
Middle Atlantic	9.92	12.18	17.11	11.33	10.15	11.66	16.26	10.69	9.91	11.84	16.39	10.82	11.17	10.94	10.91
E. N. Central	7.77	11.52	17.80	7.81	7.20	9.62	16.75	8.87	8.00	10.82	16.62	9.02	8.86	8.62	9.27
W. N. Central	8.32	11.85	18.79	9.56	8.17	10.47	18.33	10.39	9.51	12.24	17.83	9.96	9.80	9.70	10.58
S. Atlantic	12.29	20.05	26.86	13.20	11.09	15.44	22.43	12.68	11.10	16.05	22.36	12.80	14.63	12.95	13.03
E. S. Central	10.53	15.83	20.82	11.32	9.71	12.66	19.57	11.99	9.70	14.12	20.31	12.69	12.05	11.33	11.65
W. S. Central	10.33	16.49	22.10	13.09	9.32	13.93	19.60	11.16	8.01	13.44	19.89	11.48	13.18	11.37	10.66
Mountain	8.21	10.17	13.91	8.76	8.22	10.29	14.20	9.25	9.00	10.28	13.92	9.29	9.14	9.31	9.70
Pacific	12.02	12.64	12.90	11.30	11.63	12.12	13.01	11.59	12.44	12.58	12.92	11.85	12.01	11.87	12.34
U.S. Average	9.73	13.00	17.74	10.19	9.39	11.83	16.78	10.59	9.64	12.16	16.74	10.72	10.92	10.64	10.87
Commercial Retail															
New England	9.55	9.97	10.61	9.53	11.09	12.31	11.27	10.56	10.58	10.63	10.54	10.42	9.71	11.15	10.54
Middle Atlantic	7.66	7.42	6.82	7.38	8.10	7.60	7.06	7.53	7.67	7.51	6.96	7.55	7.43	7.72	7.51
E. N. Central	6.63	7.90	8.98	6.21	6.19	6.97	8.86	6.91	6.66	7.62	9.04	7.14	6.84	6.73	7.13
W. N. Central	6.96	7.80	9.11	7.04	7.00	7.14	9.01	7.43	7.65	7.98	9.03	7.49	7.28	7.30	7.77
S. Atlantic	8.89	10.00	9.56	8.91	8.32	9.22	9.68	8.68	8.51	9.36	9.75	8.80	9.16	8.74	8.89
E. S. Central	9.05	10.28	10.76	9.30	8.69	9.29	10.14	9.09	8.66	9.68	10.21	9.18	9.53	9.06	9.15
W. S. Central	7.63	8.20	8.86	8.18	7.24	7.81	8.42	7.76	7.31	7.77	8.38	7.81	8.09	7.65	7.68
Mountain	6.88	7.37	8.27	7.21	6.99	7.56	8.62	7.46	7.61	7.85	8.56	7.48	7.22	7.41	7.72
Pacific	9.09	9.06	9.08	8.54	8.91	8.66	8.86	8.47	8.73	8.81	9.12	8.84	8.92	8.72	8.84
U.S. Average	7.71	8.33	8.69	7.56	7.66	8.08	8.67	7.87	7.80	8.25	8.67	7.98	7.87	7.90	8.02
Industrial Retail															
New England	7.81	7.04	6.39	7.05	9.05	8.91	7.06	7.83	8.24	7.47	6.90	7.93	7.19	8.35	7.76
Middle Atlantic	7.69	7.59	7.62	7.18	8.29	7.64	7.50	7.62	7.98	7.34	7.38	7.67	7.53	7.91	7.72
E. N. Central	5.86	5.96	5.59	5.30	5.74	5.06	5.90	6.00	6.63	6.27	6.16	6.15	5.66	5.69	6.37
W. N. Central	5.01	4.29	4.25	4.68	5.04	4.26	4.63	5.27	5.78	4.88	4.66	5.29	4.60	4.84	5.21
S. Atlantic	5.35	5.00	4.88	4.93	5.39	4.78	4.78	5.12	5.46	4.87	4.87	5.27	5.05	5.04	5.14
E. S. Central	5.06	4.59	4.40	4.56	4.99	4.30	4.30	4.74	4.93	4.44	4.44	4.90	4.67	4.61	4.70
W. S. Central	3.42	3.42	3.30	3.14	3.34	3.13	3.34	3.46	3.55	3.30	3.43	3.58	3.32	3.32	3.47
Mountain	5.31	5.36	5.61	5.50	5.41	5.32	5.95	6.05	6.18	5.85	6.07	6.12	5.43	5.68	6.07
Pacific	7.31	6.71	6.32	6.35	7.05	6.27	6.47	6.58	7.04	6.49	6.65	6.78	6.71	6.61	6.76
U.S. Average	4.50	4.11	3.89	4.00	4.48	3.87	3.91	4.30	4.64	4.02	4.01	4.43	4.14	4.16	4.29