PLANO Meeting
Effects of the Trump presidency on the US Oil Patch

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Tulane Energy Institute
2-23-17

Policy Changes

- After 8 years, the advent of a hydrocarbon friendly administration
- US petrochemical production, investment and exports are increasing and will continue to increase due to cost advantaged NGLs.
- With plentiful supplies, the US is becoming a formidable exporter of light sweet crude, medium sour crude, LNG, refined products, NGLs/Olefins and bulk plastics.
- Cheap domestic energy and feed stocks should translate into more plentiful downstream domestic manufacturing jobs.
- Additional infrastructure spending is bi-partisan and can accelerate the process, providing near term employment. (River dredging and IHNC)
- Expect more pipelines connecting population centers to shale based energy centers.
- Expect more CCGT power generation.
- Trade policy: globalization will wane as protectionism waxes. Back to Bi-lateral trade agreements.
- Tax policy will probably be disappointing because of inertia as well as known and unknown ripple effects.

Exploration and Production

Baker Hughes Rig Count 2-17-17

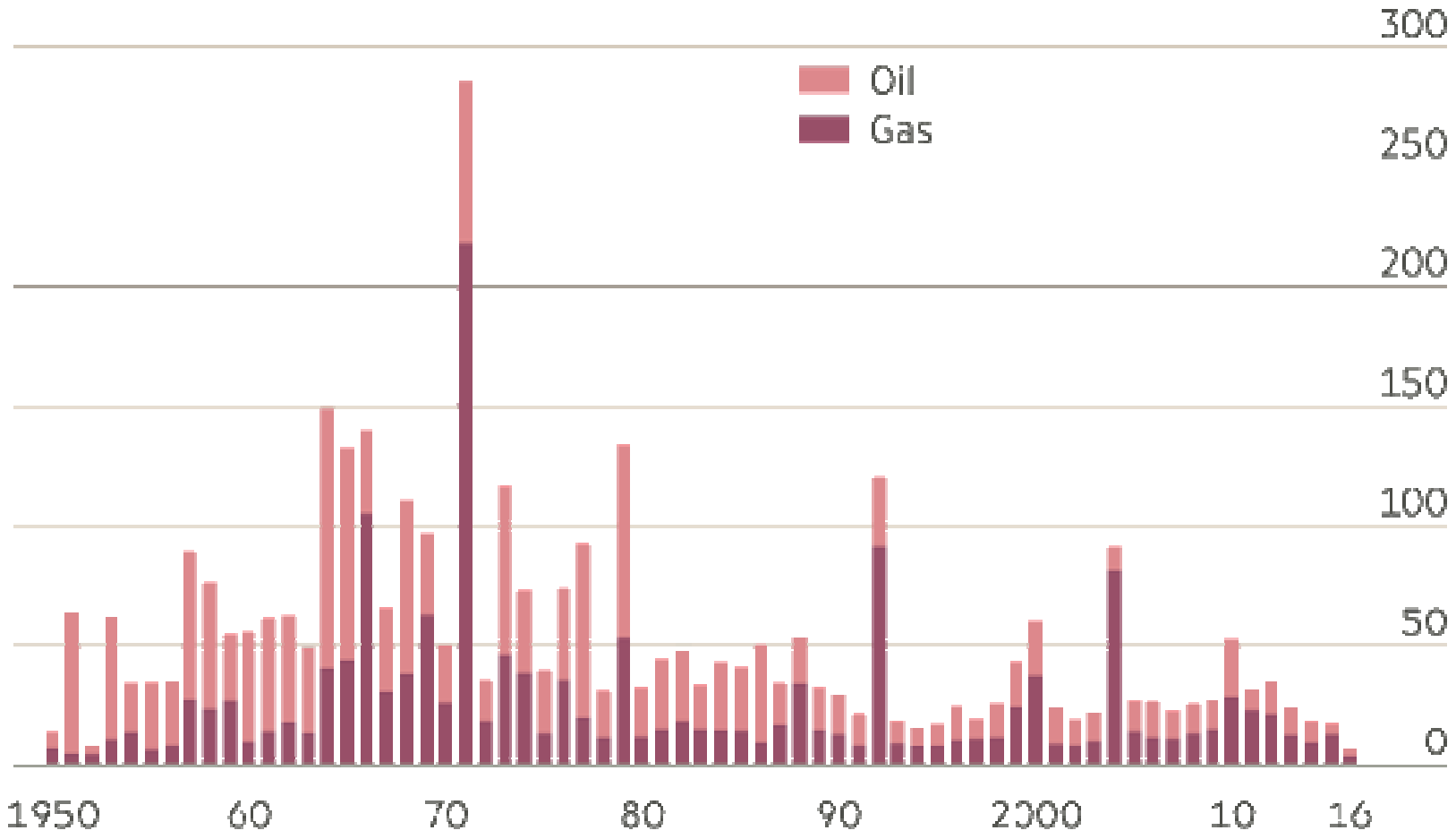
- US Rig Count = 751 rigs, an increase of 10 in the last week. A year ago 514 rigs were working. Total 2017 US wells should jump 26.8% to 18,552 from 14,631 in 2016.

- GOM Offshore Rig count was 17 down 8 from the same week of 2016 or down 33 from the same week of 2015. The last time La. was this low was in August, 2010.

- La. Lost 3 rigs, but should see a 31% increase with the state overall increasing 12.8% to 123 from 109 in 2016.

Discoveries at their lowest level since the 1950s

Estimatec recoverable resources of newly found fields (bn boe)



Source: IHS Markit

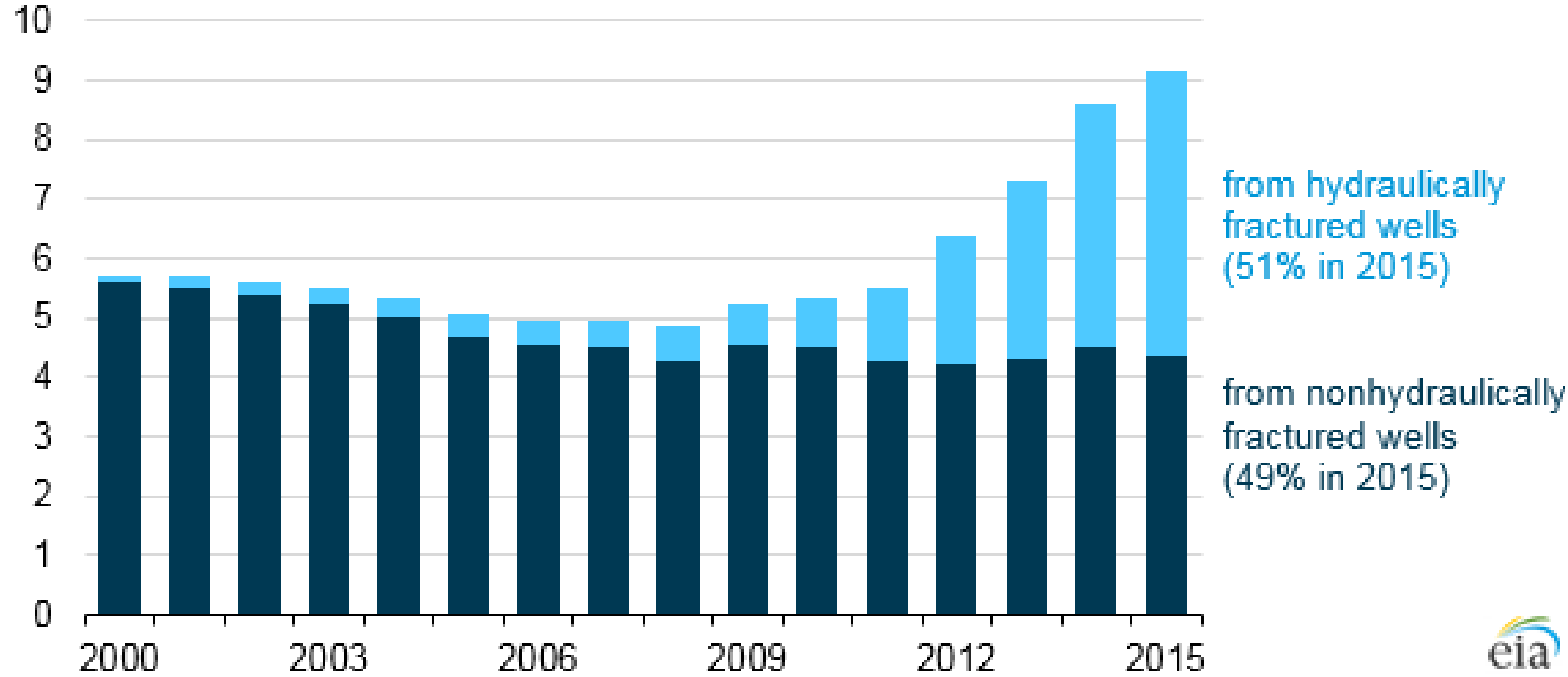
FT

We’re not looking and we’re not discovering!

- The world added 190 bn BOE in the last 10 years
- But, only 174 discoveries in 2016 vs. 400-500/year until 2013
- Low discovery level => less conventional and more shale drilling and production.
- Deepwater offshore wells cost $150 mm whereas onshore shale oil wells cost $4-10 mm. There’s no discovery risk and easier access to infrastructure. As for execution risk, practice makes perfect!
- World wide, exploration expenditures dropped from $100 bn in 2014 to $40 bn in 2016.
- Discoveries hit a six decade low in 2015 and then dropped again in 2016 to ~8.2 billion bbl.
- The world’s two largest discoveries in 2016 were both in the US, Smith Bay (up to 4 bn bbl) and the Willow discovery (300 mm bbl) , both in Alaska. Other discoveries included Senegal and Angola. Zohr, offshore Egypt, was in 2015.

Oil production in the United States (2000-2015)

million barrels per day



Lower 48 onshore crude oil production by region (Reference case)
million barrels per day

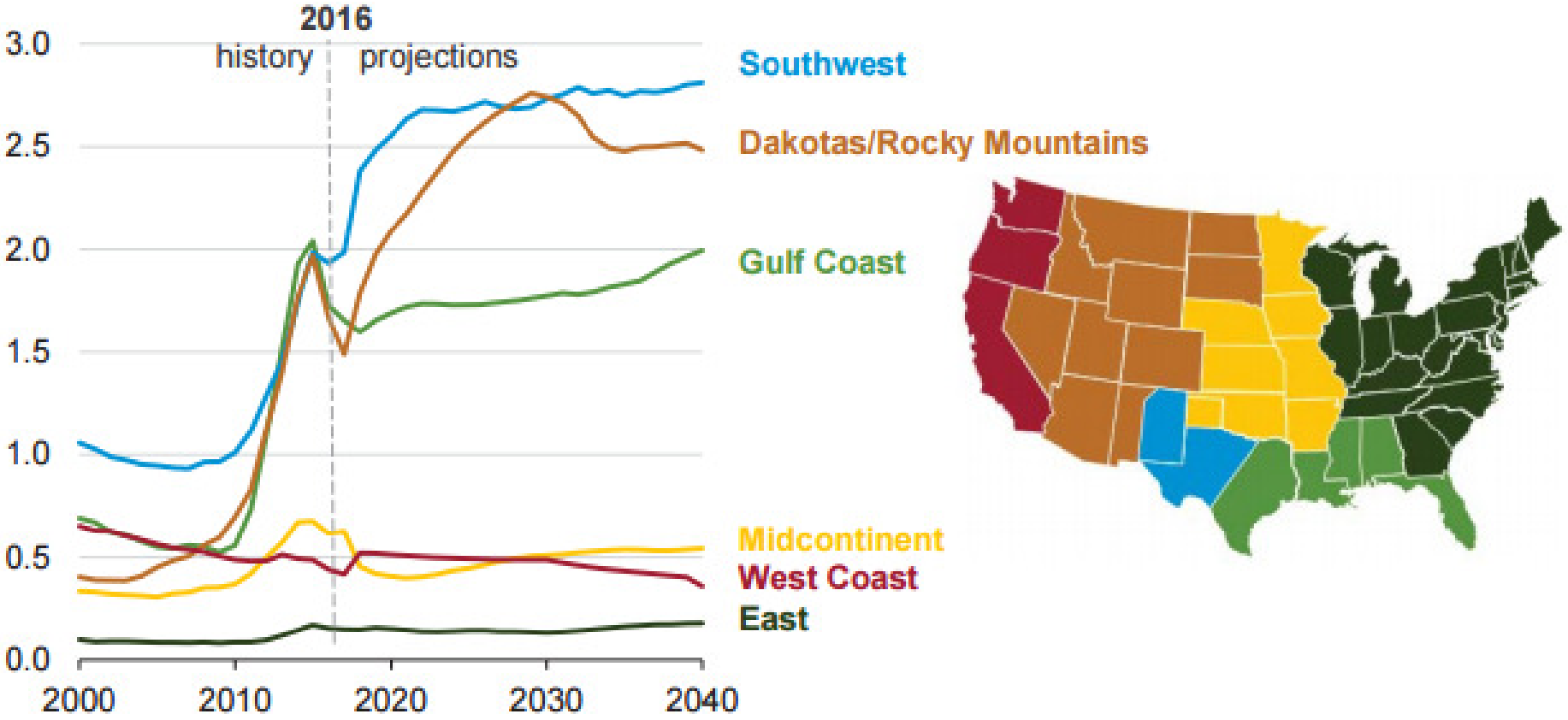


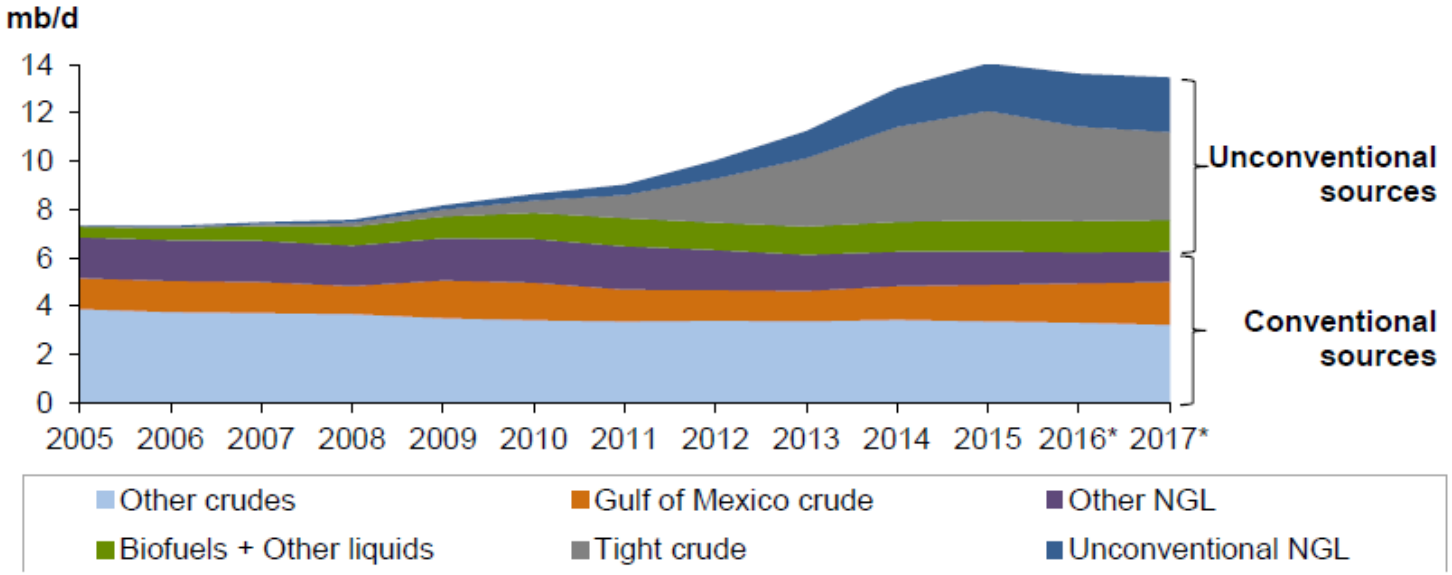
Table 5.4: US liquids production breakdown forecast, 2016-2017, tb/d

	2014	2015	Change	2016	Change	2017	Change
Tight crude	3,926	4,524	*598*	3,910	*-614*	3,628	*-282*
Gulf of Mexico crude	1,397	1,515	*118*	1,625	*110*	1,775	*150*
Other crudes	3,441	3,376	*-65*	3,324	*-52*	3,234	*-90*
Unconventional NGL	1,594	1,961	*367*	2,183	*222*	2,260	*77*
Other NGL	1,420	1,382	*-39*	1,280	*-102*	1,250	*-30*
Biofuels + Other liquids	1,238	1,283	*45*	1,295	*11*	1,315	*20*
US total supply	**13,017**	**14,041**	***1,024***	**13,617**	***-424***	**13,462**	***-155***

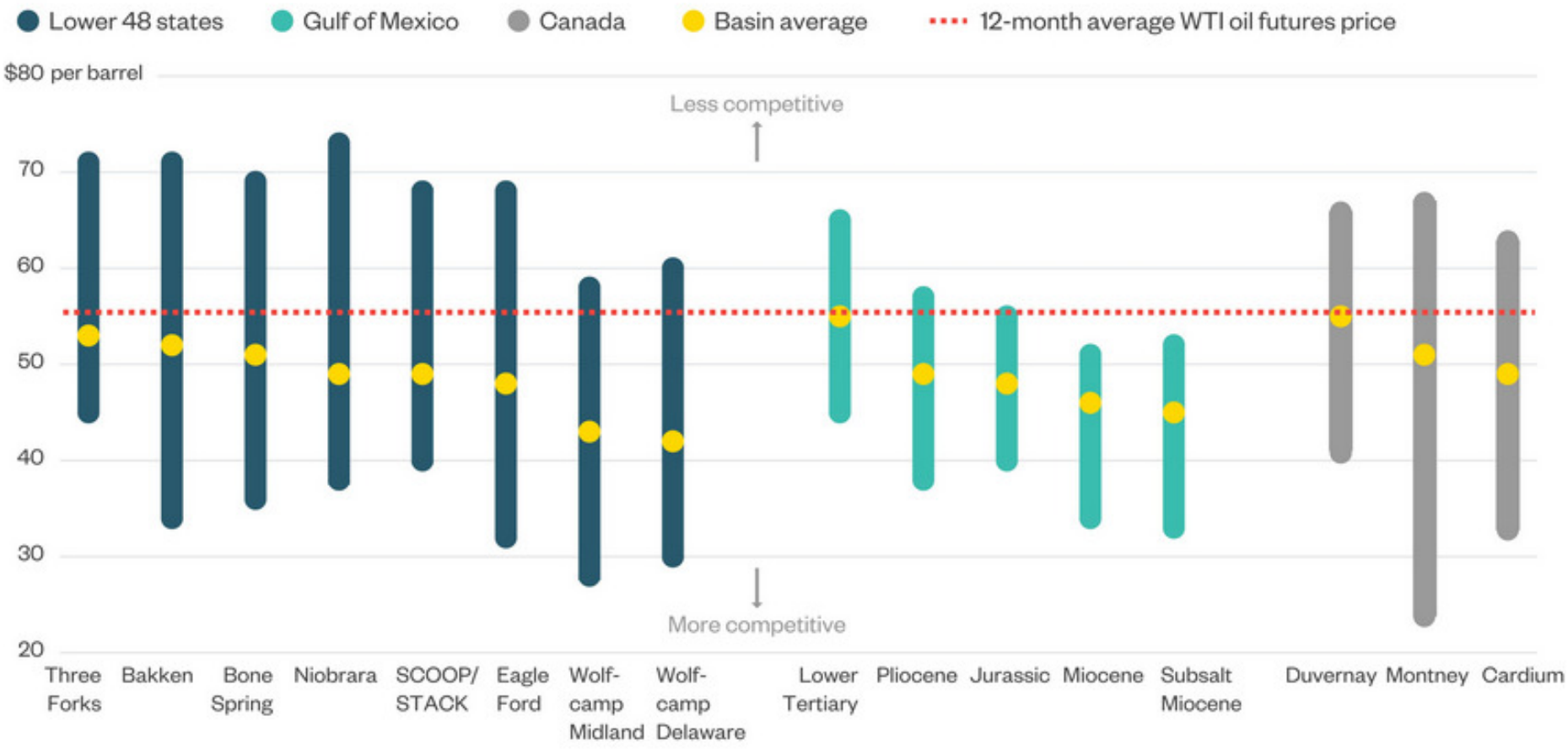
*Note: * 2016 = Estimate and 2017 = Forecast.*

Source: OPEC Secretariat.

Graph 5.8: Trend of US oil production's components, 2005-2017



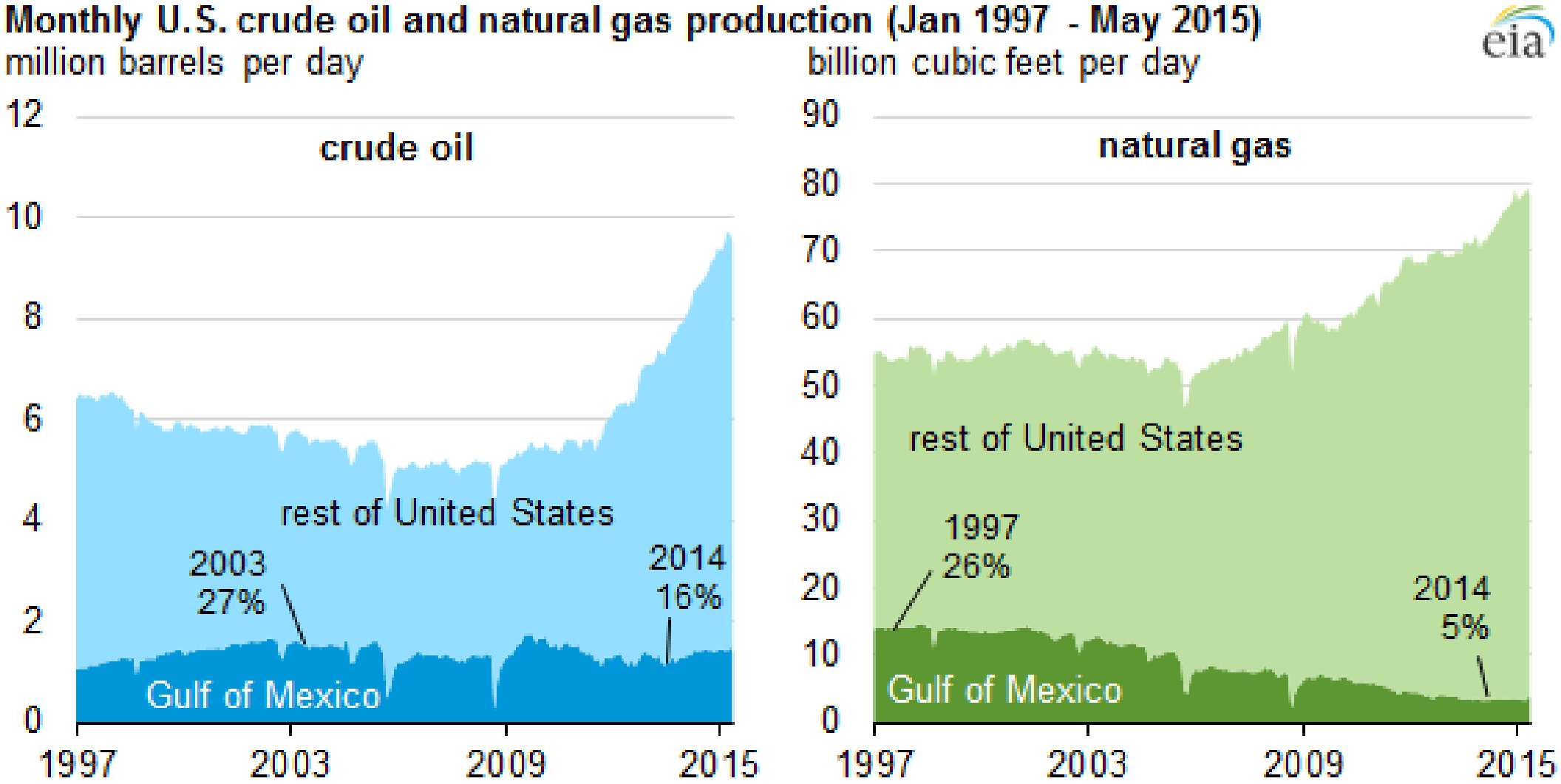
Breakeven oil prices for North America's shale basins and the Gulf of Mexico vary widely, but on average they look competitive even with oil below $60 a barrel



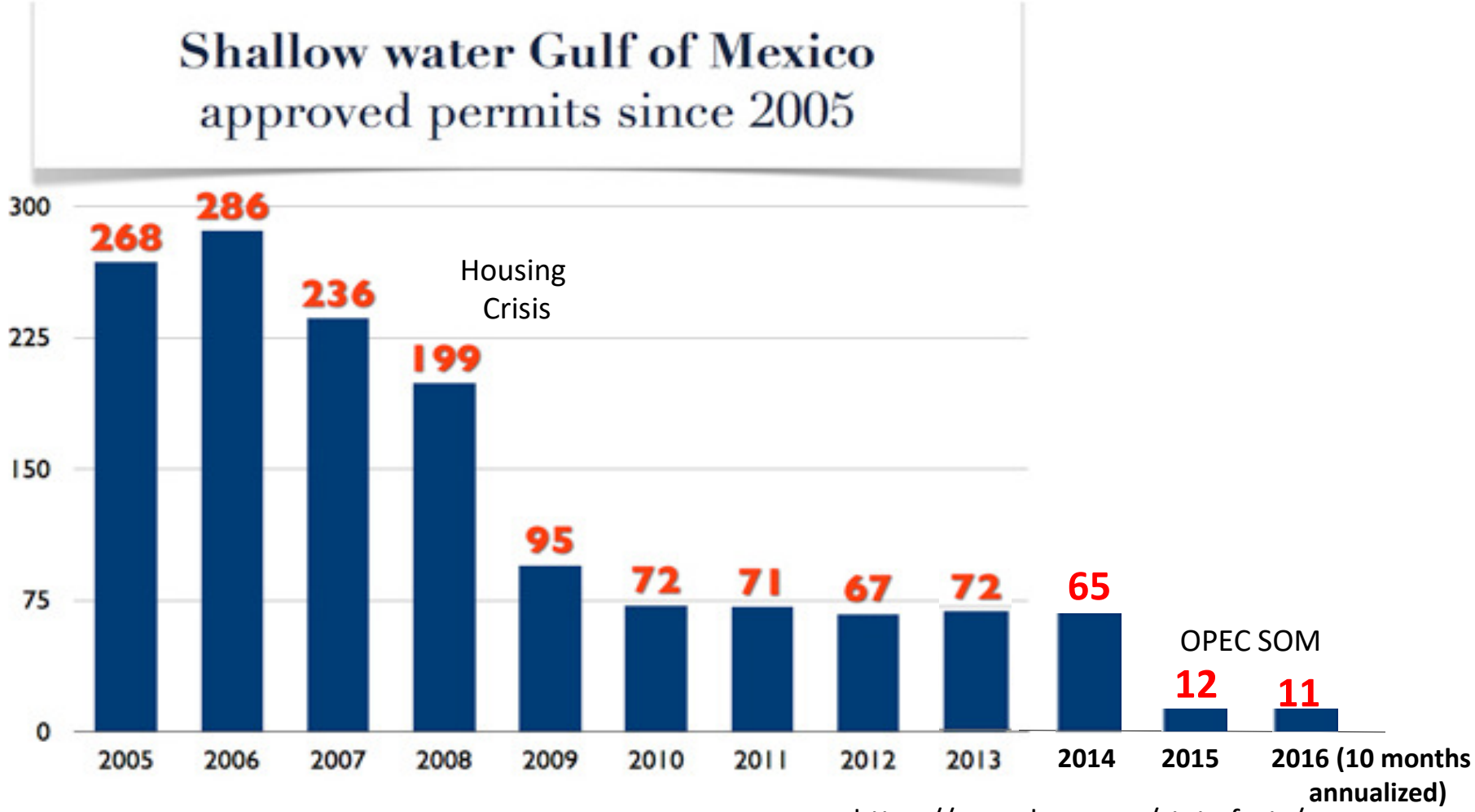
Source: Wood Mackenzie

BloombergGadfly

Note: Breakeven prices reflect projected level needed to generate a 10 percent return on drilling and completion costs in 2017.


Monthly U.S. crude oil and natural gas production (Jan 1997 - May 2015)
eia
million barrels per day
billion cubic feet per day
crude oil
natural gas
rest of United States
Gulf of Mexico
2003
27%
2014
16%
1997
26%
2014
5%
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90
1997
2003
2009
2015

Approved permits for shallow water Gulf of Mexico (1ft to 499ft):



https://www.bsee.gov/stats-facts/ocs-regions/status-of-gulf-of-mexico-well-permits

Approved permits for deepwater Gulf of Mexico (500ft or deeper):

https://www.bsee.gov/stats-facts/ocs-regions/status-of-gulf-of-mexico-well-permits

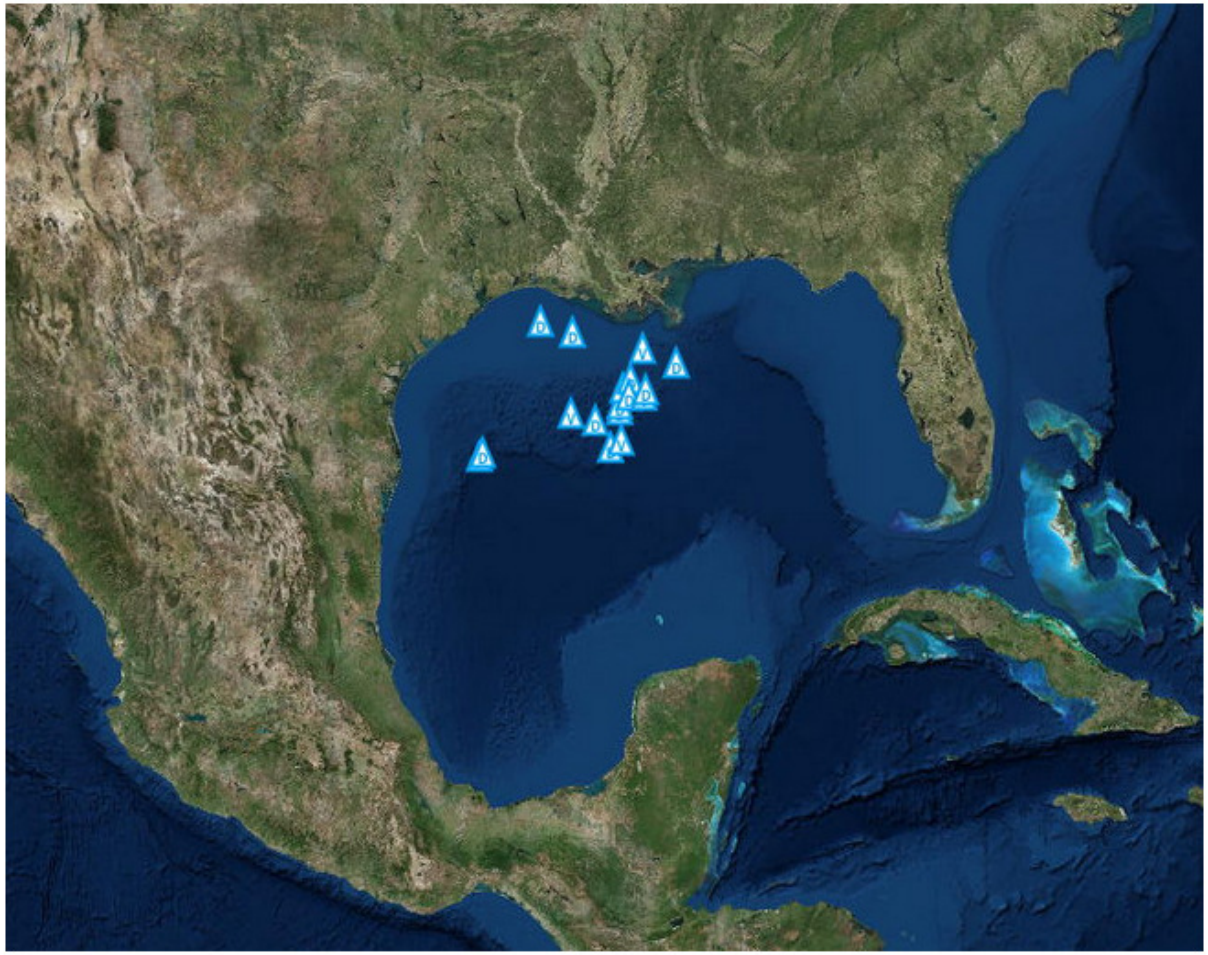
Deepwater Gulf of Mexico field starts (2015)

Field name	Majority operator	Associated project	Water depth (ft)	Discovery year
Silvertip	Shell	Perdido	9,280	2004
West Boreas	Shell	Mars B	3,094	2009
Hadrian South	ExxonMobil	Lucius	7,983	2009
Lucius	Anadarko	Lucius	7,168	2009
Deimos South	Shell	Mars B	3,122	2010
Big Bend	Noble Energy	Rio Grande	7,273	2012
Marmalard	LLOG Exploration	Delta House	6,148	2012
Dantzler	Noble Energy	Rio Grande	6,580	2013

Anticipated Deepwater Gulf of Mexico field starts (2016-17)

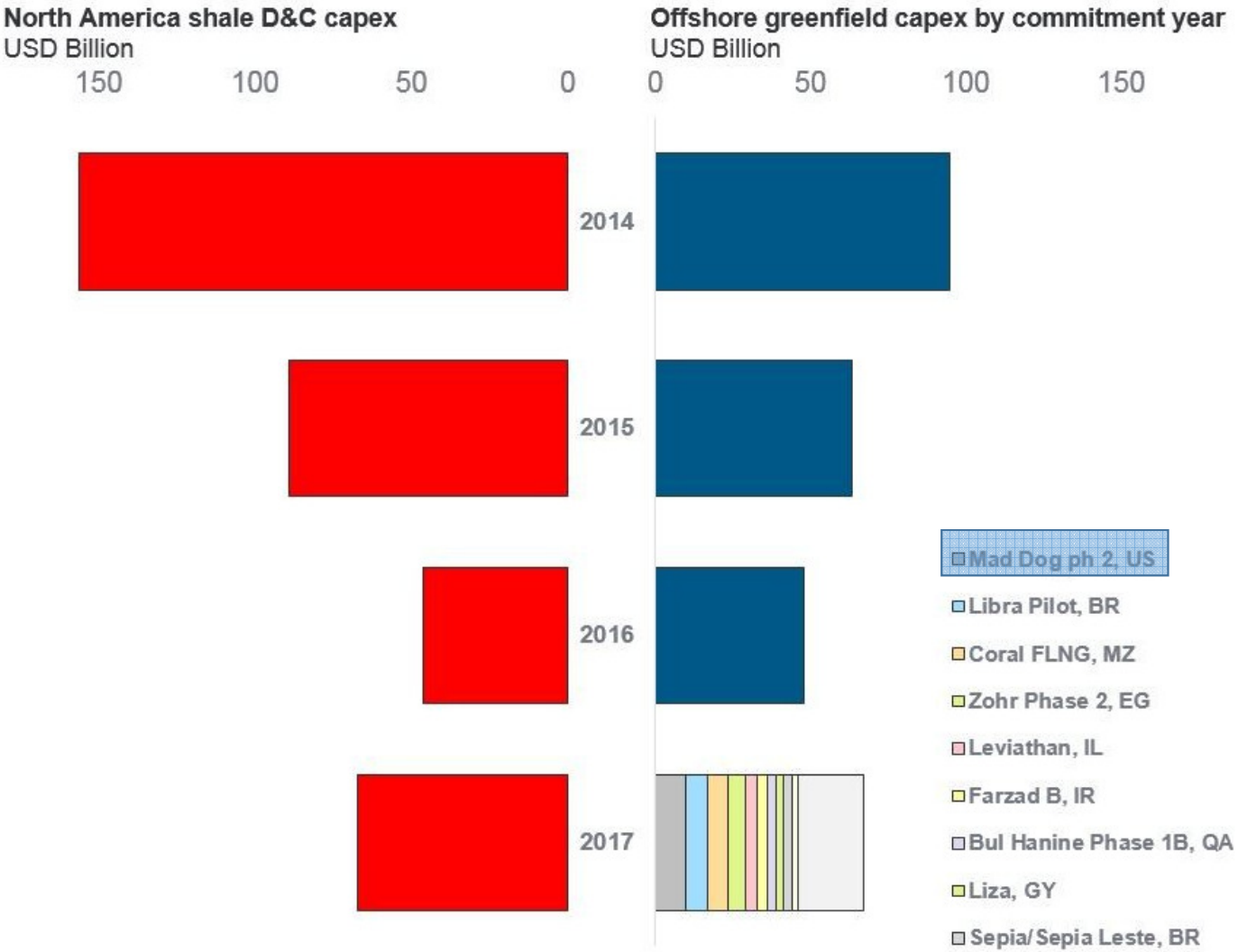
Field name	Majority operator	Water depth (ft)	Discovery year	Anticipated production start
Stones	Shell	9,556	2005	2016
Gunflint	Noble Energy	6,138	2008	2016
Heidelberg	Anadarko	5,271	2009	2016
Holstein Deep	Freeport McMoRan	4,326	2014	2016
Son of Bluto 2	LLOG Exploration	6,461	2012	2017
Horn Mountain Deep	Freeport McMoRan	5,400	2015	2017

U.S. offshore rig count declines further



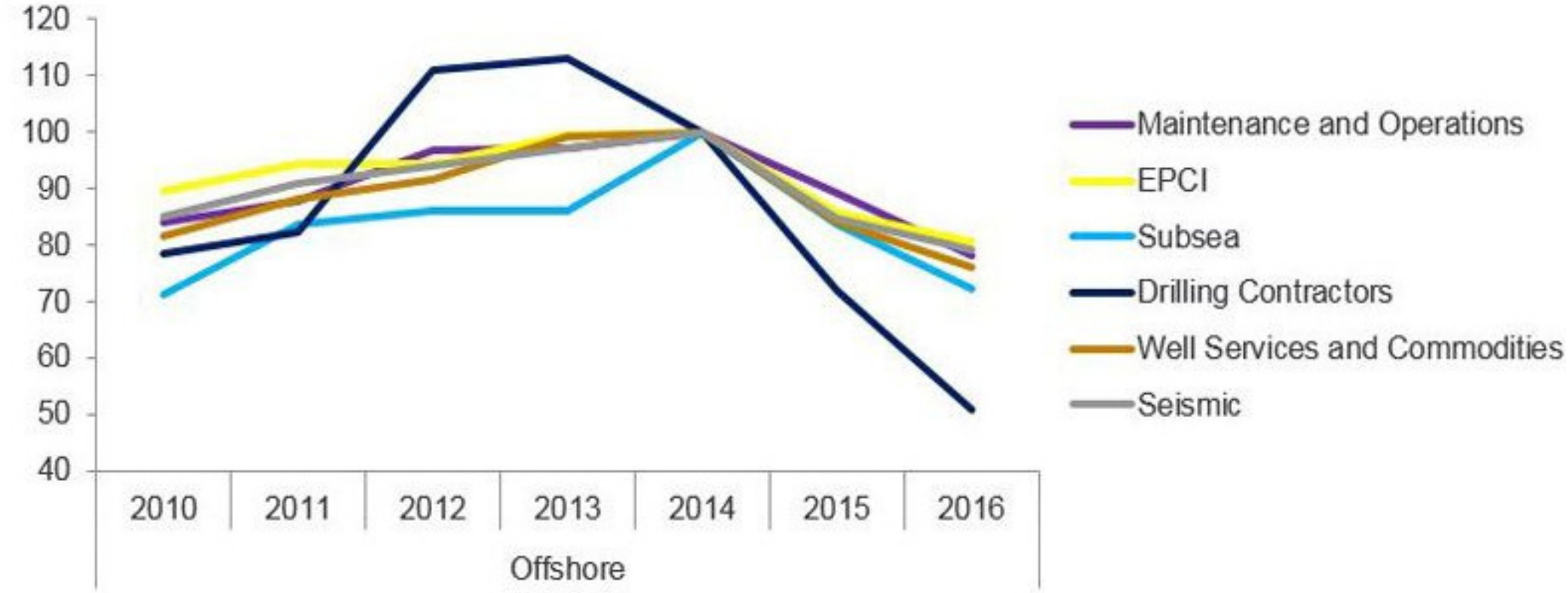
The U.S. weekly offshore rig count has fallen by three units, leaving the U.S. with only 18 active offshore drilling rigs. The U.S. onshore rig count is on the rise.

Shale vs. Offshore



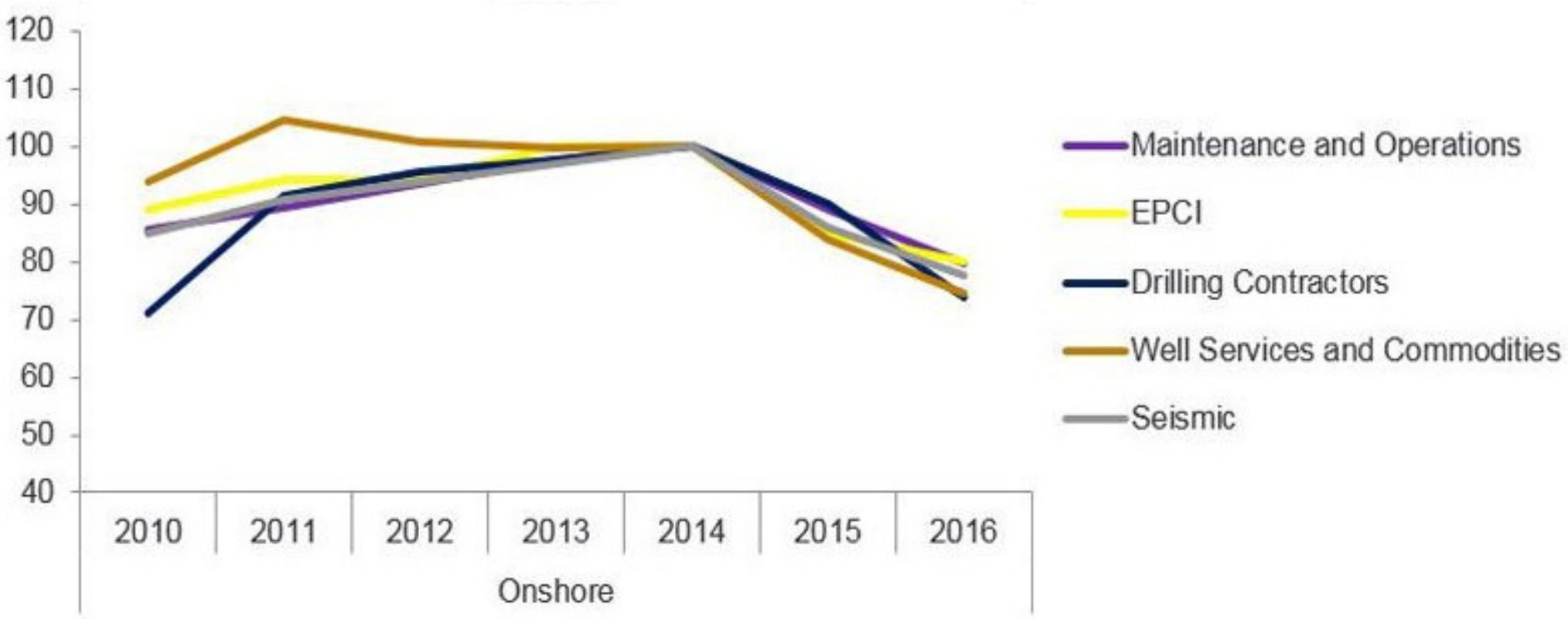
Source: Rystad Energy DCube, Offshore 2-17-17

Rystad Energy Oilfield Service Index by award year
Indexed to 2014



Source: Rystad Energy DCube, Offshore 2-17-17

Rystad Energy Oilfield Service Index by award year
Indexed to 2014



Source: Rystad Energy Research and Analysis

, Offshore 2-17-17

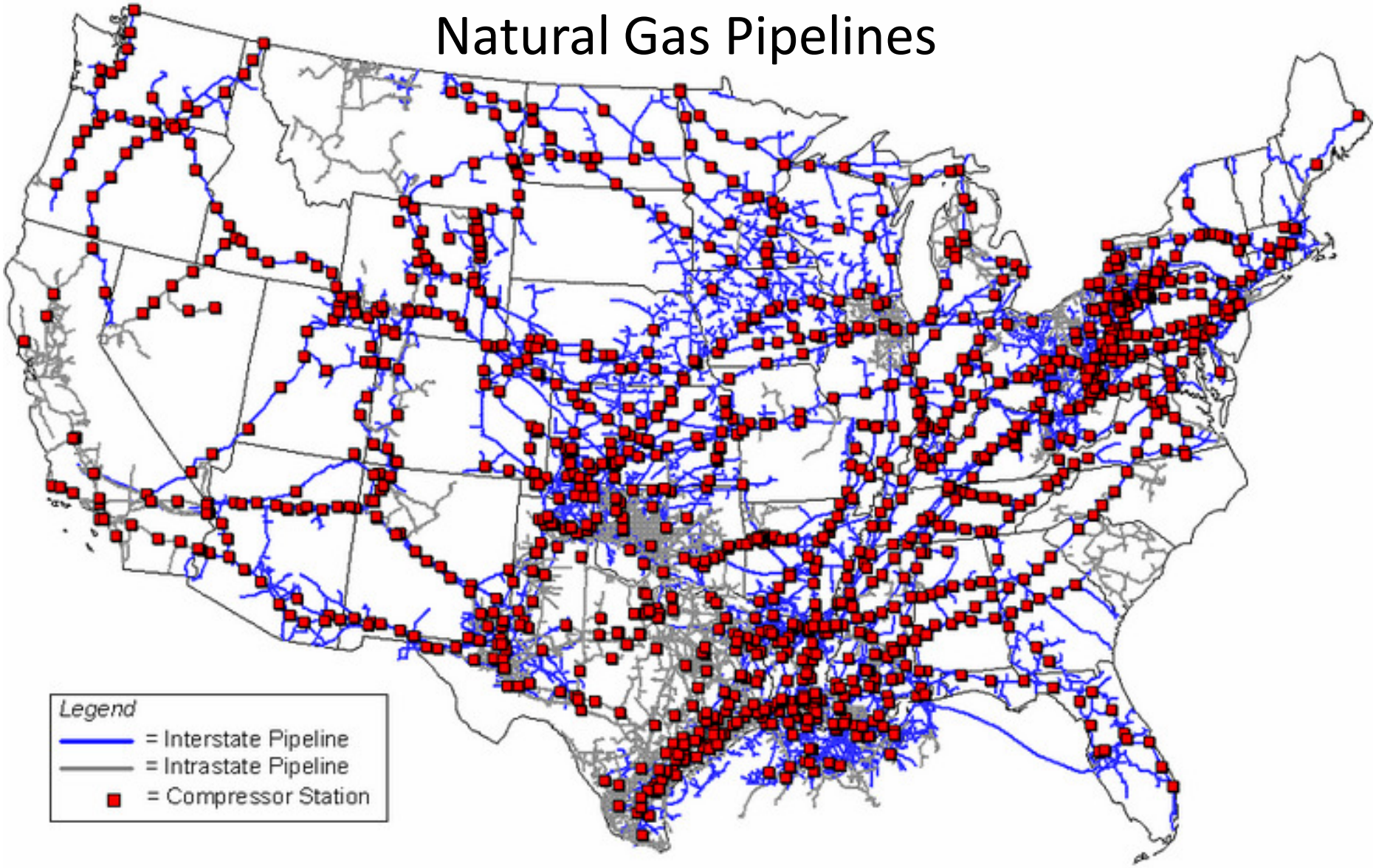
Source: Rystad Energy DCube, Offshore 2-17-17

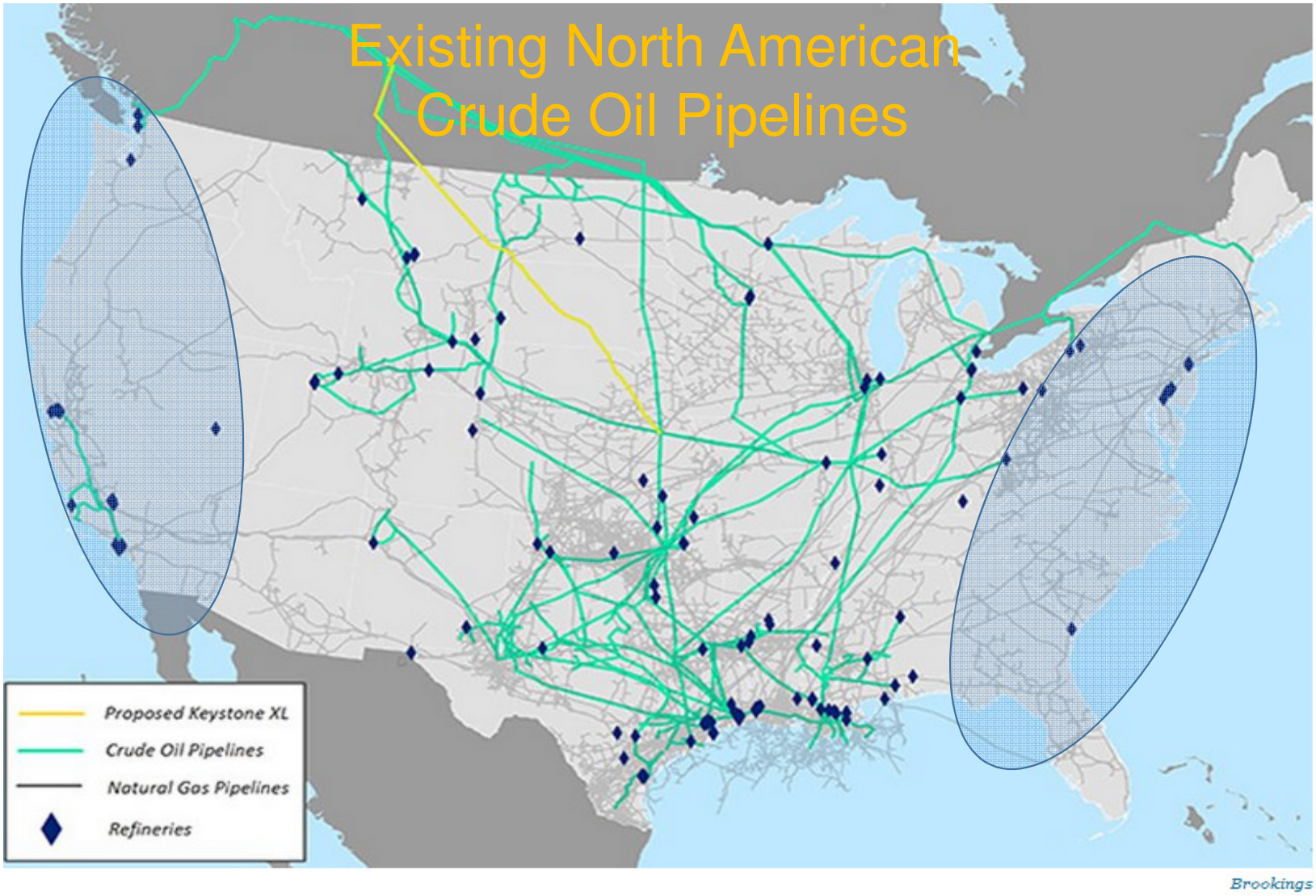
Pipelines

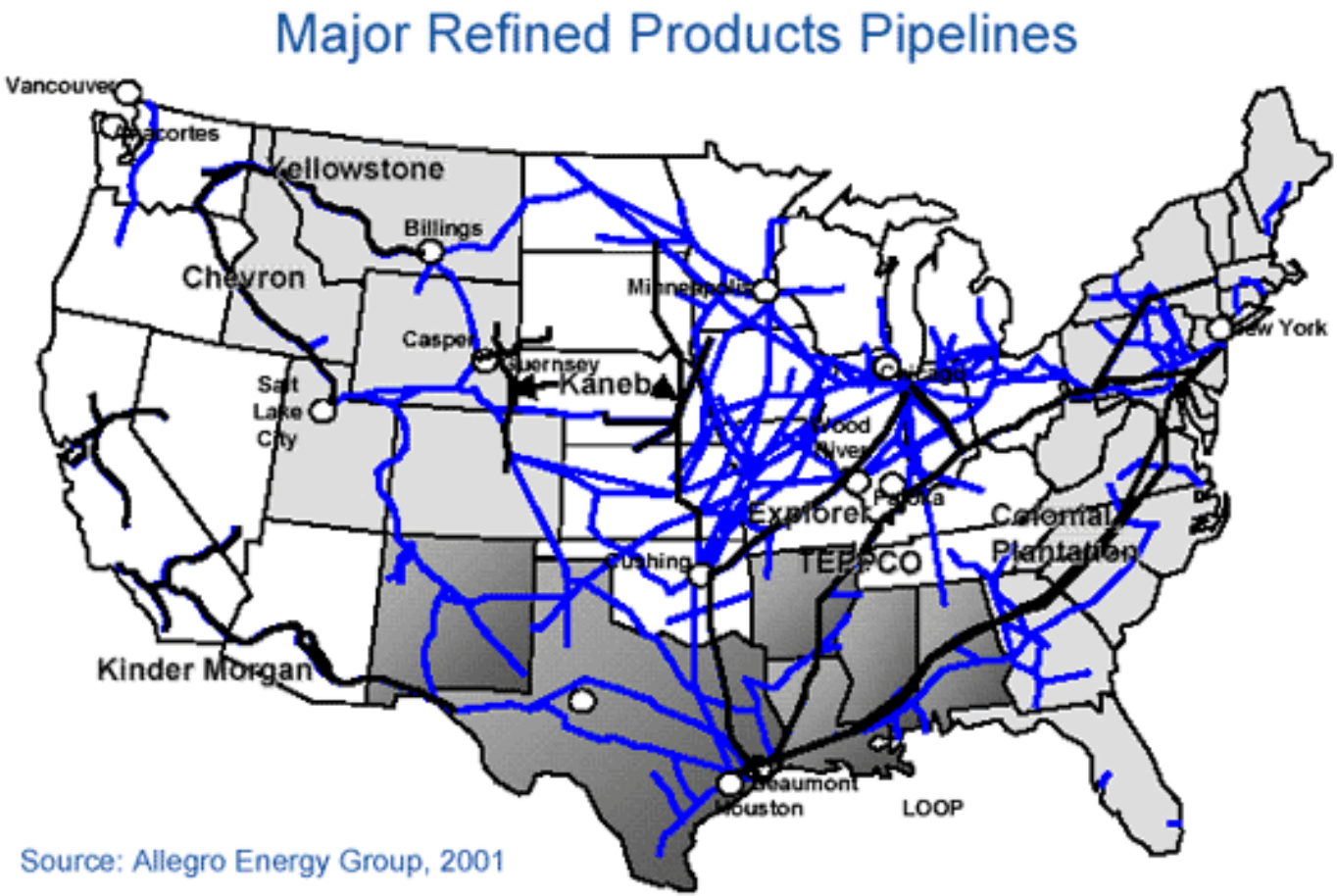
Gas

Liquids – Crude, Refined Products, NGLs

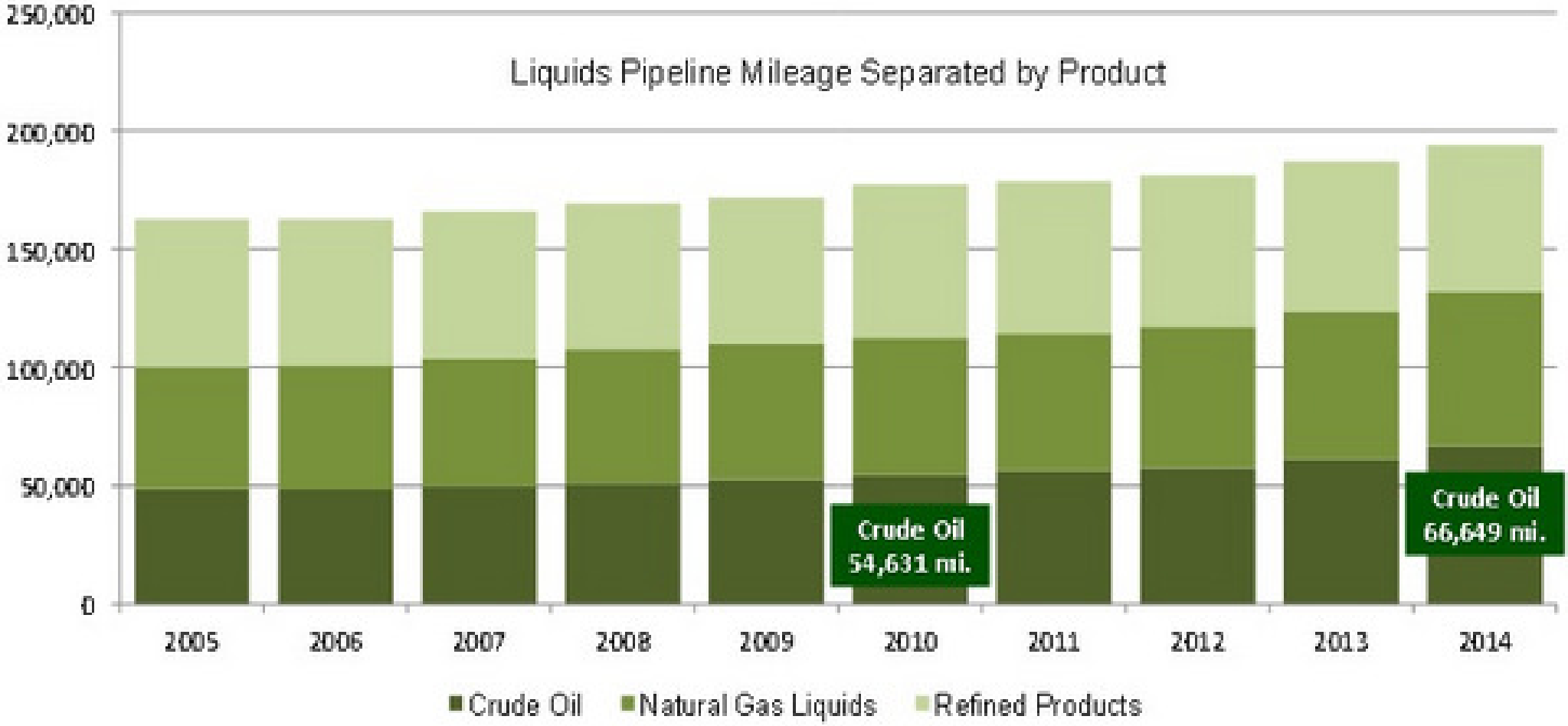
Natural Gas Pipelines




Existing North American
Crude Oil Pipelines
Proposed Keystone XL
Crude Oil Pipelines
Natural Gas Pipelines
Refineries
Brookings



There are approximately 95,000 miles nationwide of refined products pipelines. These refined product pipelines vary in size from relatively small 8 to 12 inch diameter lines up to 42 inches in diameter. The major pipelines for the Atlantic Seaboard are the Plantation Pipeline, which ends south of Washington, DC and the Colonial Pipeline which supplies product to the entire seaboard, ending in Linden, NJ.



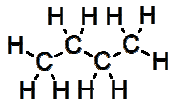
From Association of Oil Pipe Lines and American Petroleum Institute

Pipeline Issues

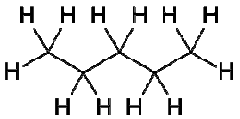
- Canadian Heavy Crude Imports to Gulf Coast via Keystone XL doesn't solve Louisiana's Venezuelan problem
- Domestic Shale Oil "Imports" to Louisiana for use and export wia Dakota Access and Bayou Bridge pipelines
- Gas pipelines face stasis at FERC until commission quorum re-established
- Liquids pipelines have no federal access to eminent domain
- "Buy American" impact unknown

Refining and Petrochemicals

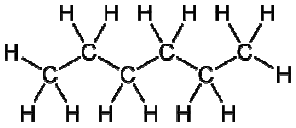
Separation- Typical Alkanes in Crude Oil

4 Butane 

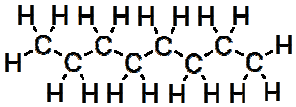
LPG

5 Pentane 

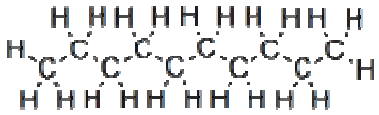
Gasoline

6 Hexane 

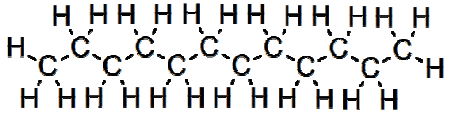
Gasoline

8 Octane 

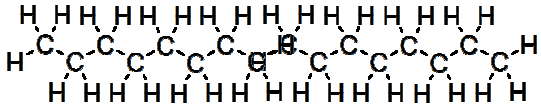
Gasoline

10 Decane 

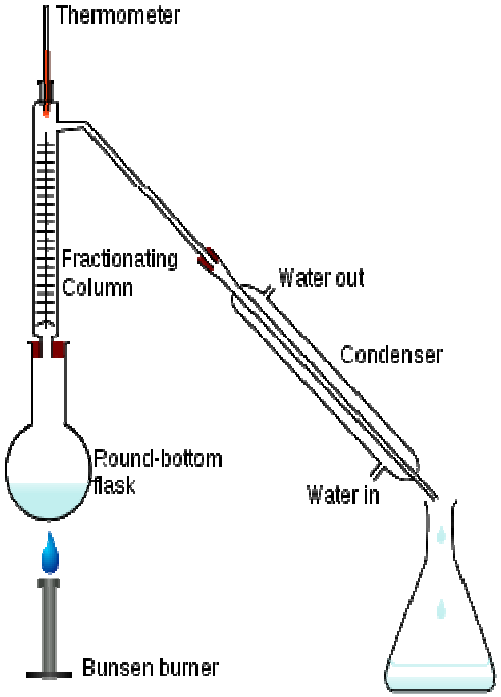
Gasoline

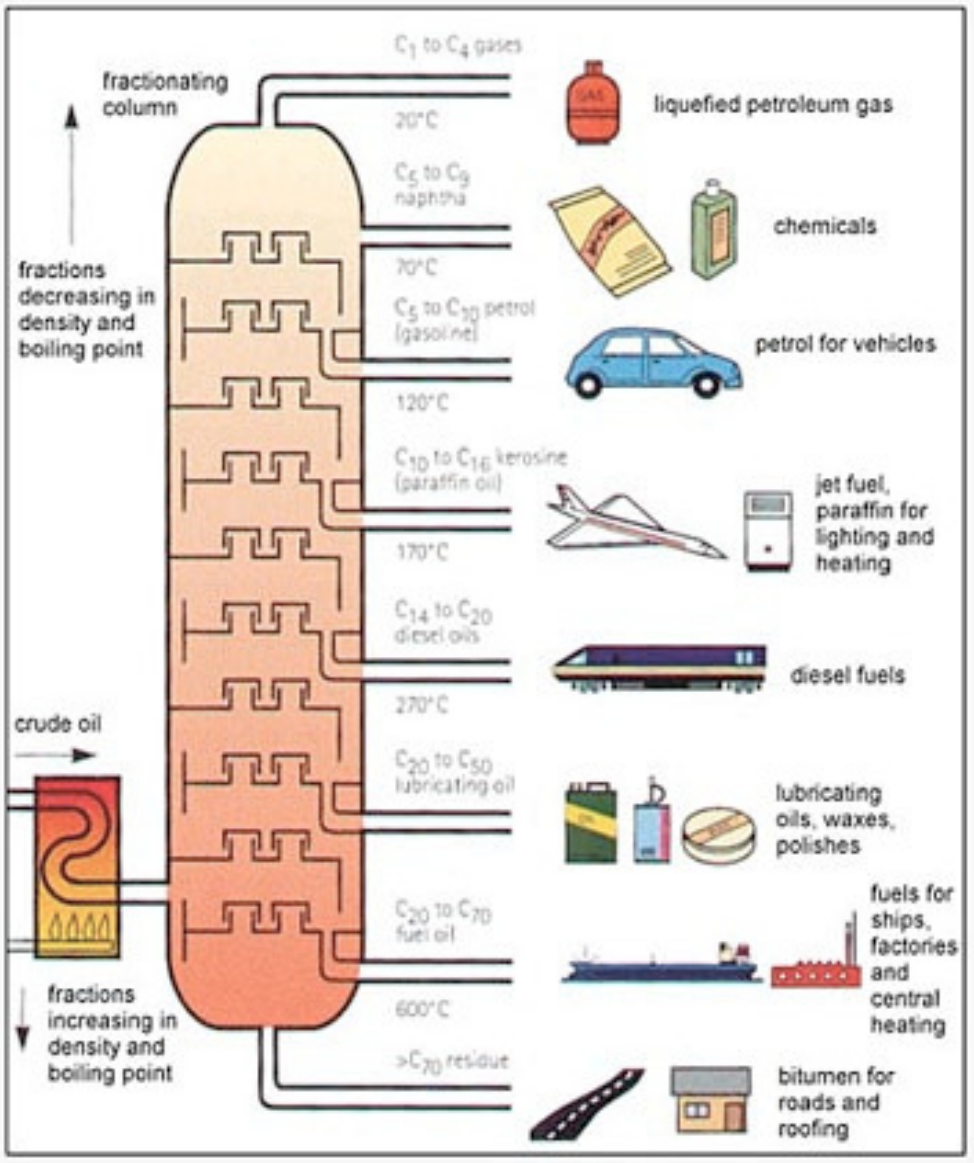
12 Dodecane 

Jet Fuel

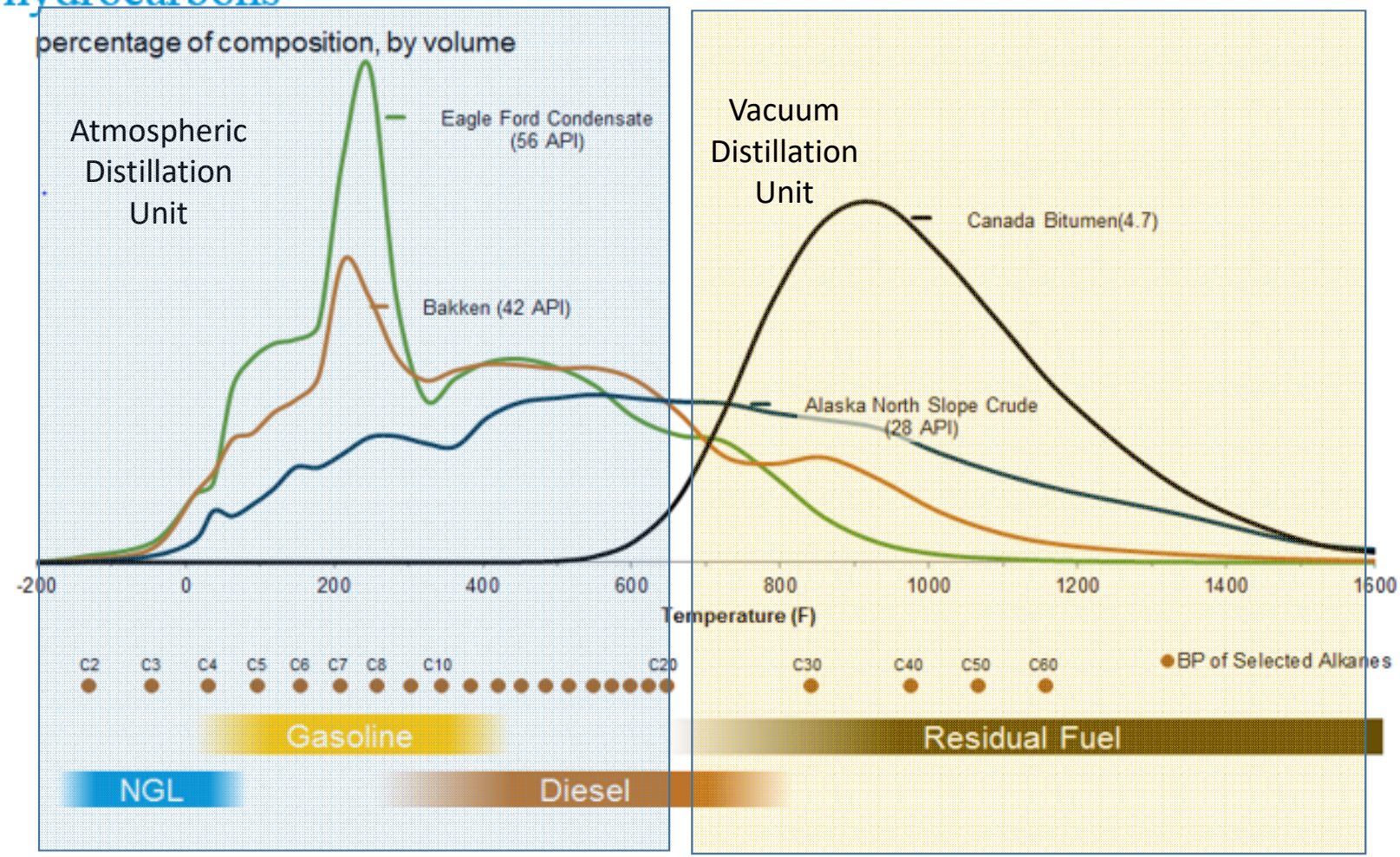
16 Cetane 

Diesel



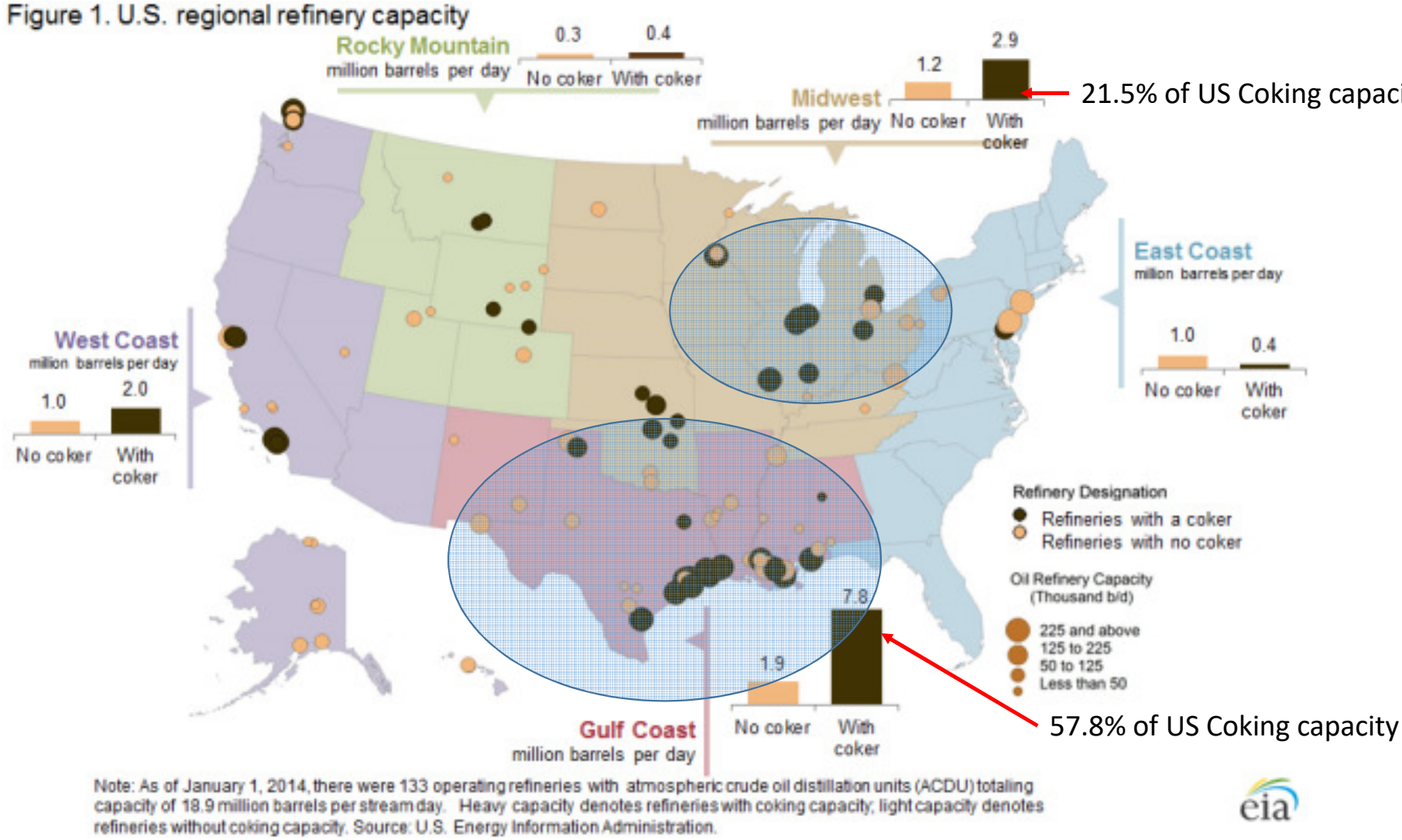

fractionating column
fractions decreasing in density and boiling point
crude oil
fractions increasing in density and boiling point
C_1 to C_4 gases
20°C
liquefied petroleum gas
C_5 to C_9 naphtha
70°C
chemicals
C_5 to C_{10} petrol (gasoline)
120°C
petrol for vehicles
C_{10} to C_{16} kerosine (paraffin oil)
170°C
jet fuel, paraffin for lighting and heating
C_{14} to C_{20} diesel oils
270°C
diesel fuels
C_{20} to C_{50} lubricating oil
lubricating oils, waxes, polishes
C_{20} to C_{70} fuel oil
600°C
fuels for ships, factories and central heating
>C_{70} residue
bitumen for roads and roofing

Crude oil and associated liquids contain a wide variety of hydrocarbons



Source: EIA via Harvey Crude Assay Management System

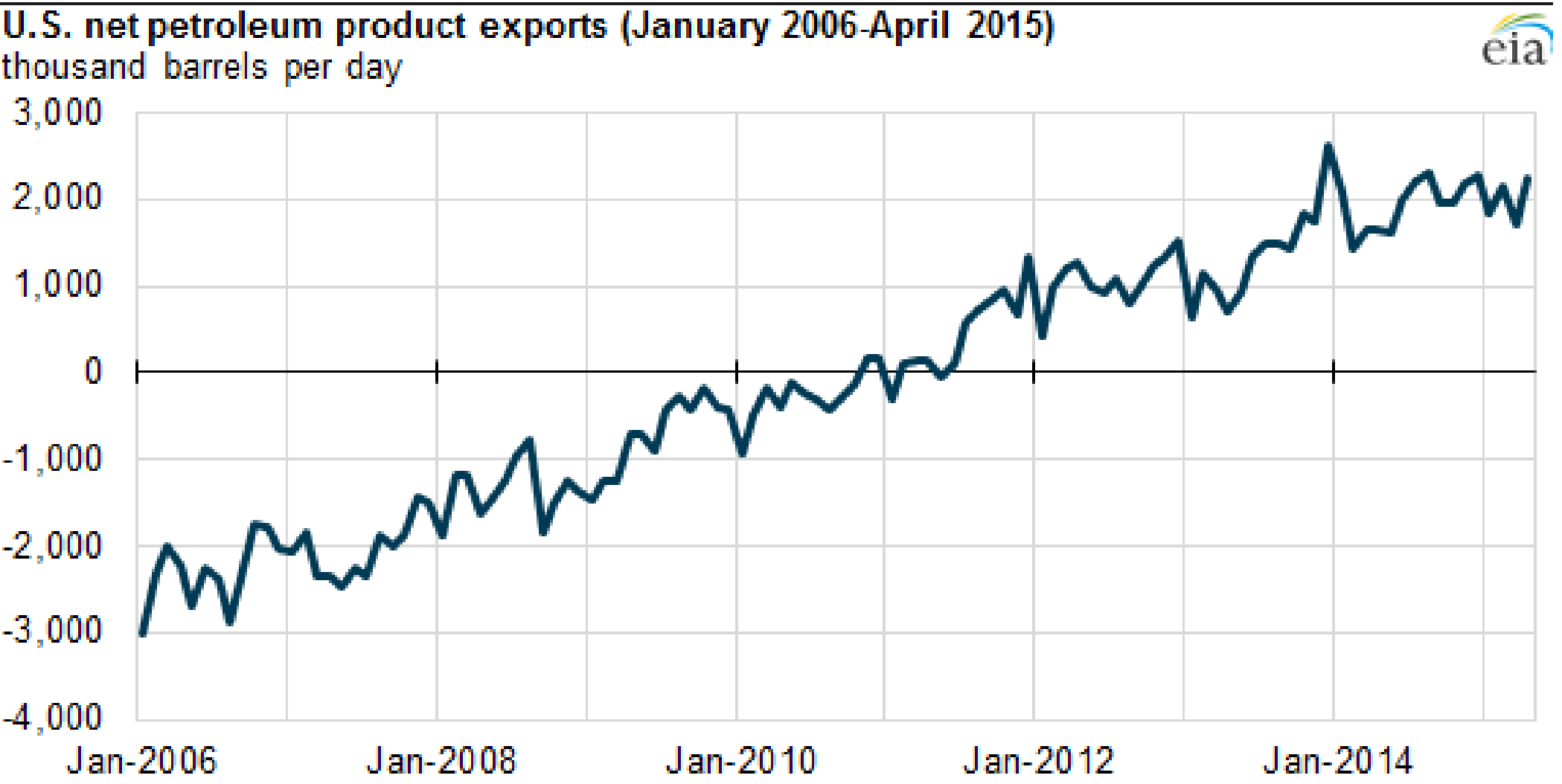
U.S. Refinery Capacity and Complexity varies by Region



Imports and Exports

Imports = Heavy Sour

Exports = Light Sweet and refined products


U.S. net petroleum product exports (January 2006-April 2015)
thousand barrels per day
eia
3,000
2,000
1,000
0
-1,000
-2,000
-3,000
-4,000
Jan-2006
Jan-2008
Jan-2010
Jan-2012
Jan-2014

Refinery Exports

- US domestic refinery shipments peaked in 2005 with ~1 mm bbl./day of exports.

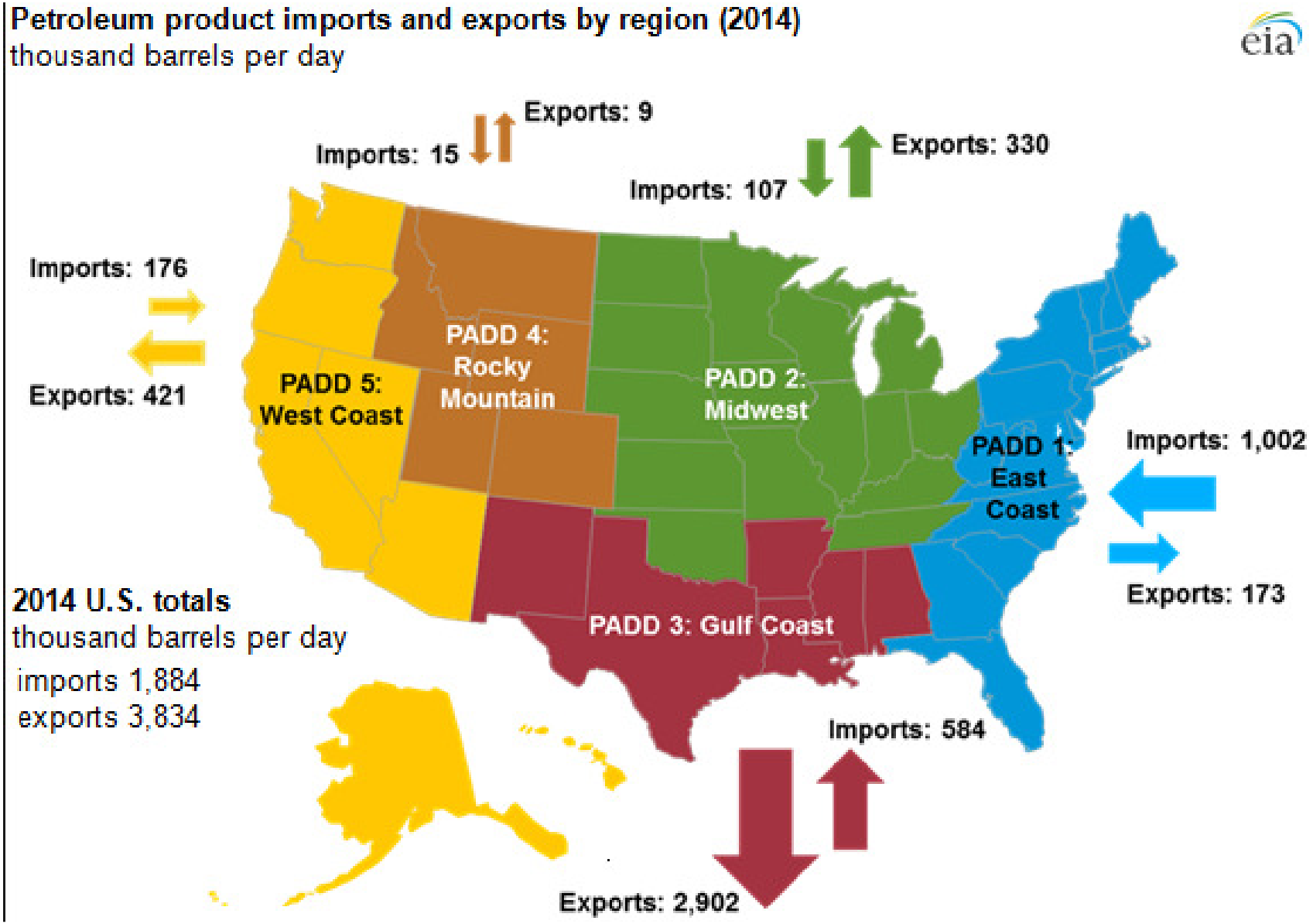
- 2014 US export shipments (2.8 mm bbl./day) to Western Hemisphere clients were at 25% or requirements vs 10% in 2005, an increase of almost 2 mm bbl/day. Argentina, Brazil, Canada, Chile, Columbia, Costa Rica, the Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Panama, Peru and Venezuela all received record or near record shipments from the US in 2014.

- Brazil imports quadrupled to 215,000 bbl./day since 2009, Canada more than doubled to 478,000 bbl/day and Mexico was up 70% to 555,000 bbl./day.

- Total international shipments are now at ~4 mm bbl./day vs. 1 mm bbl./day in 2005. Other recipients include France, Nigeria, China, South Korea, Australia and Lebanon

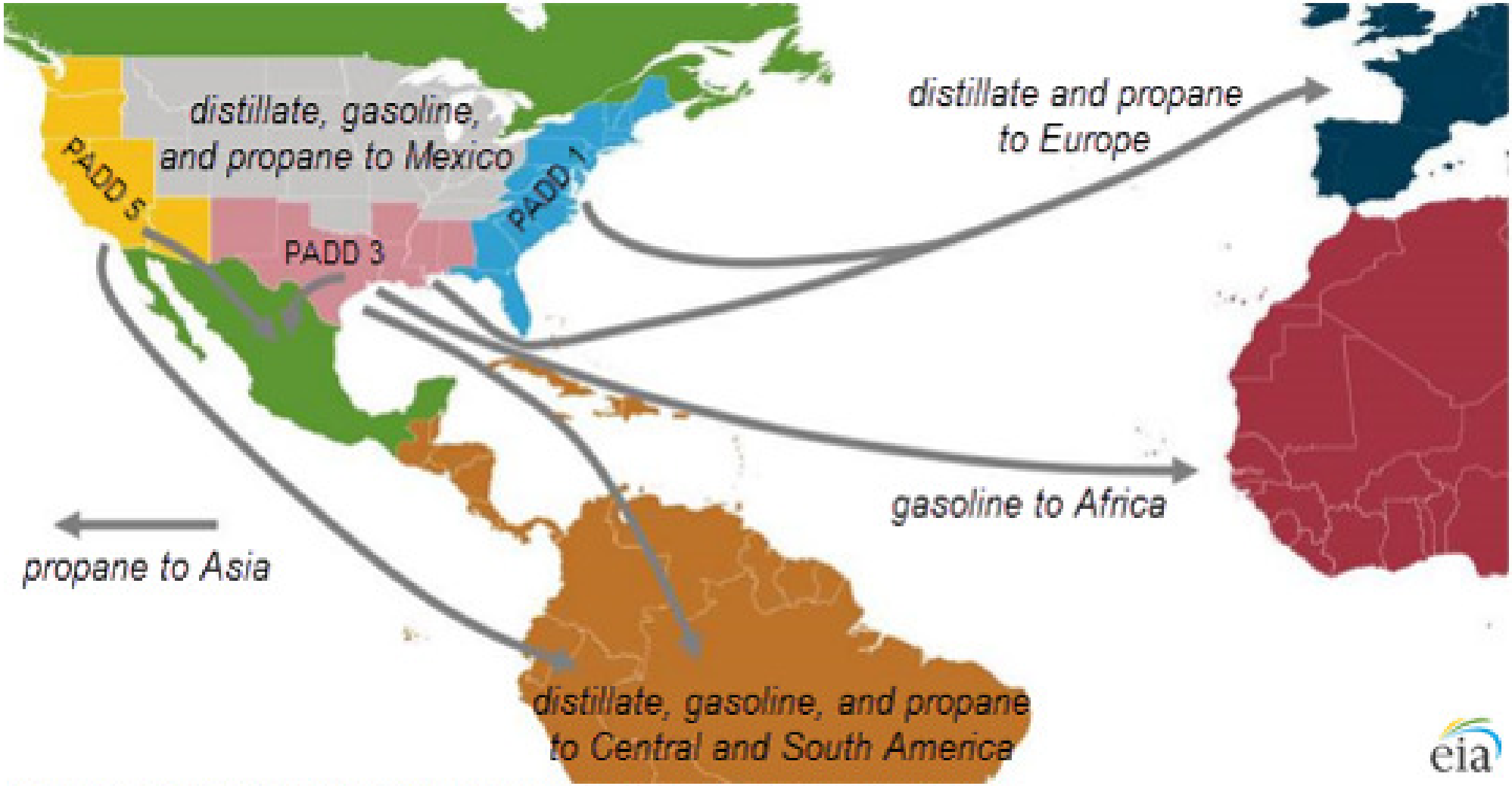
- The last time refined exports soared this high was in 1945, at the end of WWII.

Petroleum product imports and exports by region (2014)
thousand barrels per day



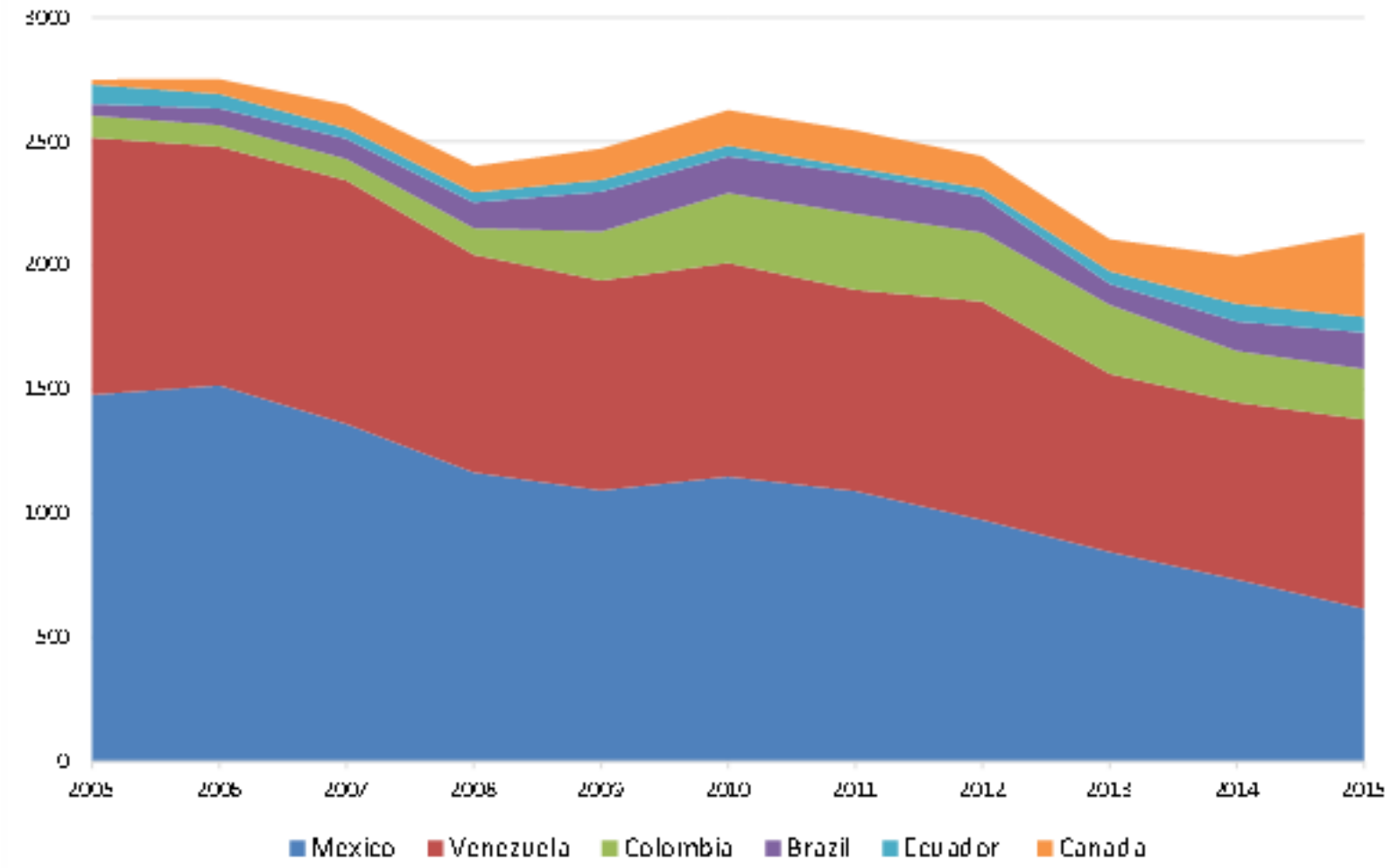
2014 U.S. totals
thousand barrels per day
imports 1,884
exports 3,834

U.S. distillate, gasoline, and propane export flows



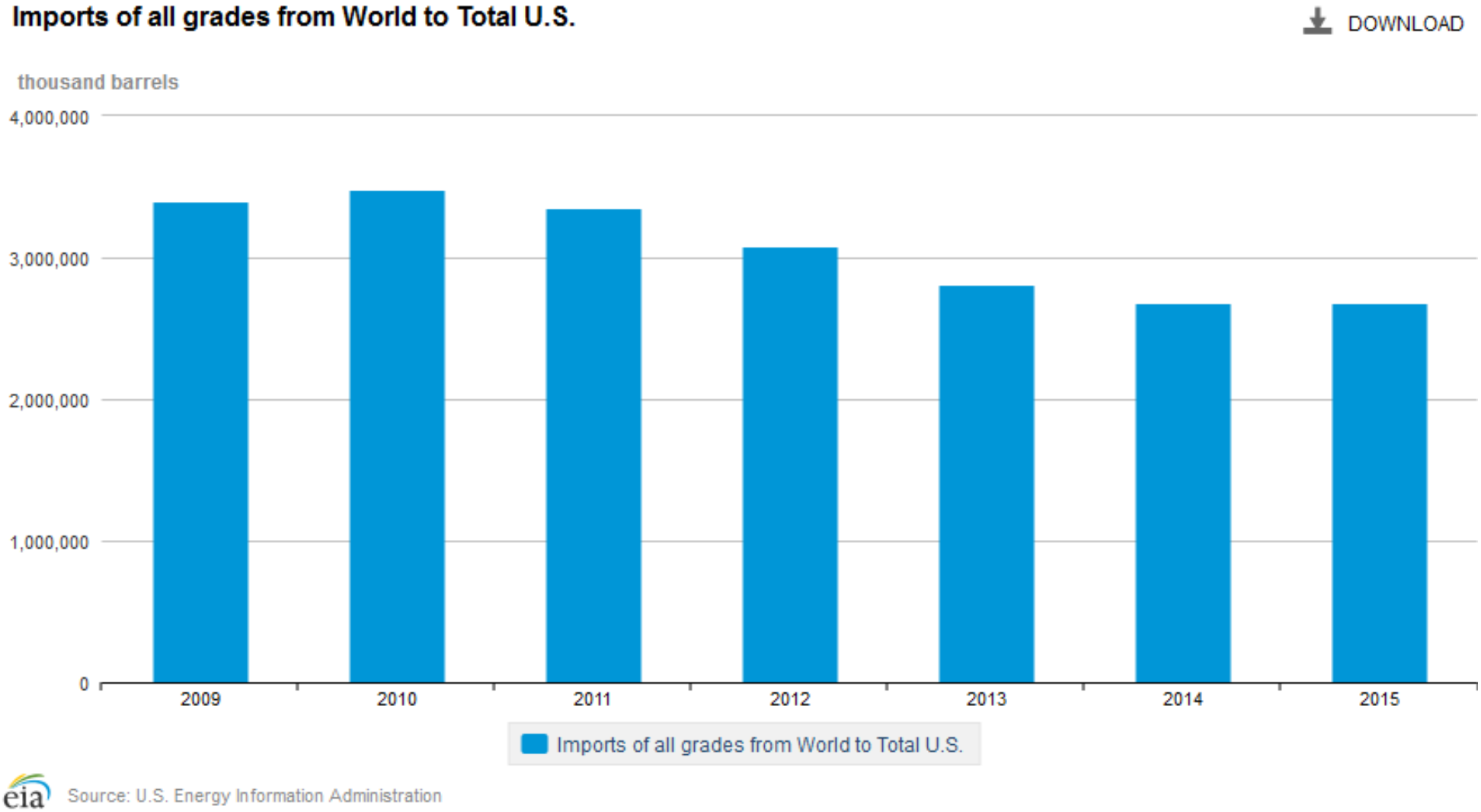
Source: U.S. Energy Information Administration, Petroleum Supply Monthly
Note: PADD is Petroleum Administration for Defense Districts.

Figure 3.4: US Gulf Coast Heavy Crude Imports
(thousand barrels per day)

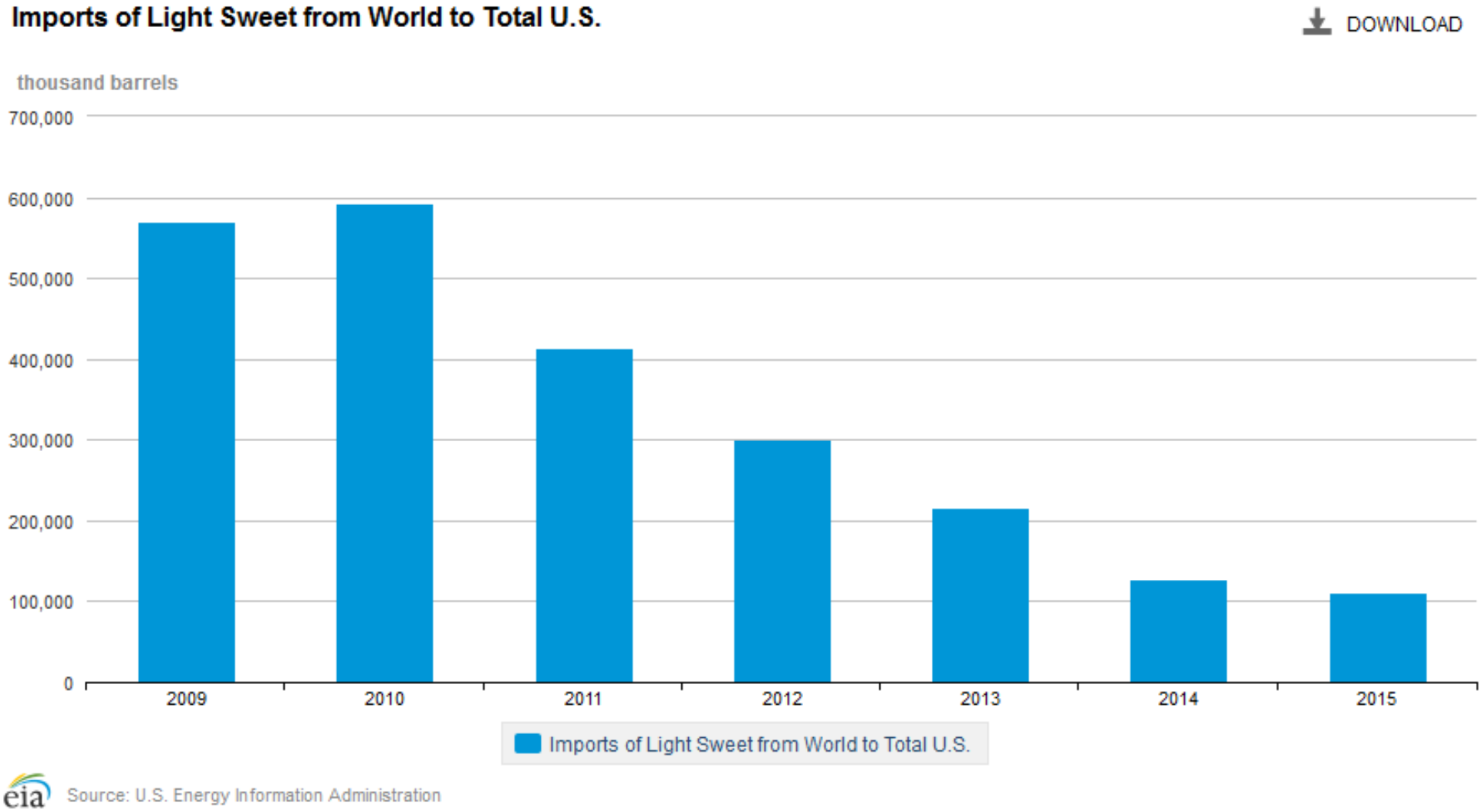


Source: EIA PADD 3 imports by country of origin, 2015

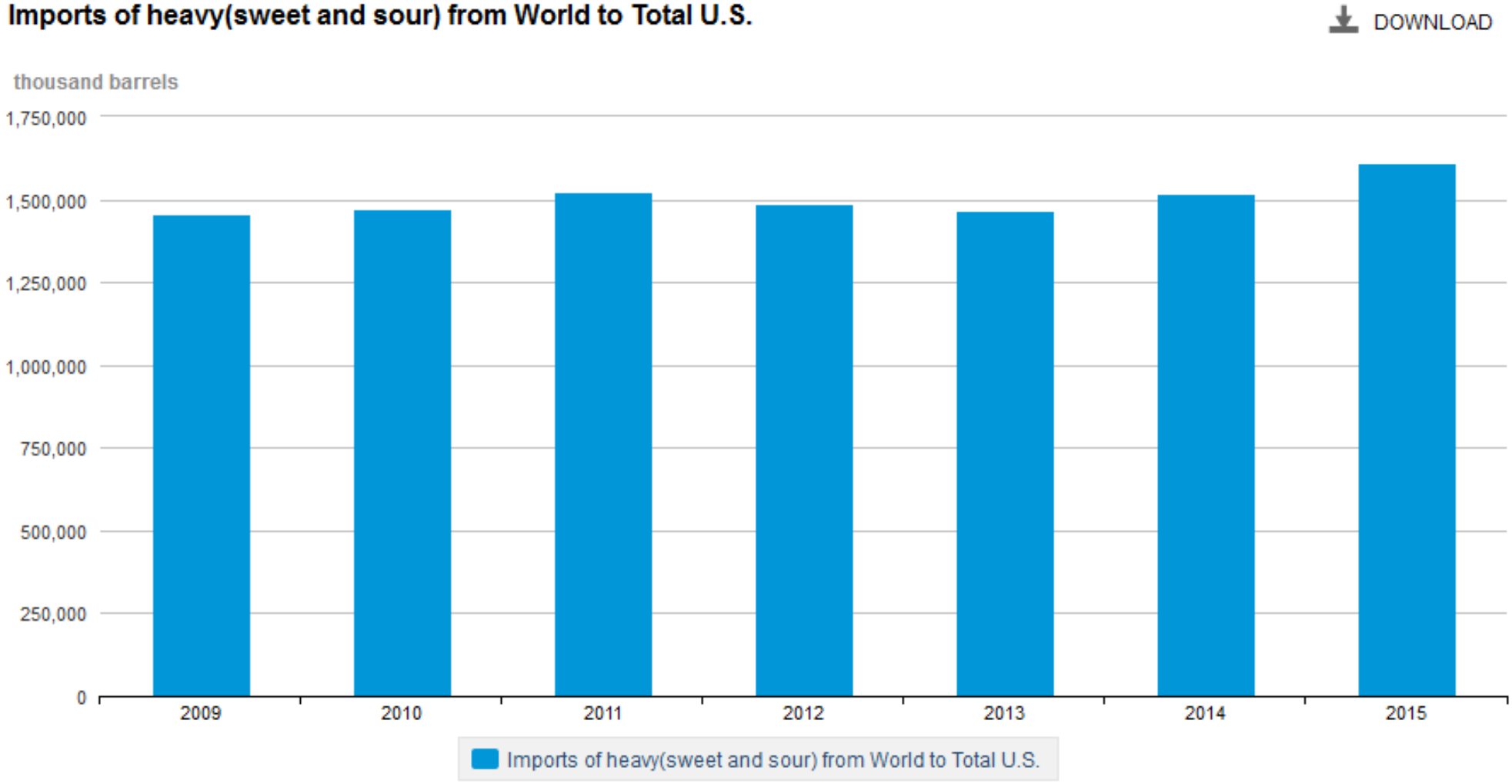
Overall, Crude Oil Imports have Declined



Light, Sweet Crude Oil Imports have Declined Significantly



Heavy Crude Oil Imports Have Increased



eia Source: U.S. Energy Information Administration

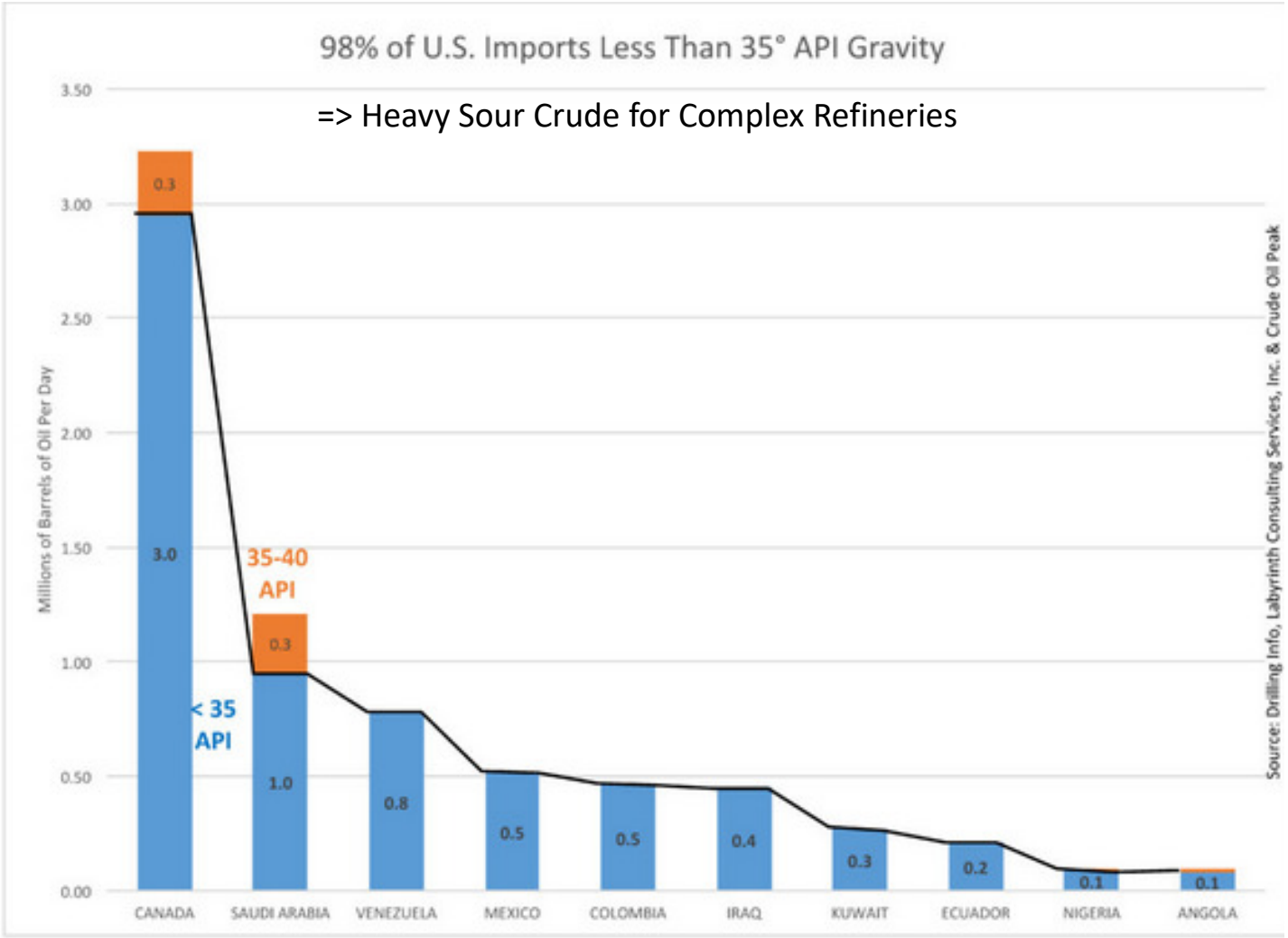
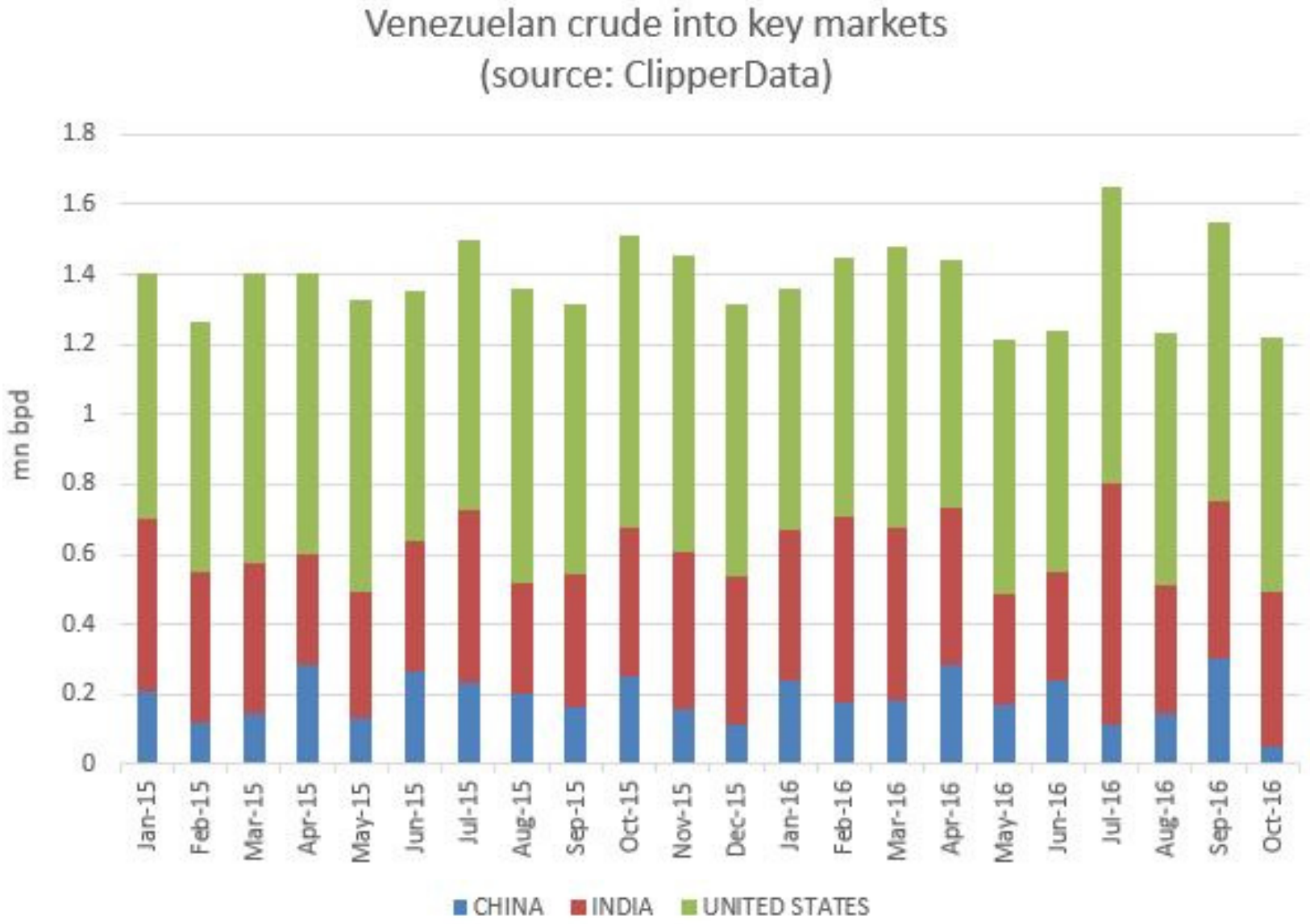
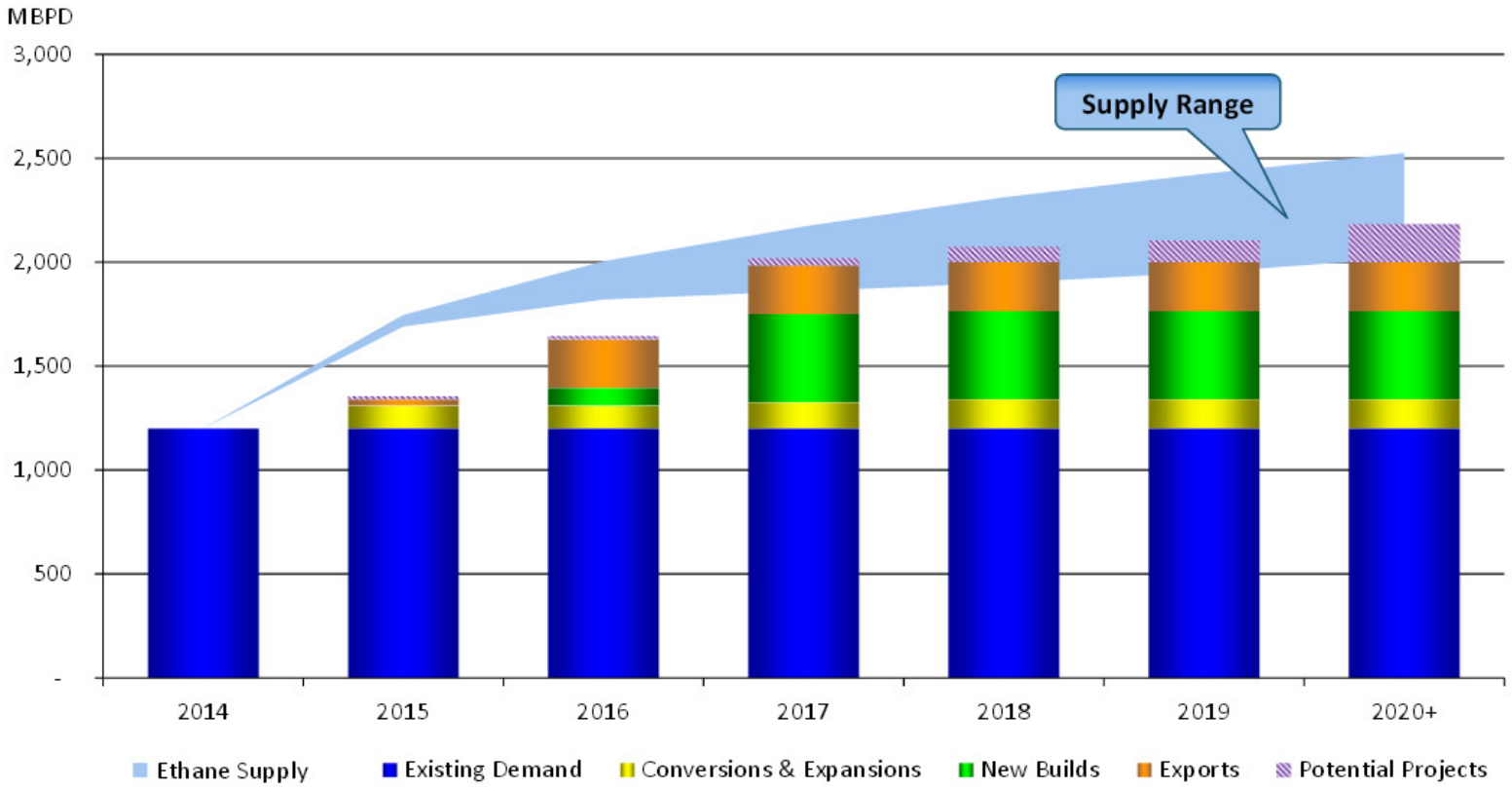


Figure 5. 98% of U.S. Imports Less Than 35° API Gravity. Source: Drilling Info, Labyrinth Consulting Services, Inc. and Crude Oil Peak.

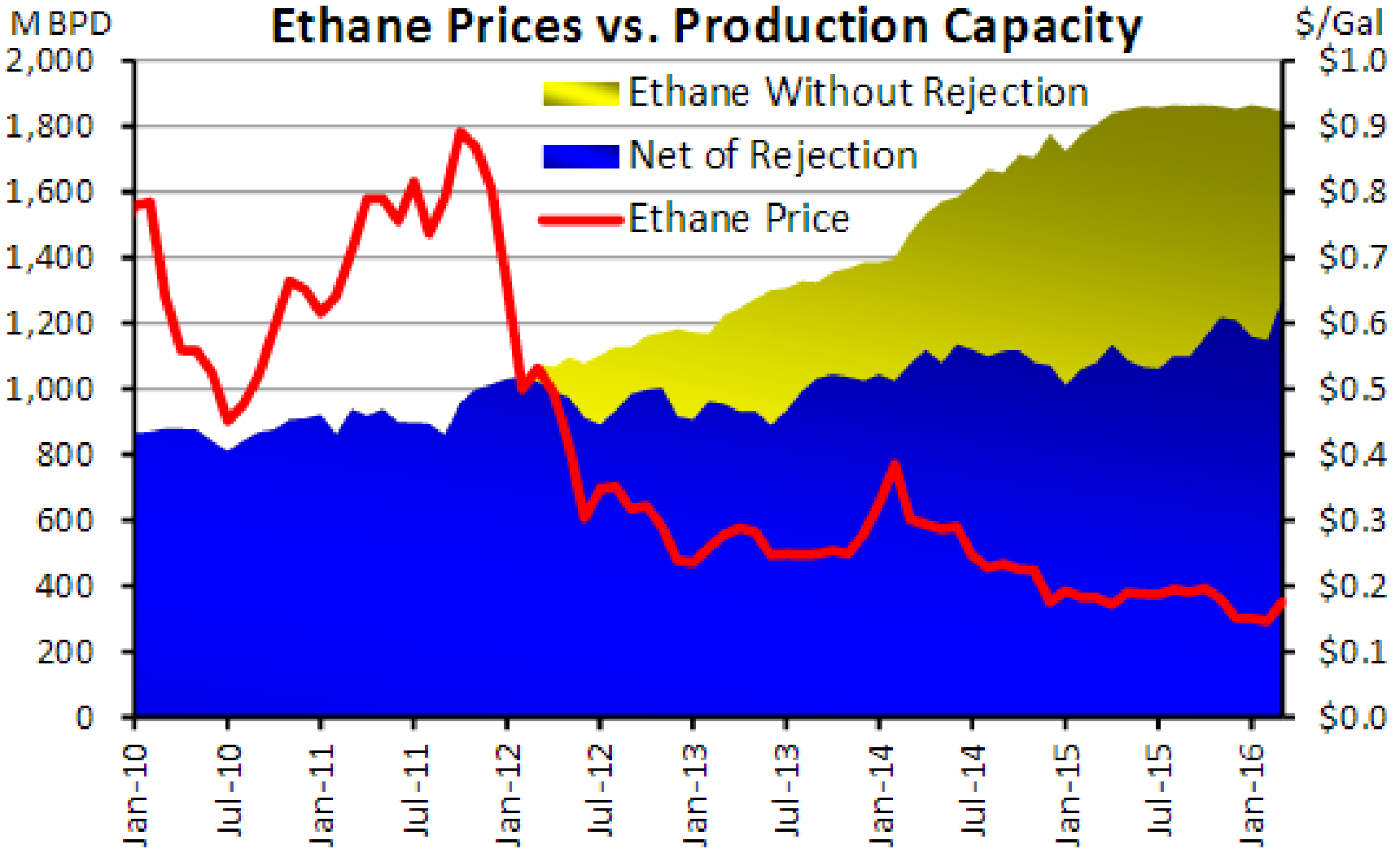

Venezuelan crude into key markets
(source: ClipperData)
mn bpd
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
Jul-15
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
CHINA
INDIA
UNITED STATES

Petrochemicals

U.S. ETHANE SUPPLY / DEMAND OUTLOOK

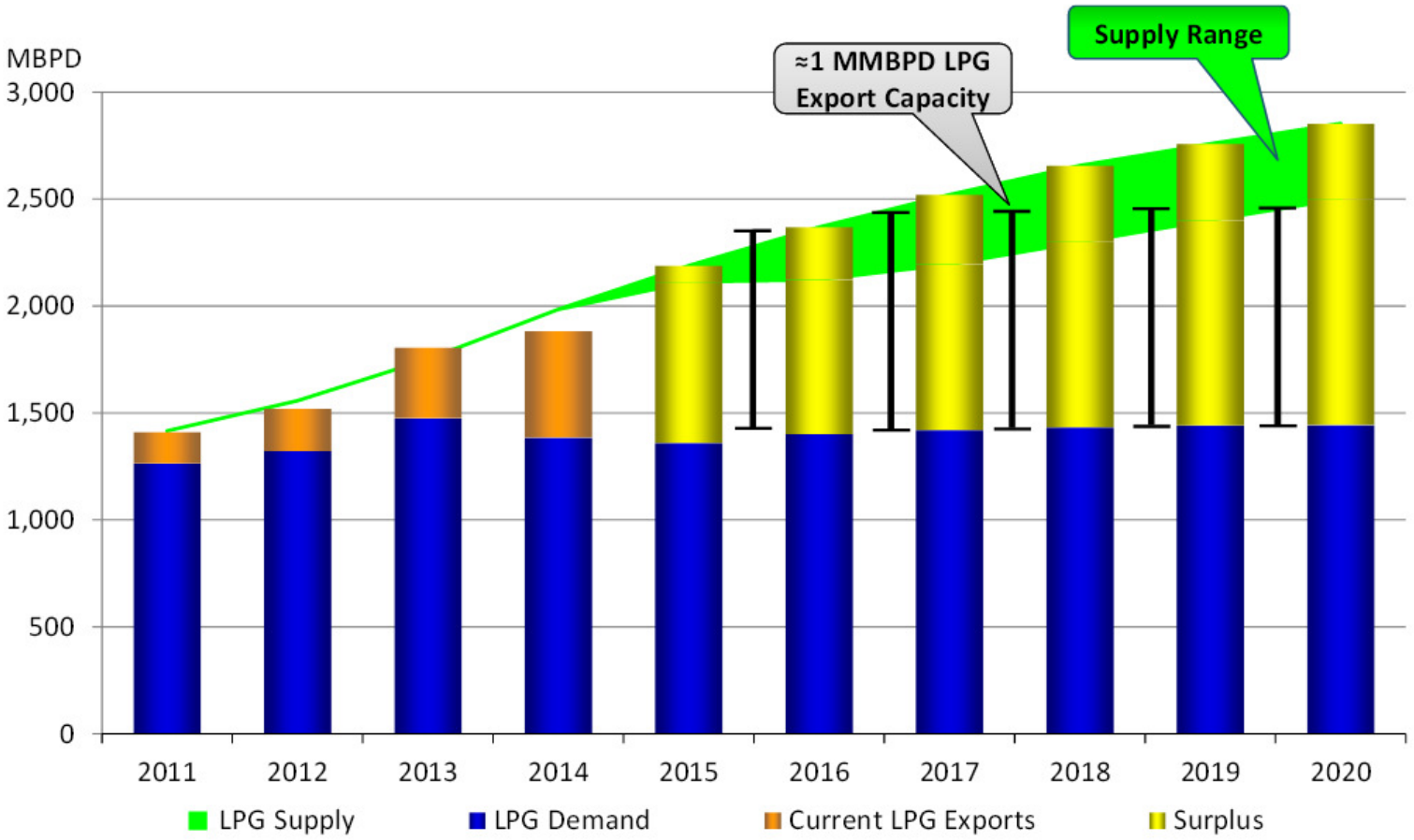


Source: EPD Fundamentals
Note: Assumes 90% operating rate for Petchems, 70% for Exports. Potential projects are viewed as <80% likely to occur.



Sources: NYMEX and EPD Fundamentals

U.S. LPG…A GROWING SURPLUS

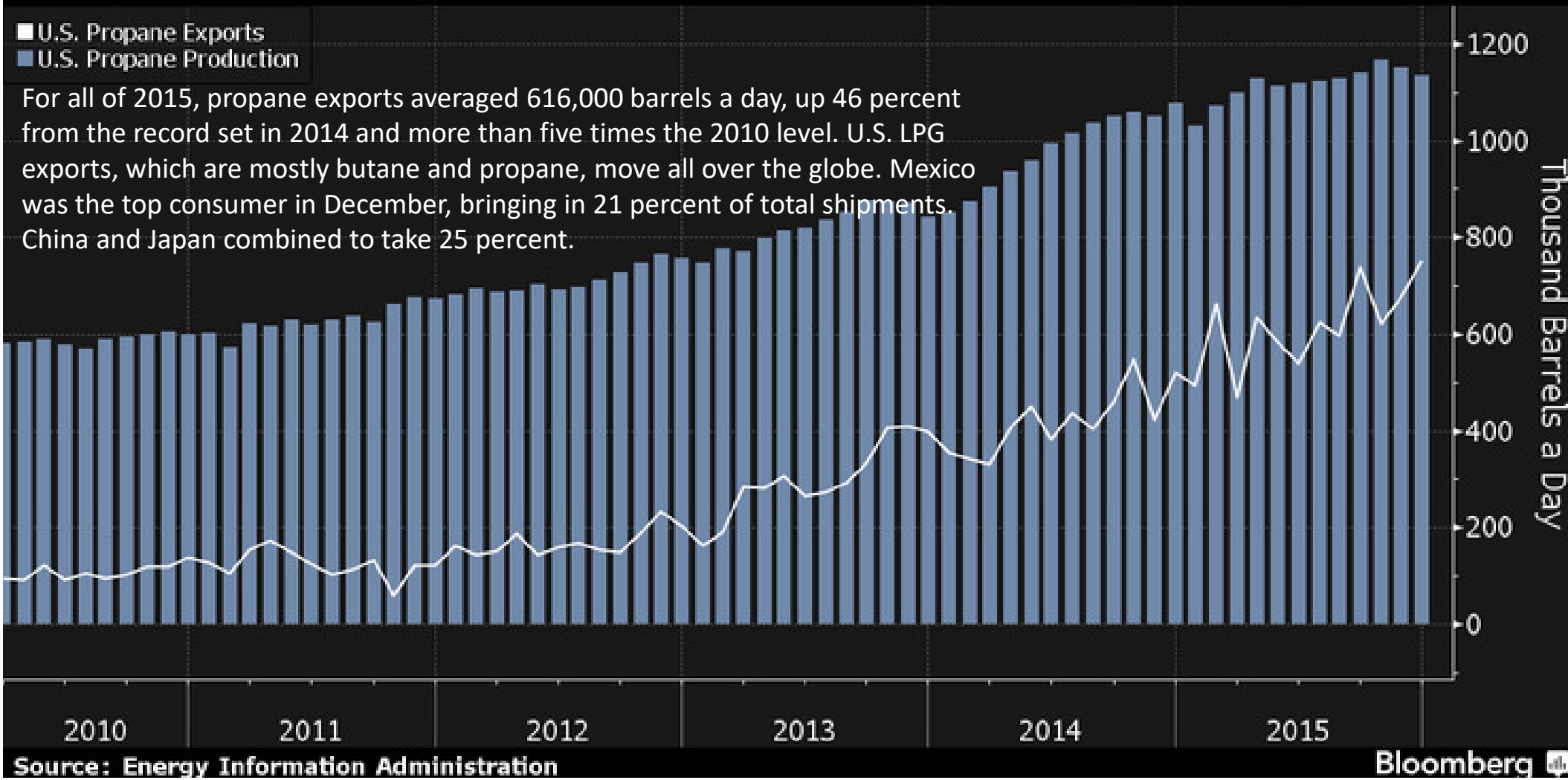


Source: EPD Fundamentals

Note: LPG is Propane and Butane

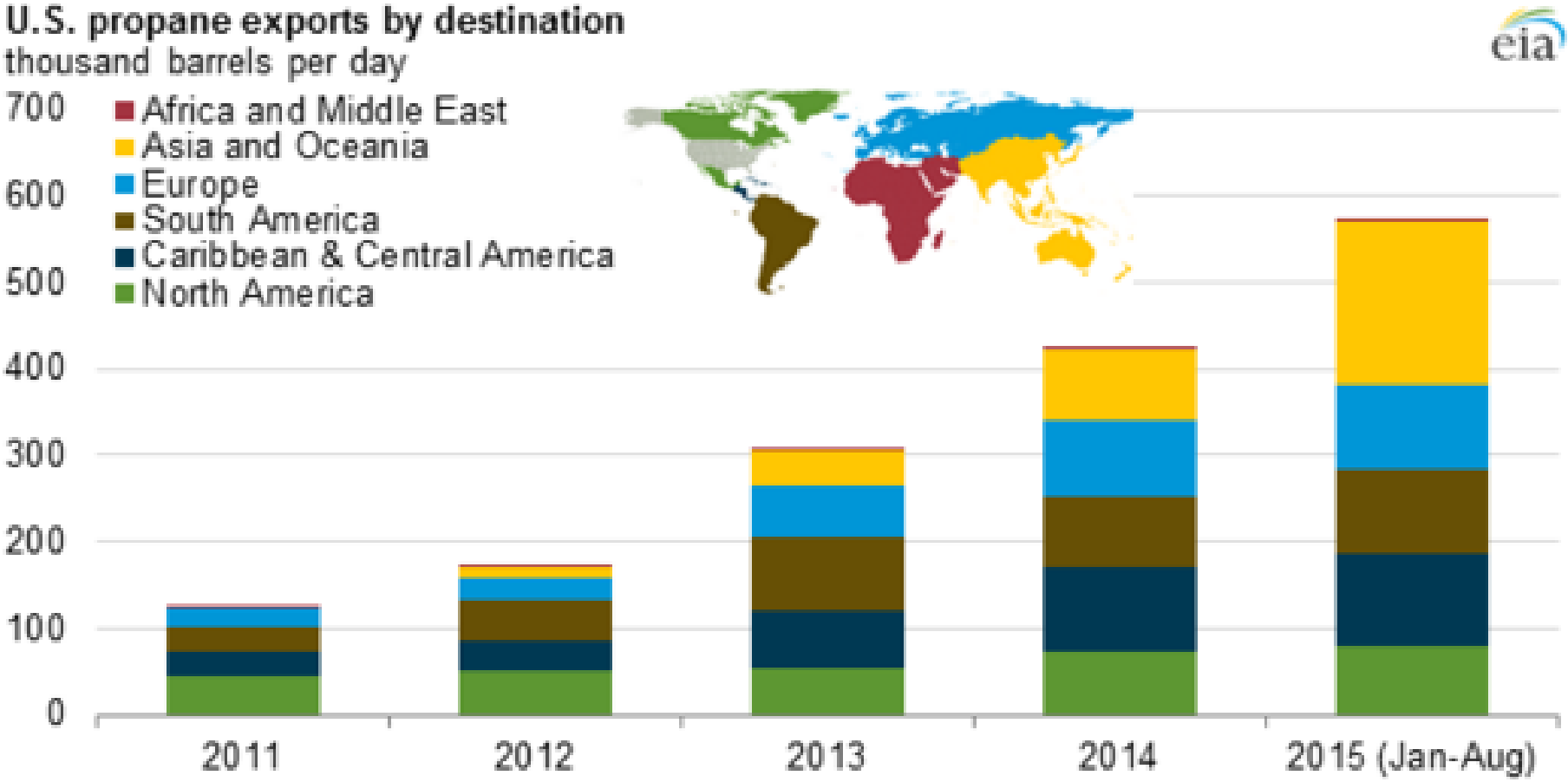
Propane Exports Jump to U.S. Record

Shipments of the fuel rose to a record in December as companies expanded docks



Source: Energy Information Administration

Bloomberg

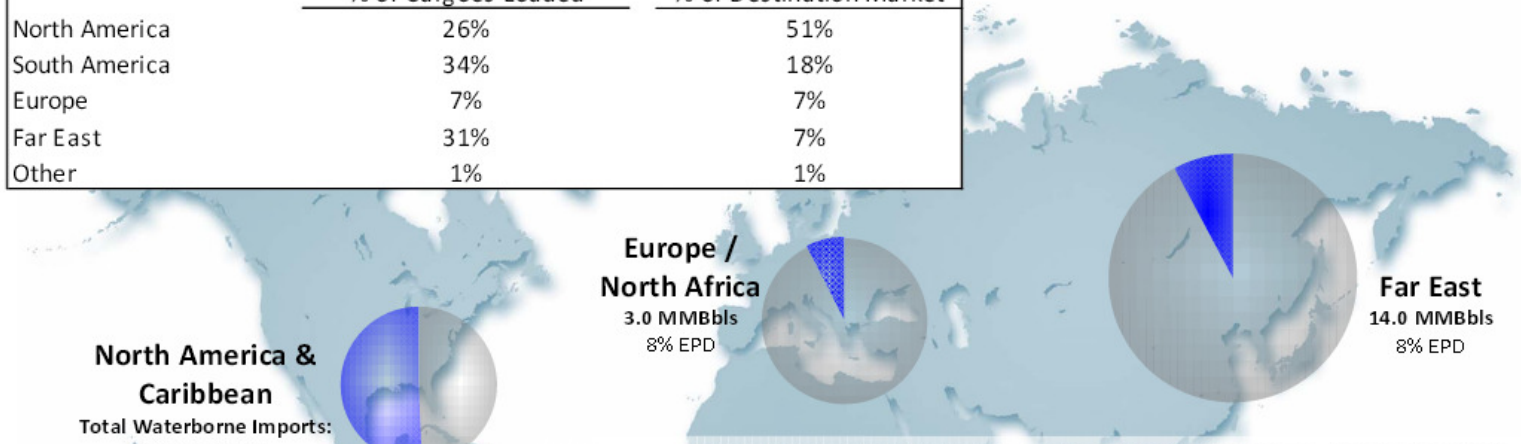


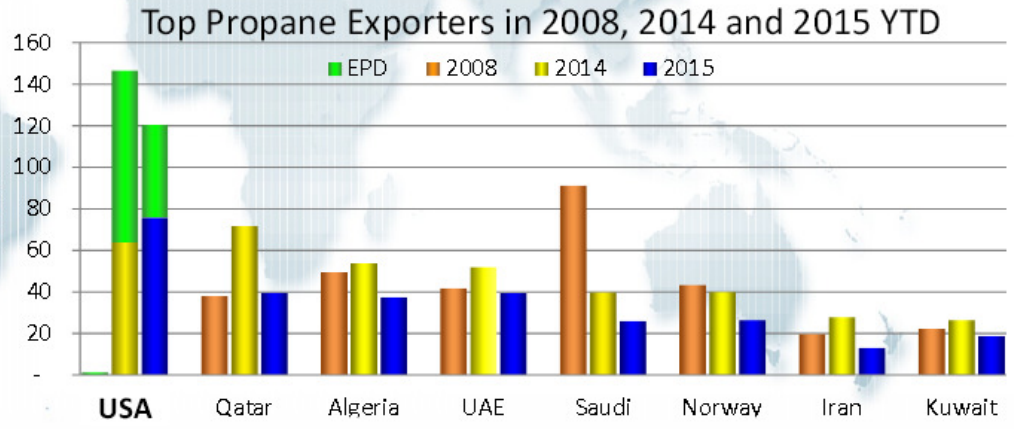
As US propane production has increased and domestic demand has remained relatively flat, the US has transitioned from being a net propane importer to a net exporter. Sources: US Energy Information Administration, US Department of Commerce.

U.S. BECOMES LARGEST EXPORTER OF PROPANE

Propane Exports from EPD Facilities as of July 2015

2015 Propane Exports from EPD Facilities by Destination Region: ≈45 MMBbls		
	% of Cargoes Loaded	% of Destination Market
North America	26%	51%
South America	34%	18%
Europe	7%	7%
Far East	31%	7%
Other	1%	1%





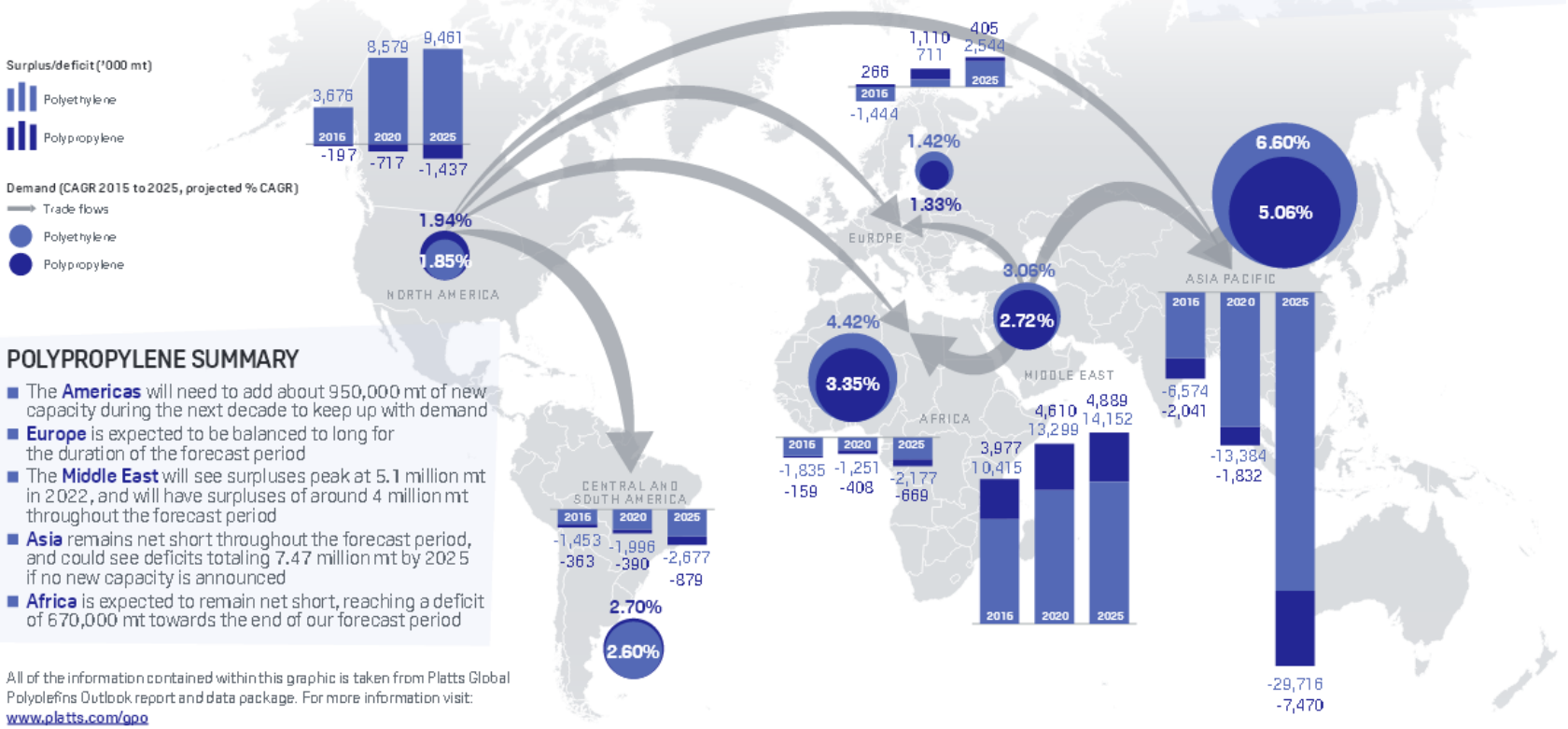
Source: Waterborne

PLATTS
McGRAW HILL FINANCIAL

GLOBAL TRADE FLOWS
POLYETHYLENE AND POLYPROPYLENE

POLYETHYLENE SUMMARY

- Global supplies of polyethylene to increase by **32%** from 2015 to 2025
- Shale based ethane and coal will be the dominant **new projects**
- India & China to remain **key global drivers** for demand growth
- Post 2023, **higher operating rates** expected reducing deficit required
- Medium term, market to expect surpluses
- **Low crude oil price** to hang over future investments

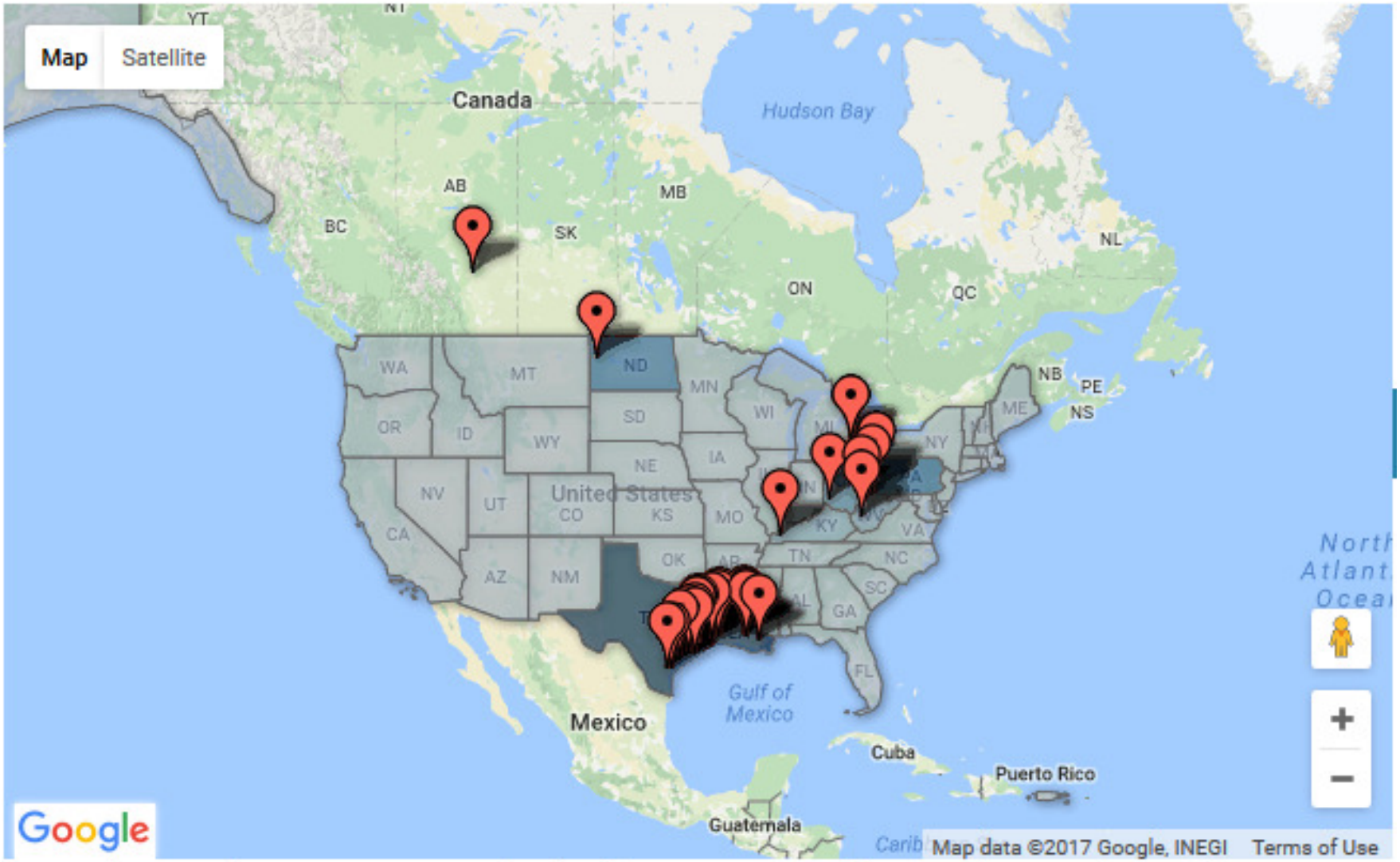


POLYPROPYLENE SUMMARY

- The **Americas** will need to add about 950,000 mt of new capacity during the next decade to keep up with demand
- **Europe** is expected to be balanced to long for the duration of the forecast period
- The **Middle East** will see surpluses peak at 5.1 million mt in 2022, and will have surpluses of around 4 million mt throughout the forecast period
- **Asia** remains net short throughout the forecast period, and could see deficits totaling 7.47 million mt by 2025 if no new capacity is announced
- **Africa** is expected to remain net short, reaching a deficit of 670,000 mt towards the end of our forecast period

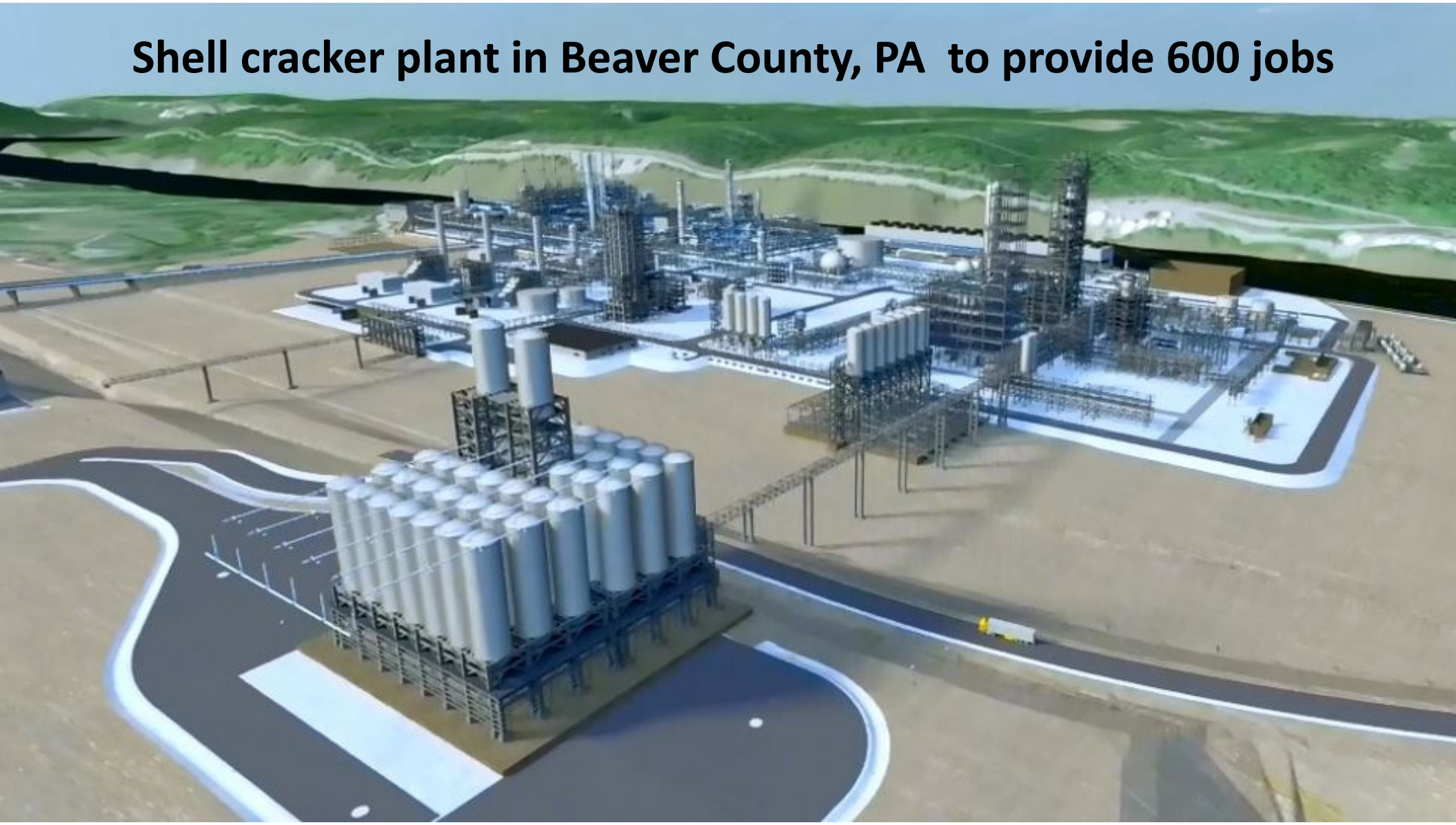
All of the information contained within this graphic is taken from Platts Global Polyolefins Outlook report and data package. For more information visit: www.platts.com/gpo

All figures correct at the time of publishing: February 2016



Major ethane cracker projects (announced and under construction) in the U.S. and proposed new ethylene capacity by state. Click on and interact with the map to learn more. Source: Petrochemical Update.

Shell cracker plant in Beaver County, PA to provide 600 jobs



Formosa Plastics Group is seeking permission from the state of Louisiana to invest $9.4 billion to build petrochemical plants. The Taiwanese chemicals producer is waiting for the U.S. state's authorization for construction of the facilities in St. James, according to Lin Keh-Yen, executive vice president of Formosa Petrochemical Corp.

The group also plans another $5 billion investment to expand production lines in Texas, Formosa Plastics Corp. Chairman Jason Lin said by phone. "Seeking a permit solidifies that Formosa wants to do the project," said Tony Potter, a vice president at IHS in Singapore. "Ethane prices will remain relatively low. Because of the lower cost, you have a situation where the U.S. ethane based production will be able to **deliver polymer products** into places like China cheaper than they can be made from naphtha in China and the surrounding countries like Taiwan, Japan, Korea, Thailand, Singapore."

Bloomberg 2-20-17

ETHYLENE EXPORT: CULTIVATING DEMAND

Enterprise's export position for LPG, Ethane and Propylene can be broadened to include Ethylene

- Asian demand for ethylene continues to grow beyond local production; Asia is looking to diversify with stable shale-advantaged pricing
- The 40% expansion in ethylene production in the U.S. will result in an over supplied U.S. ethylene market
  - Domestic producers need to reach global markets, otherwise the operating capacity of U.S. crackers will be reduced as new builds are completed
  - The LPG and ethane export model has forged the path to connect foreign consumers to the shale revolution…ethylene export is the next logical step

Economics are very similar to the Ethane Export project …and any NGL can be exported from an Ethylene terminal

Ethane transporter ship belonging to Ineos

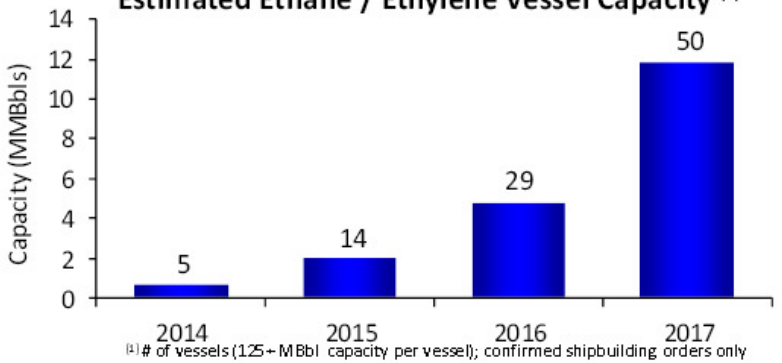
In Houston, the Enterprise Products terminal will be able to export 200,000 bbl/d of ethane. Asked why the project makes sense, one commentator says: “One word: shale.”

ETHANE EXPORT FACILITY
Largest of Its Kind

- Located at Morgan's Point on Houston Ship Channel; combined operating rate ≈200 MBPD across two docks
  - ≈ 80% committed under long–term contracts
  - All major materials ordered; on schedule for June 2016 completion

Shipbuilders Response to Increased Ethane Demand

Estimated Ethane / Ethylene Vessel Capacity [1]



[1] # of vessels (125+ MBbl capacity per vessel); confirmed shipbuilding orders only

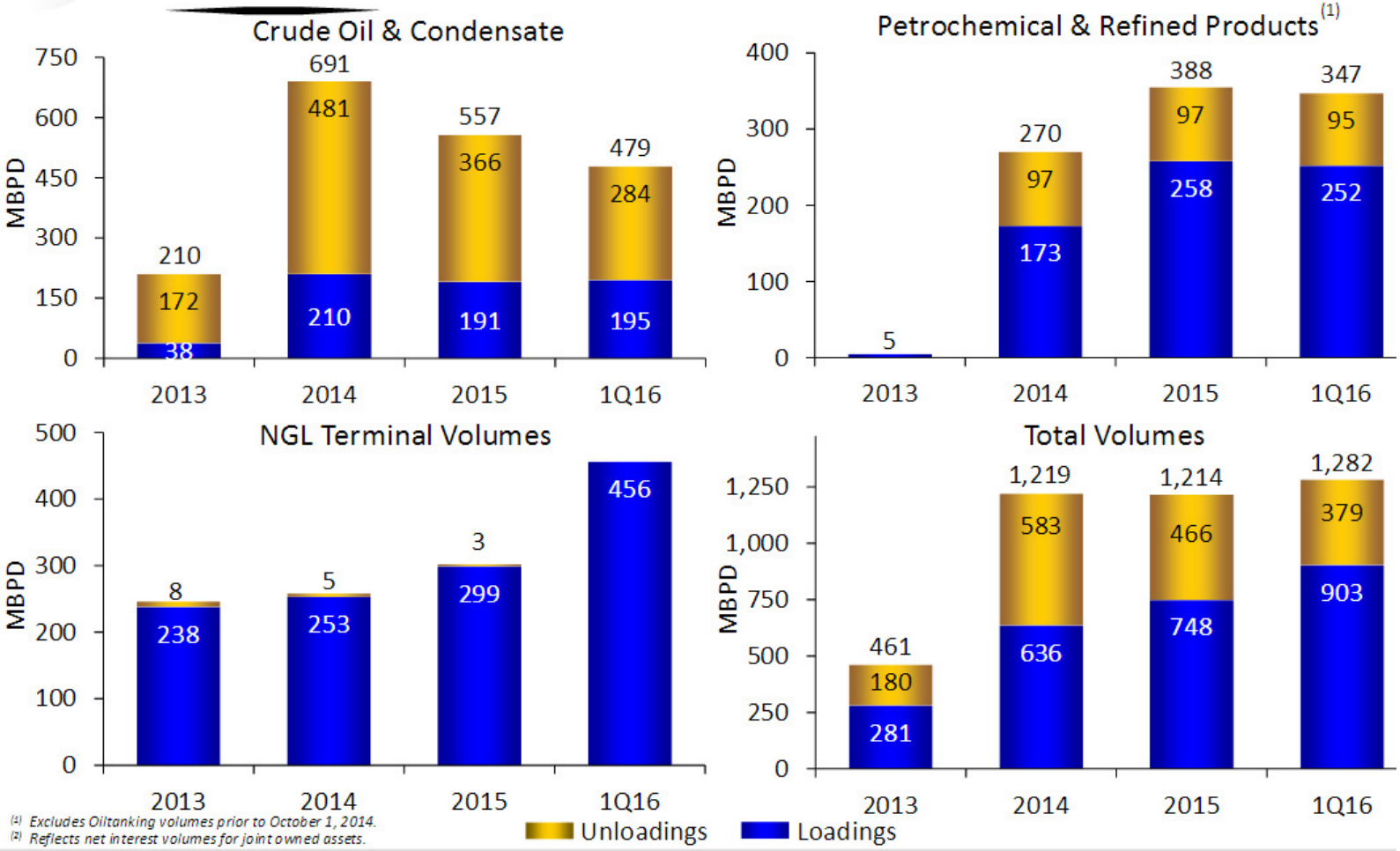
Source: EPD Fundamentals

Market Potential

- Ethylene cracker feedstock – displacing current crude oil derivative feedstocks or new demand
  - ≈300 MBPD ethane demand generated by converting 25% of NW Europe coastal operating capacity to ethane feedstock
- Fuel Market / Power generation
- Ultimate waterborne capacity needed will be dependent on roundtrip transit times to end-use market
  - Europe vs. Caribbean / South America vs. Asia

Source: EPD Fundamentals

MARINE TERMINAL / DOCK ACTIVITY



(1) *Excludes Oiltanking volumes prior to October 1, 2014.*
(2) *Reflects net interest volumes for joint owned assets.*

The contest will be between the ability of U.S. Downstream processors to handle all of the raw ethane and propane being produced.

Even if all of the new steam crackers are built, that merely moves the chokepoint down stream to the polymerization level.

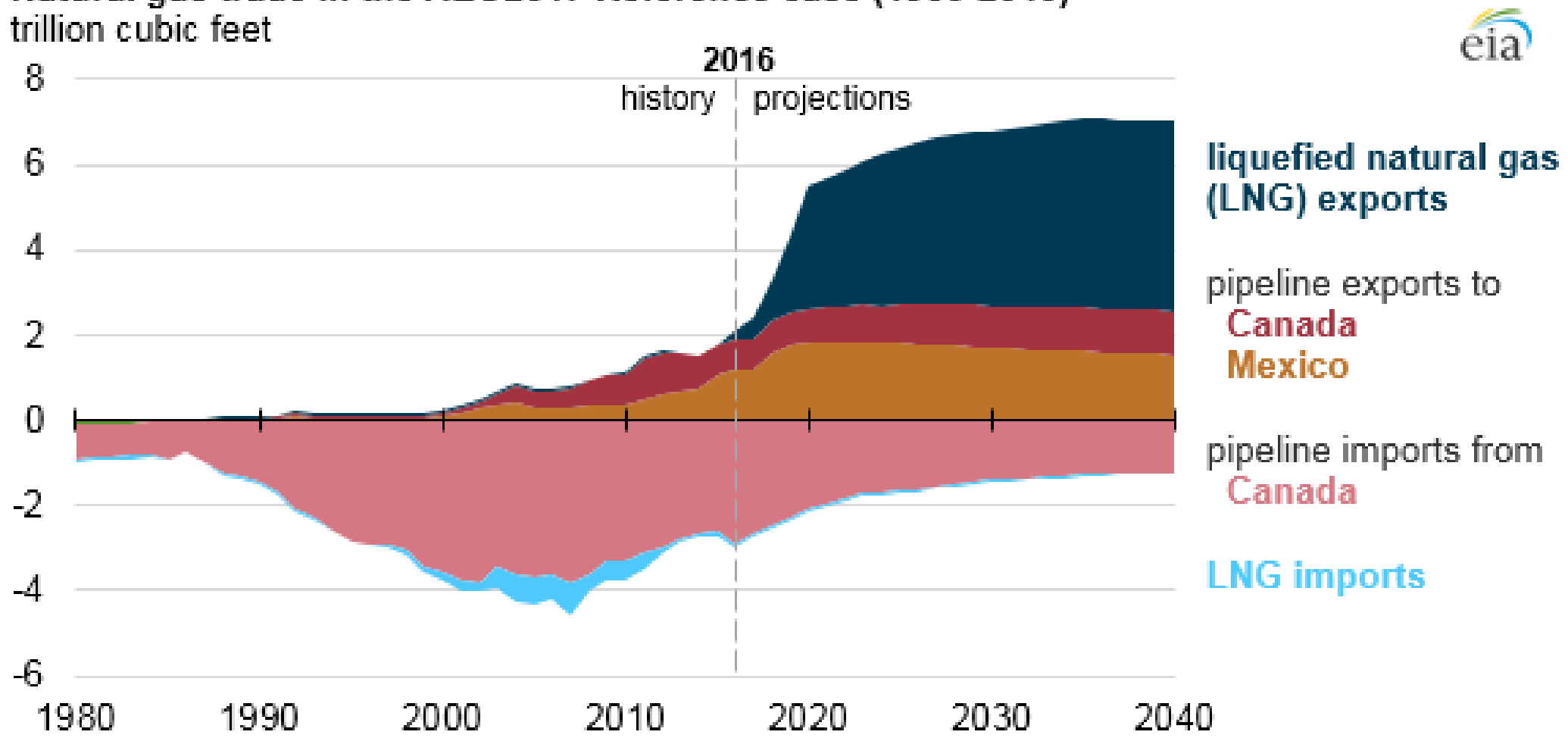
1) Ethane will be sourced along the Gulf Coast and in the Marcellus and Utica shale plays. The bulk of existing steam crackers (~31) and polymerization capacity is along the Gulf Coast.

2) Therefore, we expect the bulk of new cracker capacity to be installed there. New capacity will also be seen in the northeast. Perhaps one of the three proposed Northeast crackers will be built which will double the census.

3) Beyond domestic consumption, ethane, ethylene, propane and propylene, and bulk polymer chips will all be exported from the US.

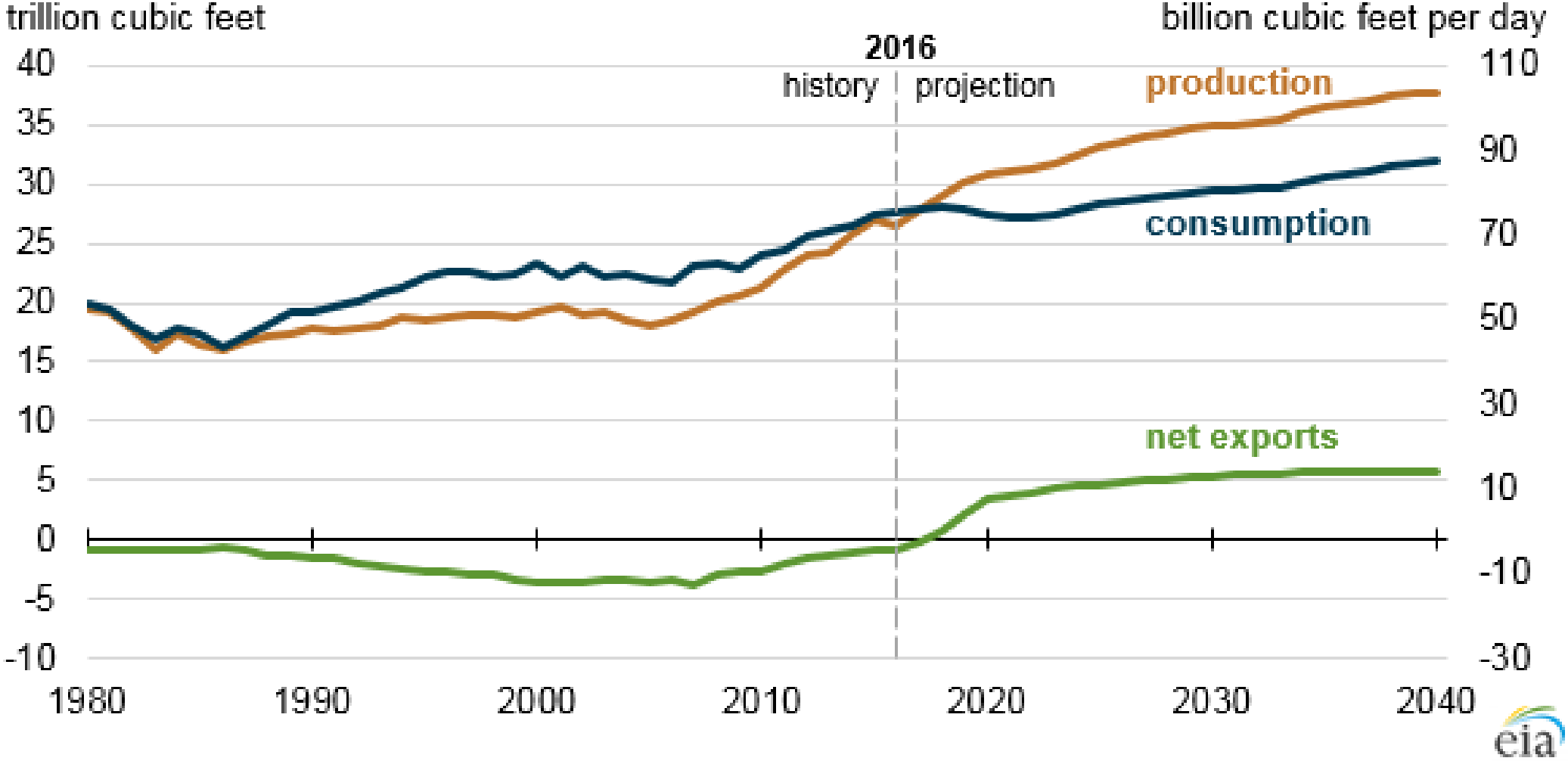
LNG Exports

Natural gas trade in the AEO2017 Reference case (1980-2040)
trillion cubic feet



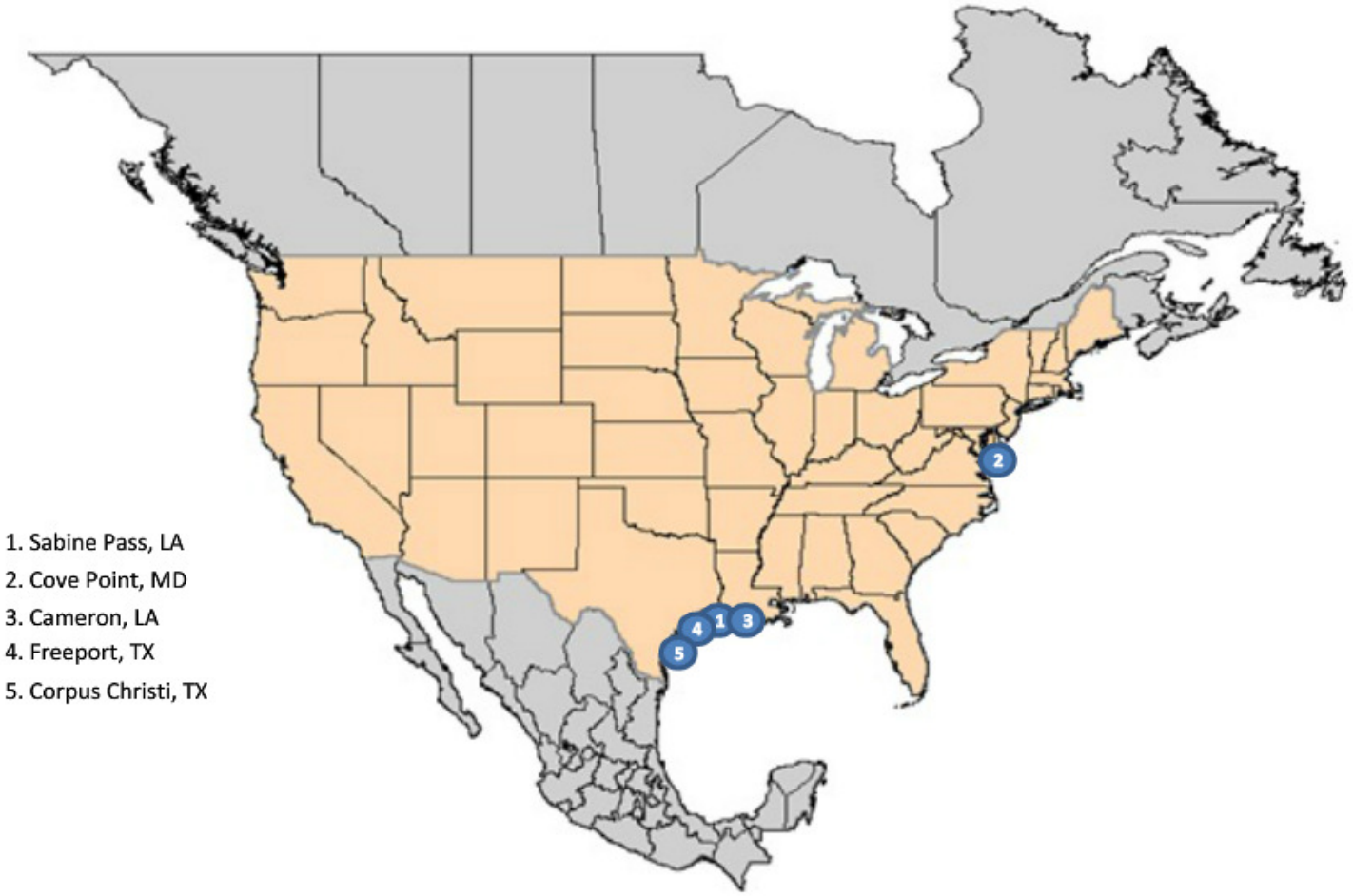
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2017 Interactive Table Viewer*

Natural gas production, consumption, and trade in the AEO2017 Reference case



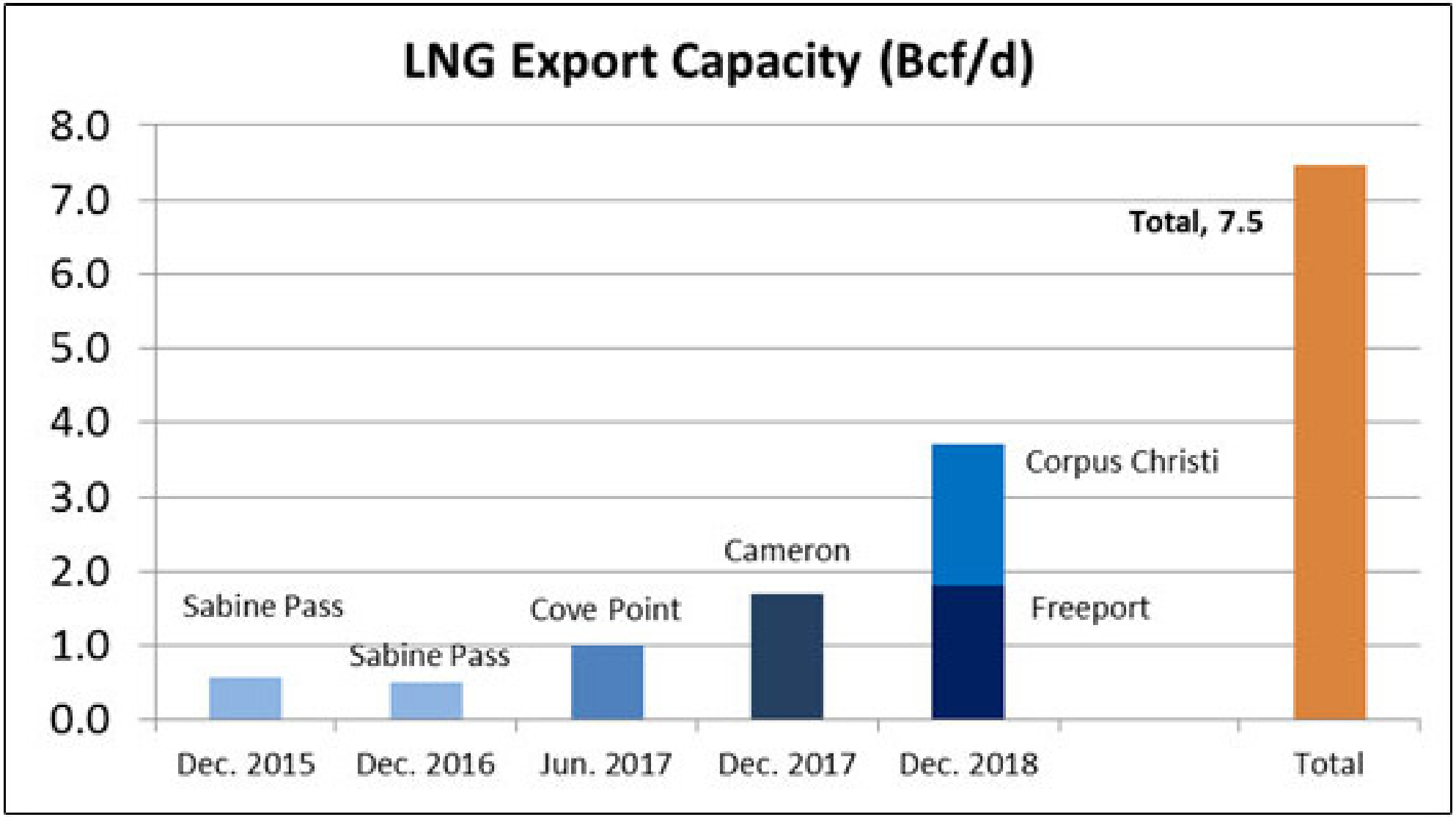
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2017 Interactive Table Viewer*

LNG US export projects under construction



1. Sabine Pass, LA
2. Cove Point, MD
3. Cameron, LA
4. Freeport, TX
5. Corpus Christi, TX

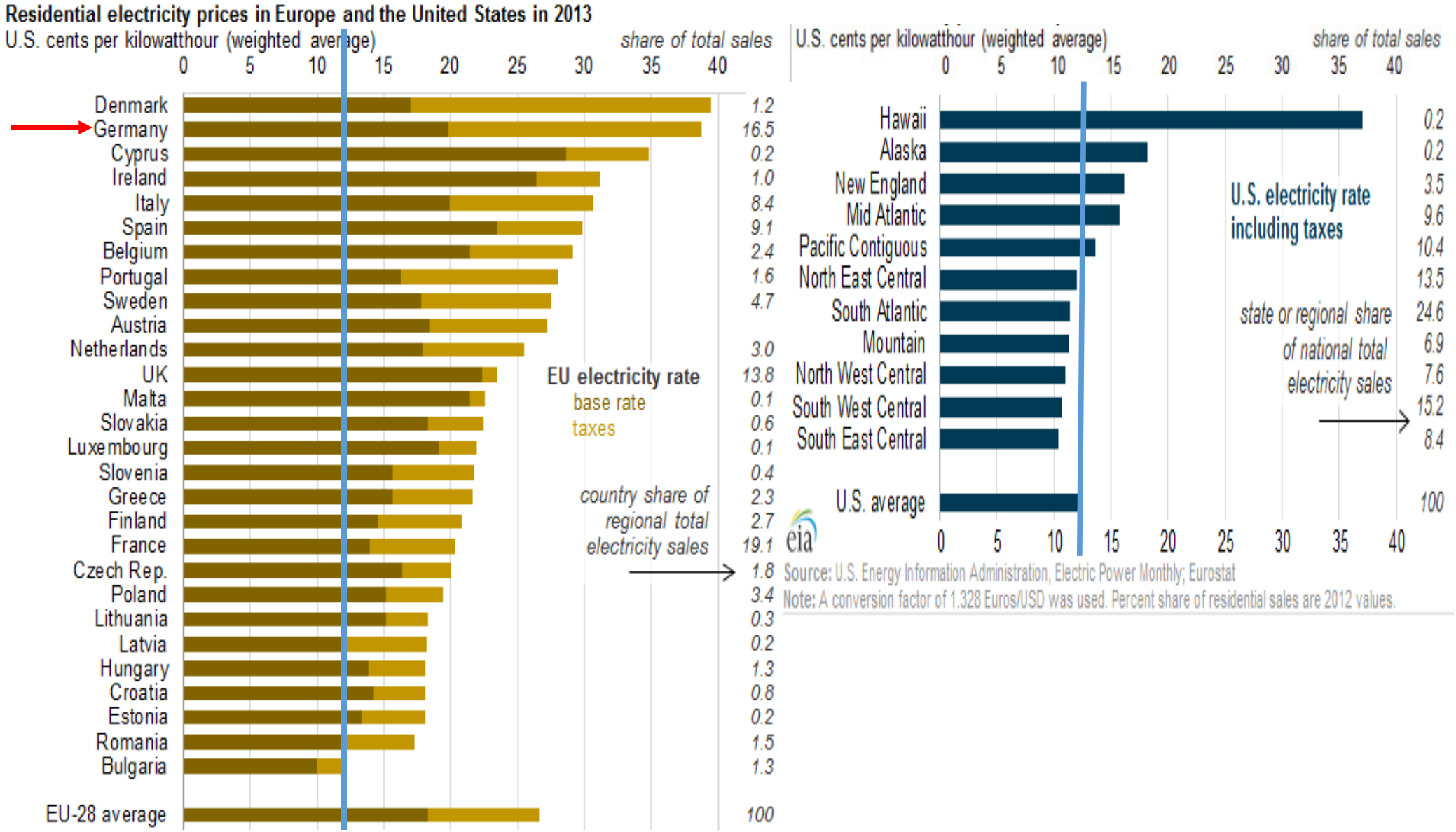
argus



Source: PointLogic Energy LNG Informant

Power

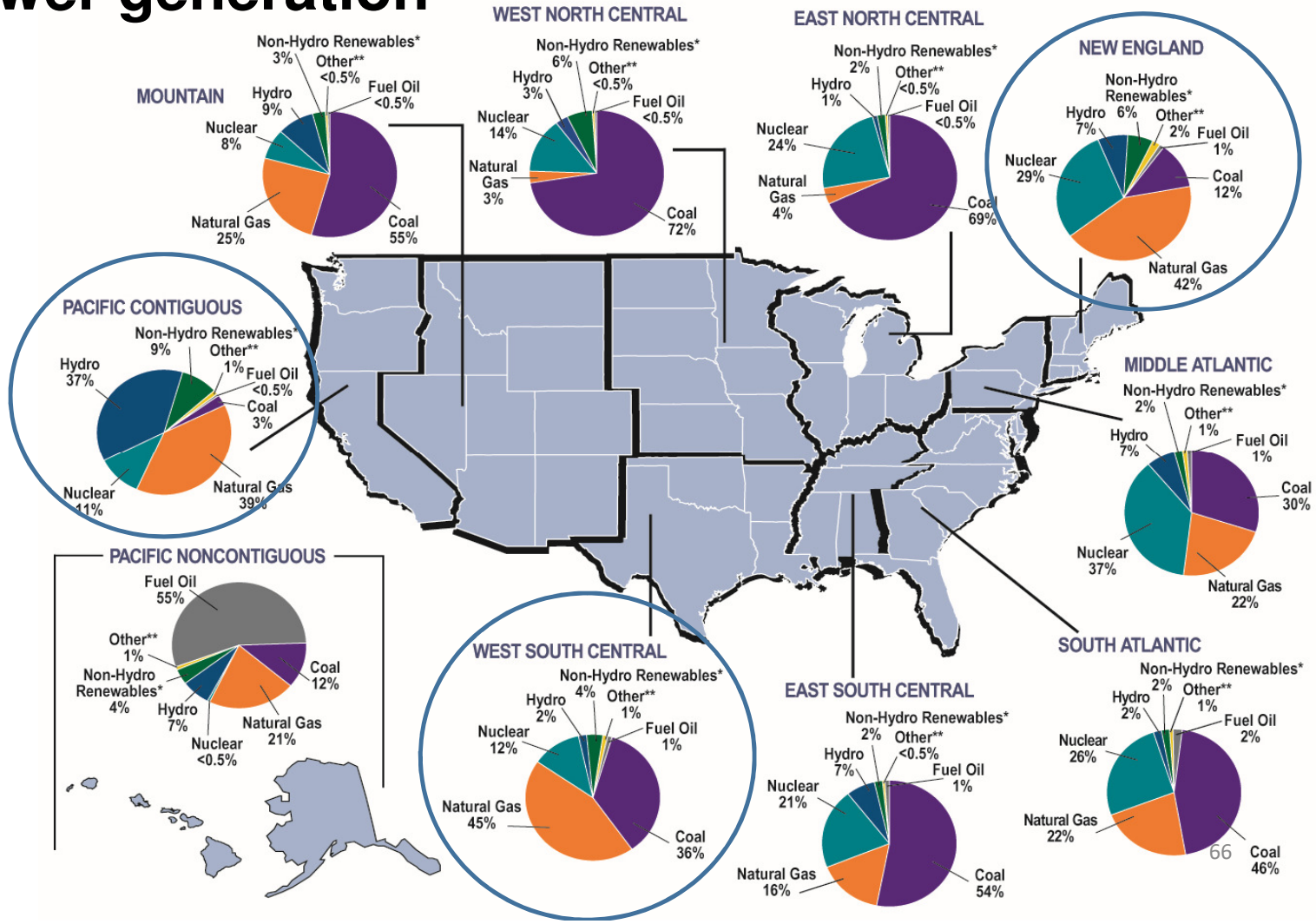

CCGT Generation

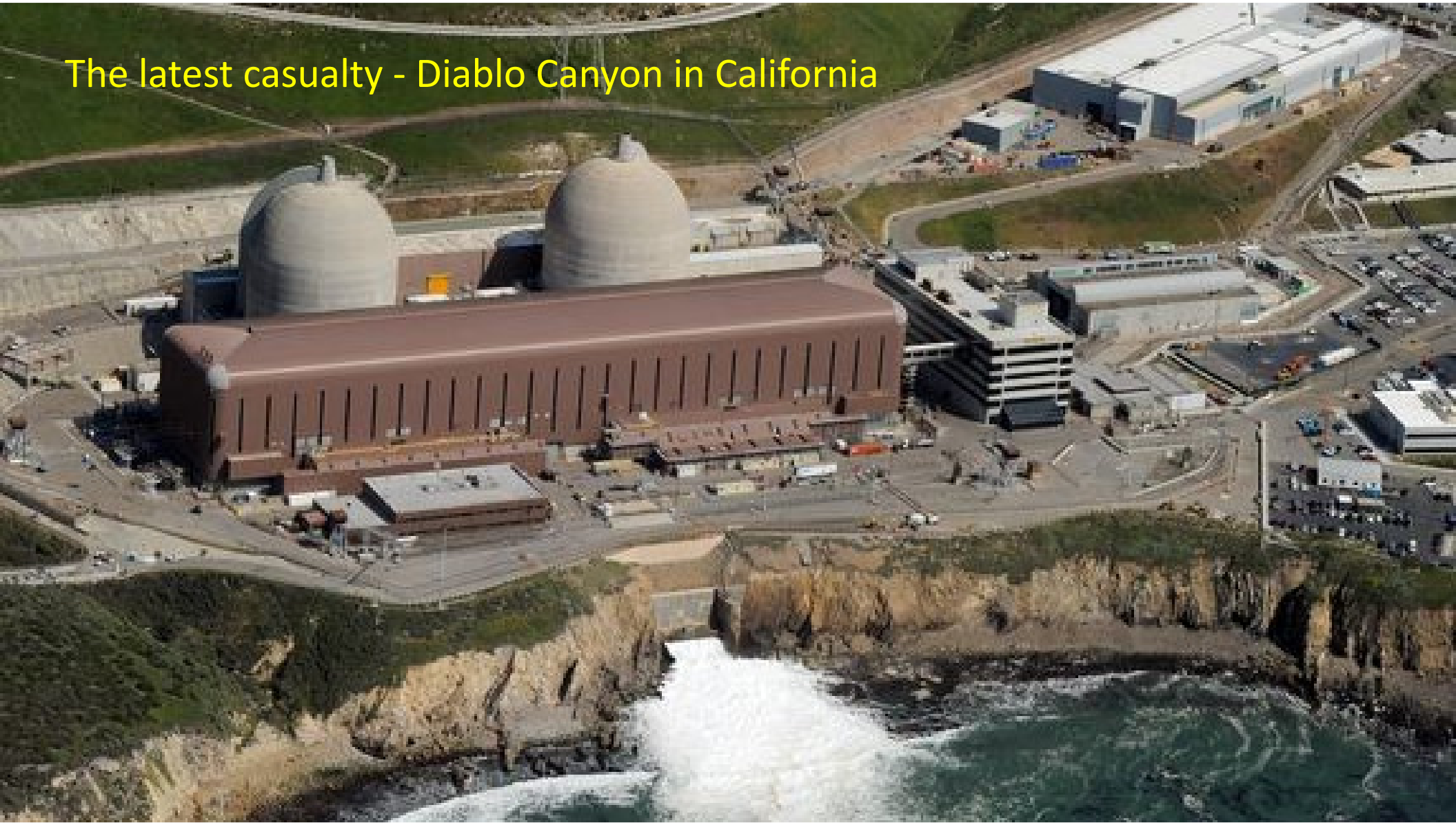

Residential electricity prices in Europe and the United States in 2013
U.S. cents per kilowatthour (weighted average)
0 5 10 15 20 25 30 35 40
share of total sales
Denmark 1.2
Germany 16.5
Cyprus 0.2
Ireland 1.0
Italy 8.4
Spain 9.1
Belgium 2.4
Portugal 1.6
Sweden 4.7
Austria
Netherlands 3.0
UK 13.8
Malta 0.1
Slovakia 0.6
Luxembourg 0.1
Slovenia 0.4
Greece 2.3
Finland 2.7
France 19.1
Czech Rep. 1.8
Poland 3.4
Lithuania 0.3
Latvia 0.2
Hungary 1.3
Croatia 0.8
Estonia 0.2
Romania 1.5
Bulgaria 1.3
EU-28 average 100
EU electricity rate
base rate
taxes
country share of regional total electricity sales
U.S. cents per kilowatthour (weighted average)
0 5 10 15 20 25 30 35 40
share of total sales
Hawaii 0.2
Alaska 0.2
New England 3.5
Mid Atlantic 9.6
Pacific Contiguous 10.4
North East Central 13.5
South Atlantic 24.6
Mountain 6.9
North West Central 7.6
South West Central 15.2
South East Central 8.4
U.S. average 100
U.S. electricity rate including taxes
state or regional share of national total electricity sales
eia
Source: U.S. Energy Information Administration, Electric Power Monthly; Eurostat
Note: A conversion factor of 1.328 Euros/USD was used. Percent share of residential sales are 2012 values.

Nuclear

Indian Point. (Patrick Stahl)

Different Regions of the Country Use Different Fuel Mixes for power generation



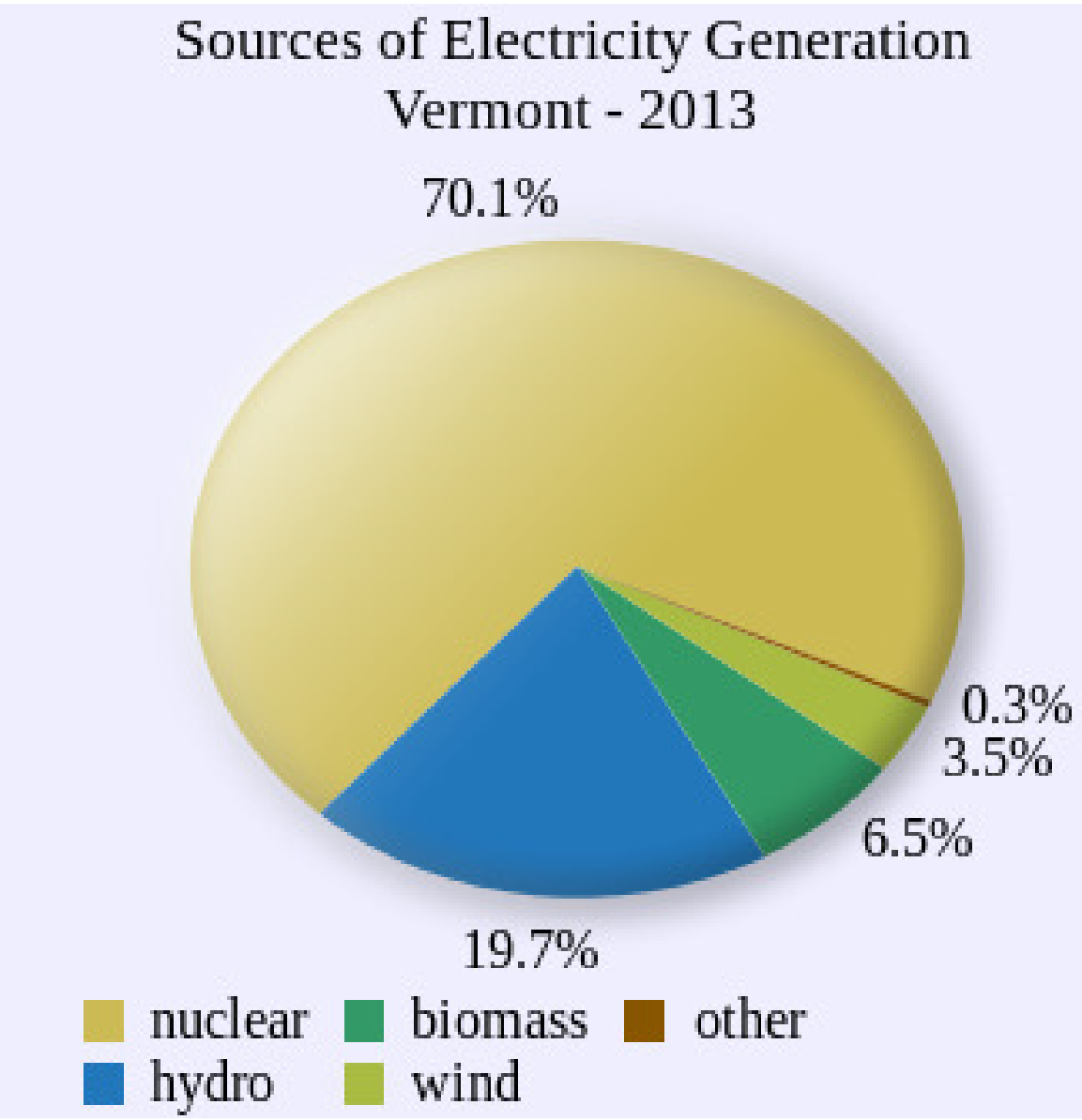

The latest casualty - Diablo Canyon in California

Entergy Corp. plans to shut down the Palisades nuclear power plant in Michigan in 2018. Marvin Fertel, president and CEO at the Nuclear Energy Institute, touted Palisades' role in providing "emissions-free" power and jobs while helping to stabilize the grid and acting as a hedge against fuel supply interruptions. But the market does not value the plant for providing any of those benefits," Fertel said in a statement. "Nuclear plants are operated by corporations, with an eye on the bottom line. What is not paid for does not endure."

Photo courtesy of Entergy.

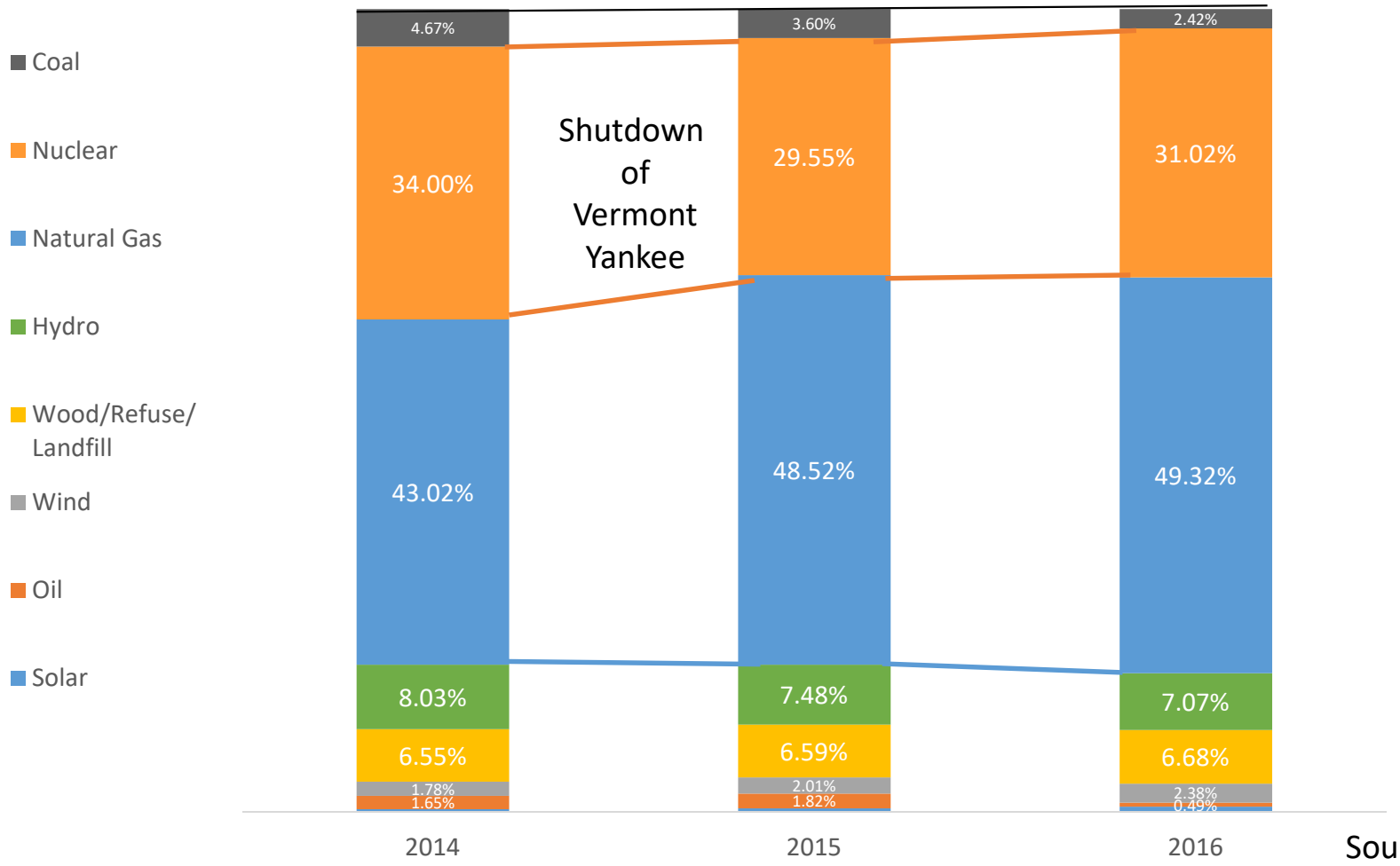
Vermont Yankee Nuclear Power Plant

On August 28, 2013, Entergy announced that due to economic factors, notably the lower cost of electricity provided by competing natural gas-fired power plants, it would cease operations and schedule the plant's


Sources of Electricity Generation
Vermont - 2013
70.1%
0.3%
3.5%
6.5%
19.7%
nuclear
biomass
other
hydro
wind


Vermont Yankee

ISO - New England Generation By Fuel Type
2014 v. 2015 v. 2016 Share of Market



Source M. Twomey

Pros/Cons: Nuclear

Pros:

- Domestically abundant fuel
- Relatively low fuel cost
- Zero CO2 emissions
- SMRs (units of <300 mw) provide for lower capex
- Avoids the addition of new CCGT plants with increased CO2 emissions

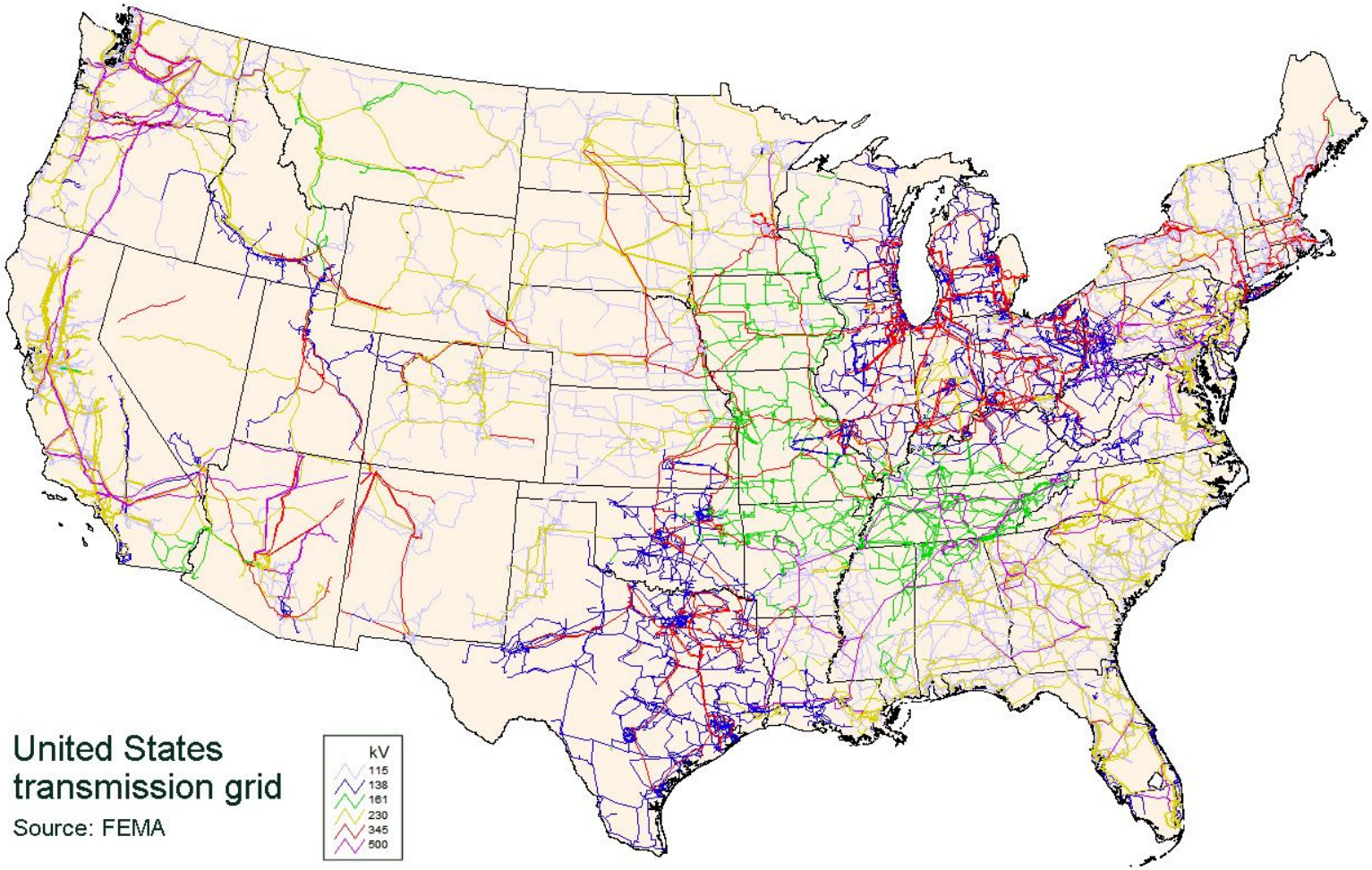
Cons:

- Very high capital cost
- Currently can't compete with natural gas fueled units
- Spent fuel disposal/storage issues
- Non-standardized fleet
- Burdensome Regulations
- Base load only; not economically dispatchable
- Eminent need for subsidies to avoid premature shutdown

High Voltage transmission

A network of cable transporting electrical energy from generating units to distribution stations and transmission customers.

Transmission grid is a massive interconnected network



Transmission: From Point A to B

Transmission allows delivery of electricity, often generated hundreds of miles from generation stations to end users.

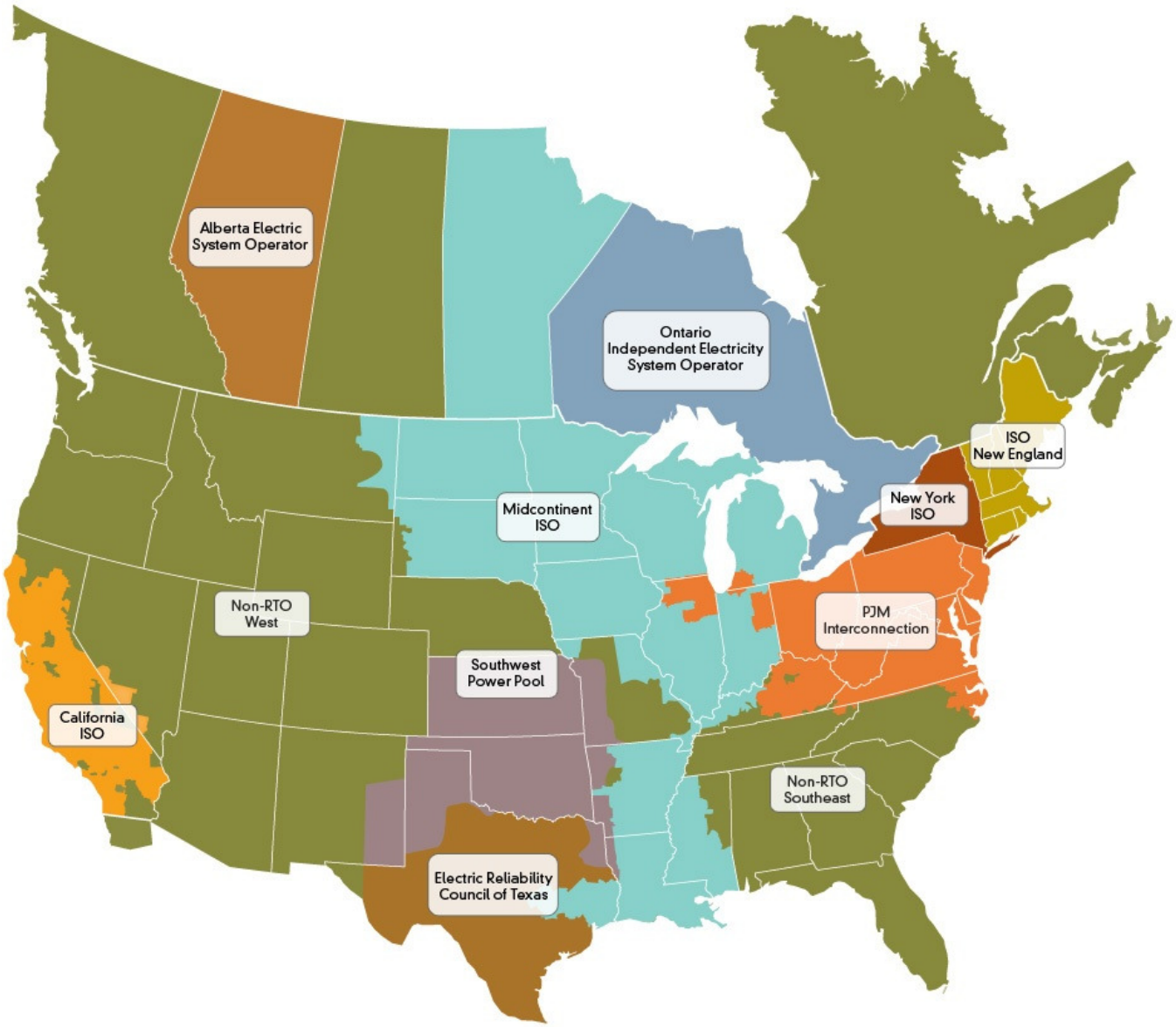
Significant rivalry amongst, State Utility Commissions, Independent System Operators and FERC in regulating Interstate power transmission.

Increasing intermittent sources (wind and solar) has complicated things.

Nine organized wholesale markets serve two thirds of US electric customers and one –half of Canadian customers

MISO, the Midcontinent ISO is the largest in terms of area.

Note the transmission choke point between MISO North and MISO South



Taxes

Tax Policy

- Beware of ripple effects! Existing tax code has been flawed and inefficient for a very long time, because it is difficult to modify. People have optimized around it.
- A century ago lawmakers focused on taxing profits regardless of where earned. They still want to ignore location. They should have focused on taxing revenue and expenses where they occur, but they didn't.
- Welcome to the BAT or the Border Adjustment Tax, a proposed import tariff similar to the one that caused the advent of OPEC in 1960.
- Obvious side effects include changes in currency values, making exports more difficult, not only for the US, but also increasing the international cost of raw materials denominated in dollars, like oil.
- Protective tariffs also allow for opportunistic increases in the cost of locally manufactured products paid for by US consumers, like gasoline, diesel, and jet fuel. That was a major cause of the depression, not to mention the US Civil War.
- Also, let's not forget the impact on non-energy products, like tourism and education, two large US service "exports".

SPE Meeting
Effects of the Trump presidency on the US Oil Patch

Eric N. Smith
Associate Director
Tulane Energy Institute
2-23-17

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