US Shale Oil Development and Impact on Aromatics Supplies

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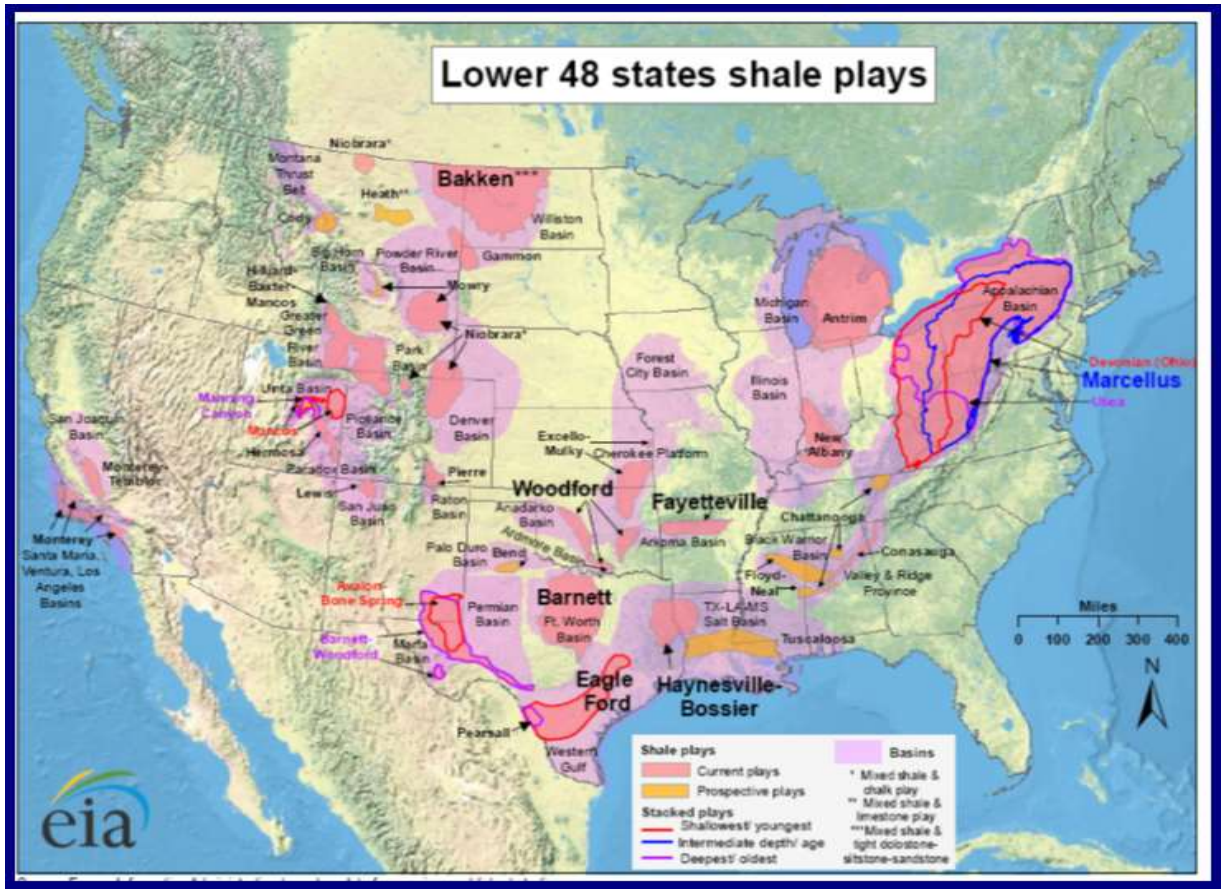
The Shale revolution in the US has changed global market dynamics



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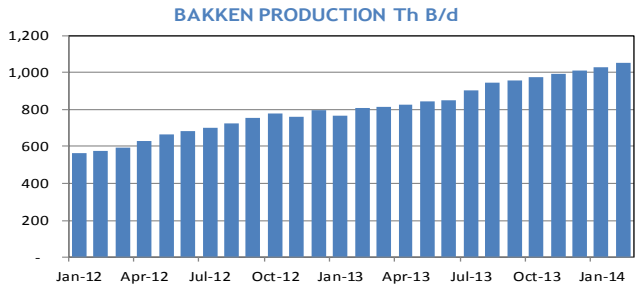
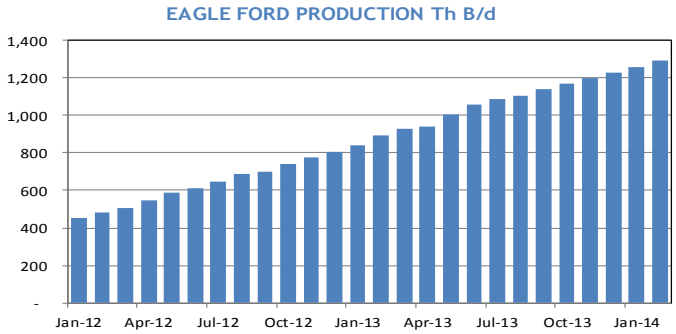
US oil production is up 60% in 60 months as a result of increased shale oil production





Source: EIA Data

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Crude oil quality comparison

Crude Comparison Table					
	NSD	Bonny Lt	WTI	Eagle Ford	Bakken
API Gravity	37.9	35	40	45	42
Sulfur Wt%	0.45	0.15	0.33	0.4	0.2
Yields Vol%					
Light Ends	4.1	1.7	1.5	3.8	3.5
C5-165 C Naphtha	25.3	22.2	29.8	40.1	35.7
Jet 165-235 C	12.4	15.8	14.9	12.6	13
Diesel 235-360 C	25.6	37.4	23.5	17.1	17.8
VGO-360-540 C	23	18.3	22.8	21.2	24.8
Resid 540+ C	9.6	4.6	7.5	5.2	5.2
Total	100	100	100	100	100
C5-165 C Naptha Vol%					
Napthenes	39	51	38	21	23
Aromatics	15	12	12	11	13
N+A	54	62	50	32	36

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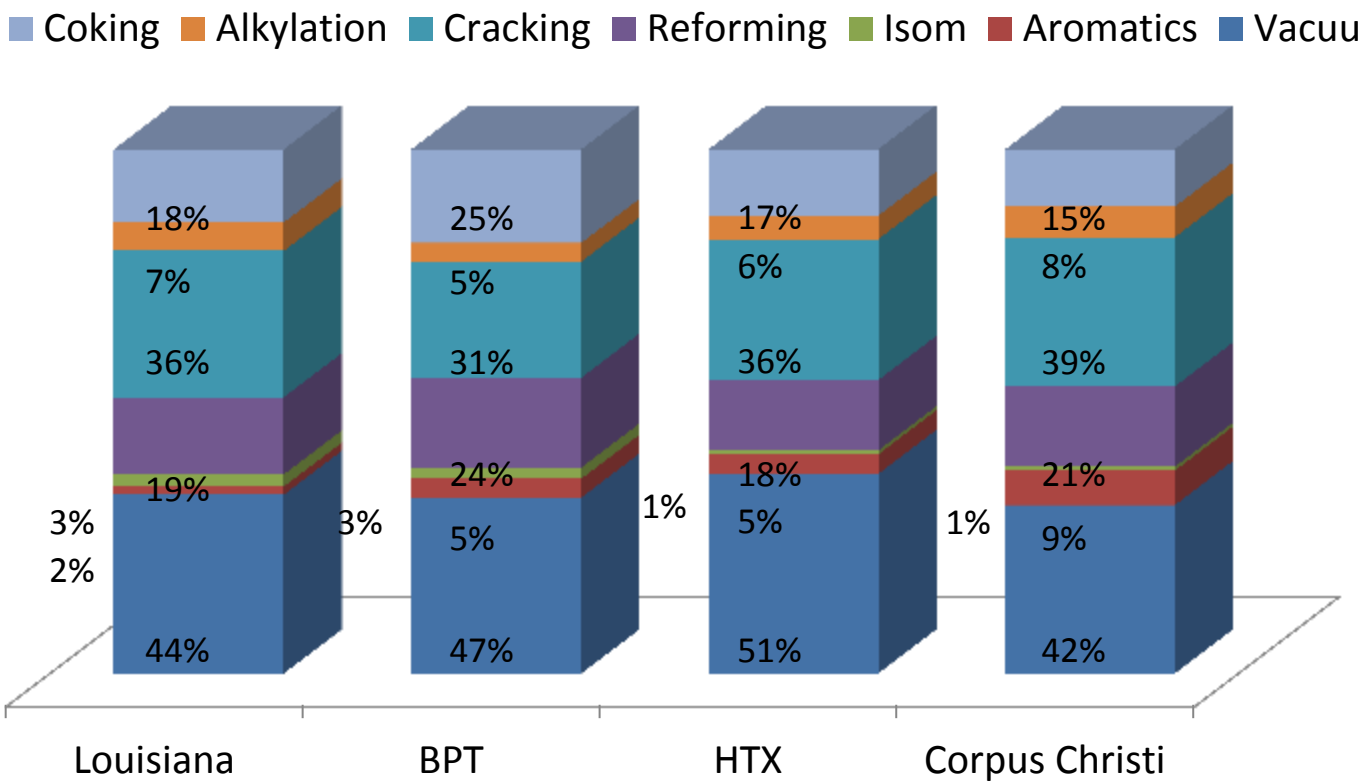
US Refining Industry Issues

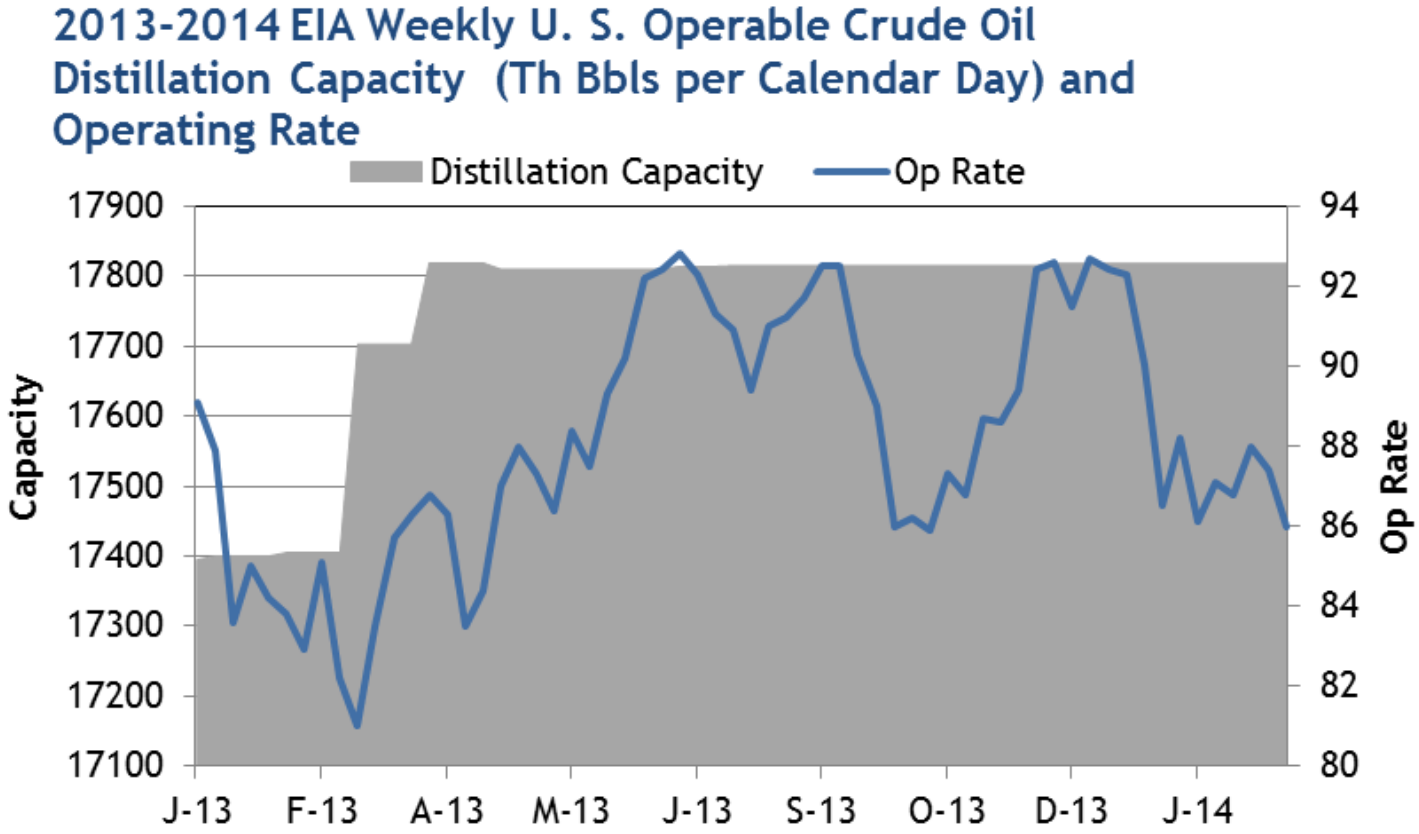
US GC refineries designed for heavier crude: Reforming units will be overwhelmed; refiners lose capacity

Upgrade Capacity in % of CDU Capacity for PADD 3



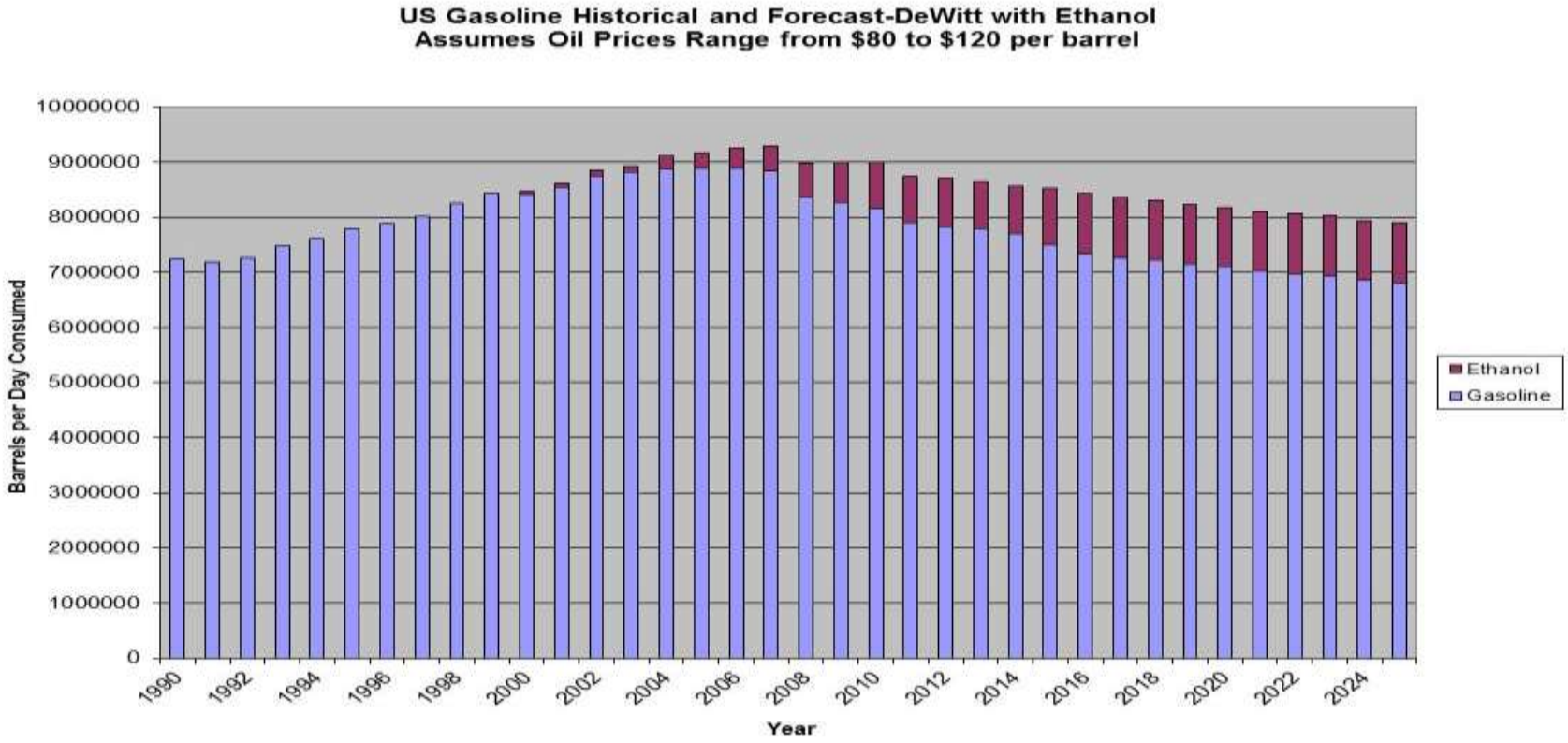
- Key process to assess is reforming, which processes naphtha to high octane gasoline; refiners will lose throughput volume with light crude

US Crude Distillation Capacity is expanding, and utilization rates are high



- Valero and Marathon are adding distillation capacity to process more shale crudes

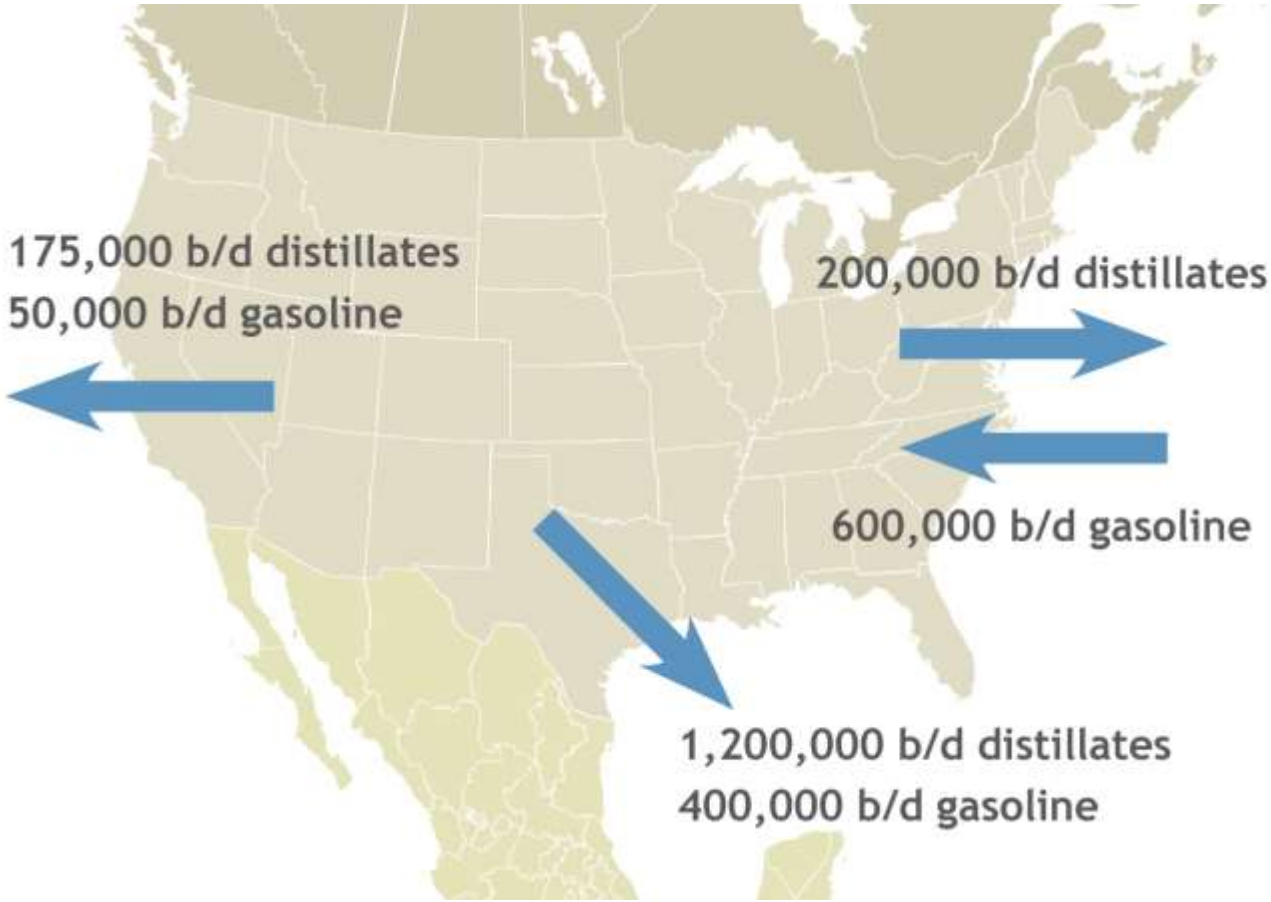
US gasoline demand to continue to fall going forward



- Slow Economic Growth; Does not include exports
- Renewable Fuel Standard-Target is 36 B gallons of ETOH by 2023(not achievable)
- CAFÉ Standard with targets of 35.5 MPG by 2016 and 54.5 MPG by 2025

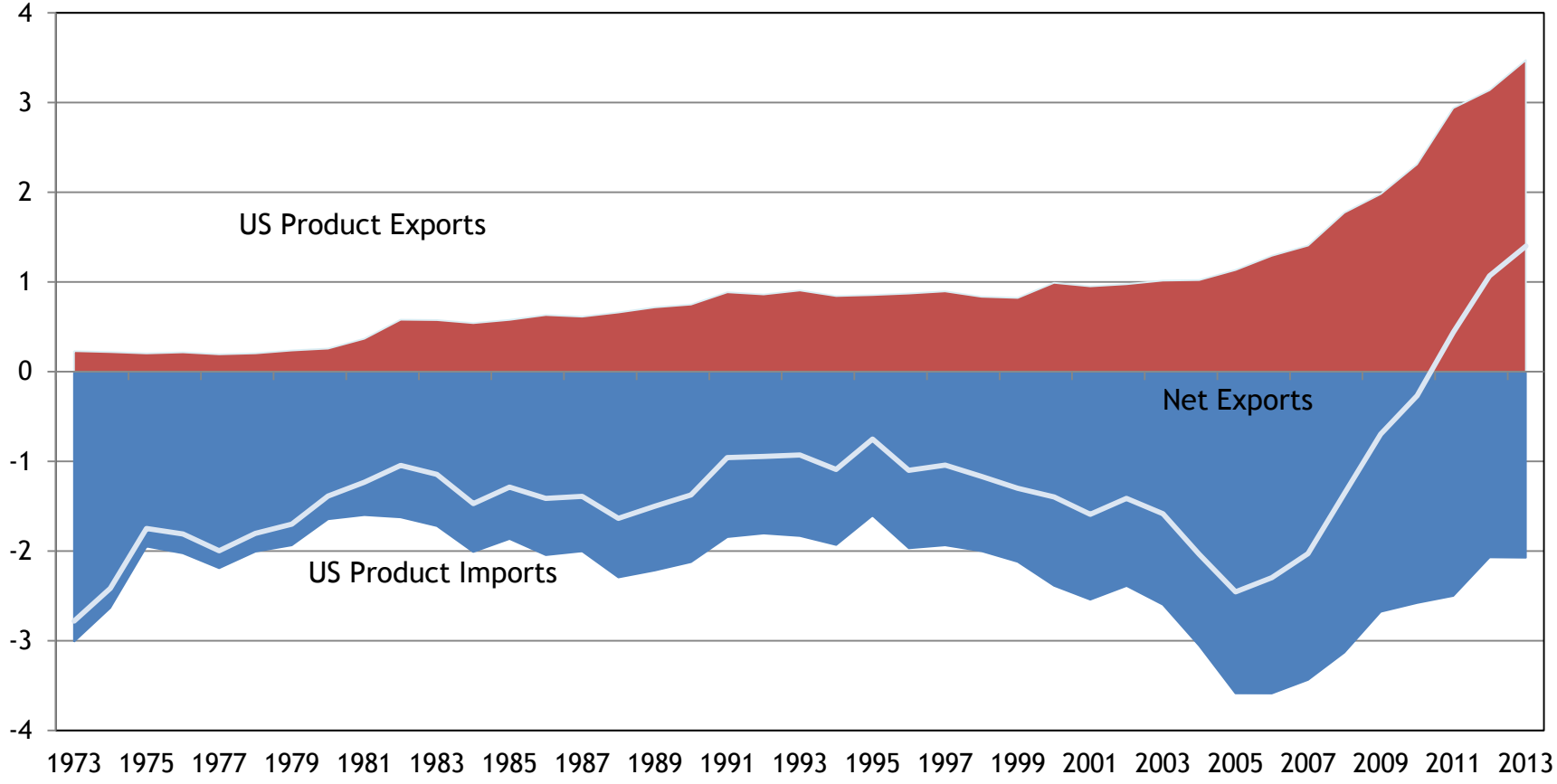
Source: EIA and DeWitt forecast

The US has sought to manage this naphtha length by increasing its exports of gasoline



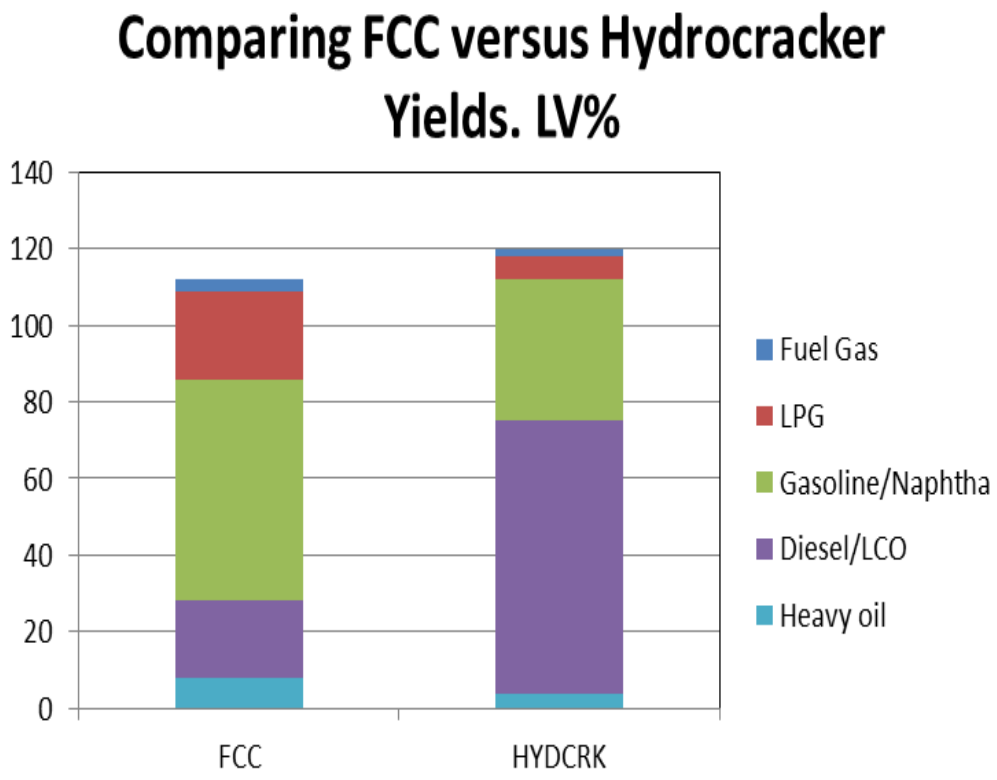
US becomes a net product exporter

Net Exports of US Products Positive through 2013
US Total Petroleum Products (mm bbls/day)



Source: EIA

Fluid Catalytic Cracking versus Hydrocracking



- In the 1990's, FCC was refinery "workhorse"
- FCC produces largest percentage of refinery gasoline
- Also the largest contributor to gasoline sulfur
- The dynamics are changing…..

Source: Argus DeWitt and Industry Data

Conclusions

- US energy production continues to grow; crude production rises over 1.0 mmbl/d in 2013
- US naphtha surplus will grow, but there are several options for disposition
- Refiners continue to look for ways to produce more diesel at the expense of gasoline; long term trends could affect petrochemicals

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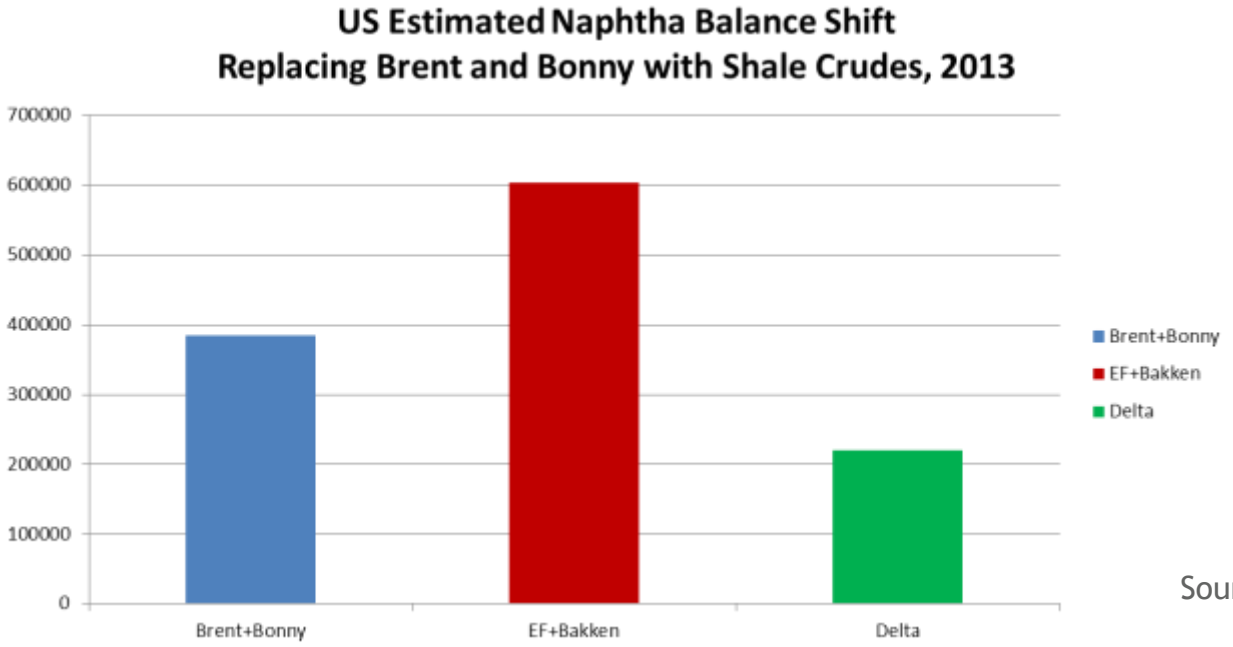
US Naphtha Supply and Demand

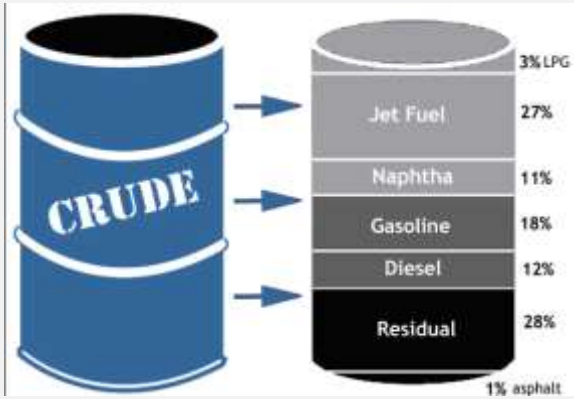
… and as a consequence of the quality of US Shale crudes, much more naphtha is being produced



Source: Argus DeWitt Est

- Based on replacing 1.6mmbbls per day of Brent/Bonny with Eagle Ford and Bakken
- With forecast production growth of shale crudes (up to 4.0MM bbls per day by 2020)

What is Naphtha ?



the lightest and most volatile fractions of the liquid hydrocarbons in petroleum.

feedstock to produce high octane gasoline component (reformate) or aromatics

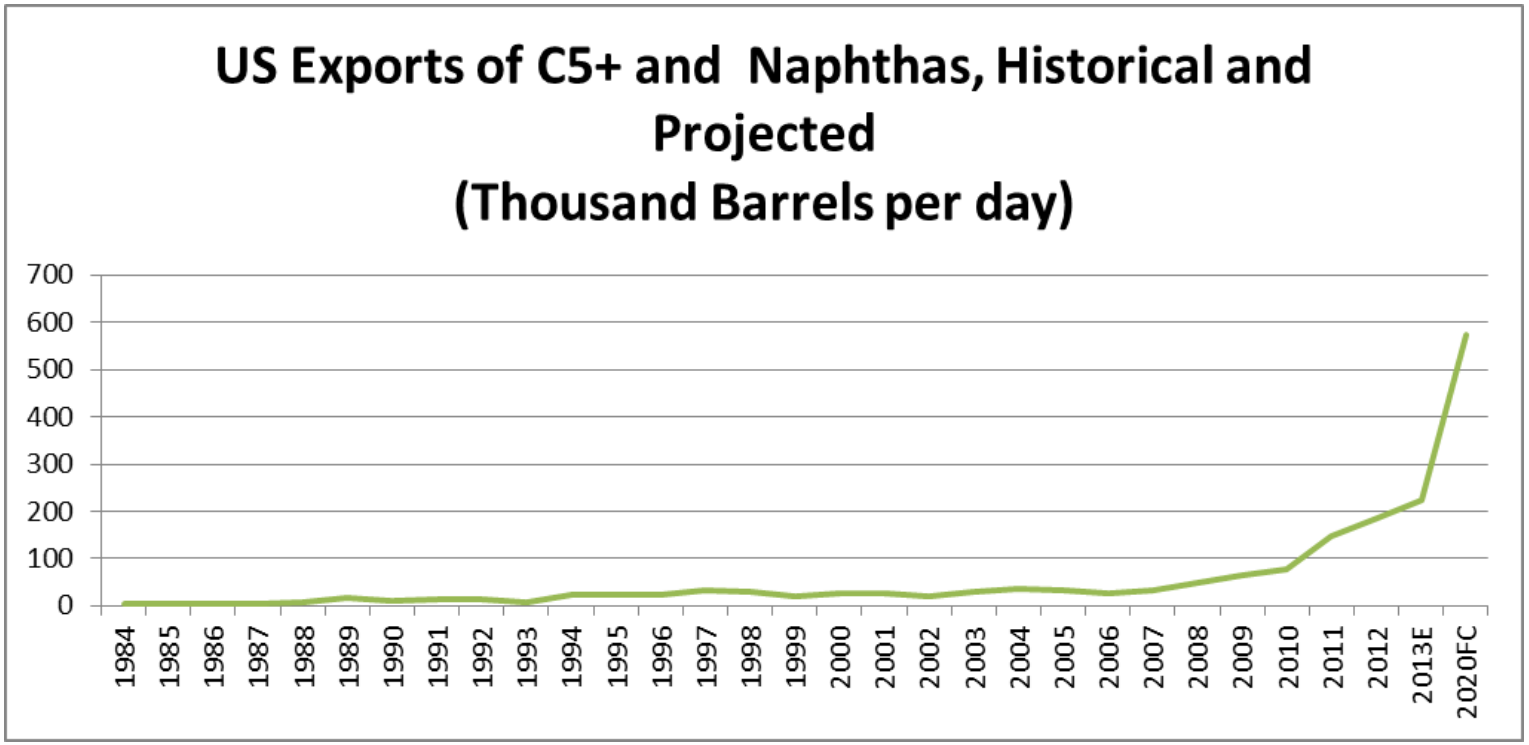
Also used in the bitumen mining industry as a diluent.

Feedstock for the petrochemical industry for producing olefins in steam crackers.

Naphtha disposition option: gasoline blending

- Reports from refiner clients discuss “sweet” naphtha blending into gasoline
  - Growing ethanol percentage of US gasoline is providing octane room for naphtha blending
  - Most refinery naphtha has been debutanized so vapor pressure is low
  - Can be used to produce sub octane product that can be destined for export
  - No good estimate of volumes blended available

But despite this, US Exports of C5+ and naphtha are rising rapidly

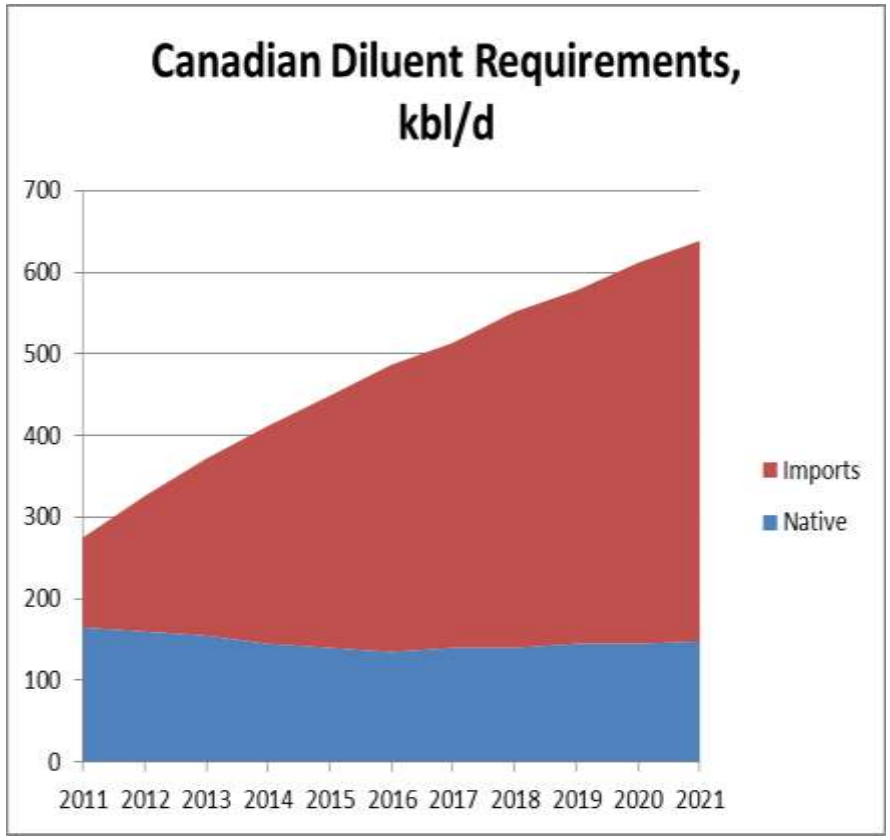


- C5+ condensate going to Canada as diluent for heavy crude production
- More cargoes are leaving the USGC headed to customers in Asia
- Forecast for 2022 depicts our view as more light crude is produced

Source: EIA and Argus DeWitt forecast

Canadian need for heavy crude diluent

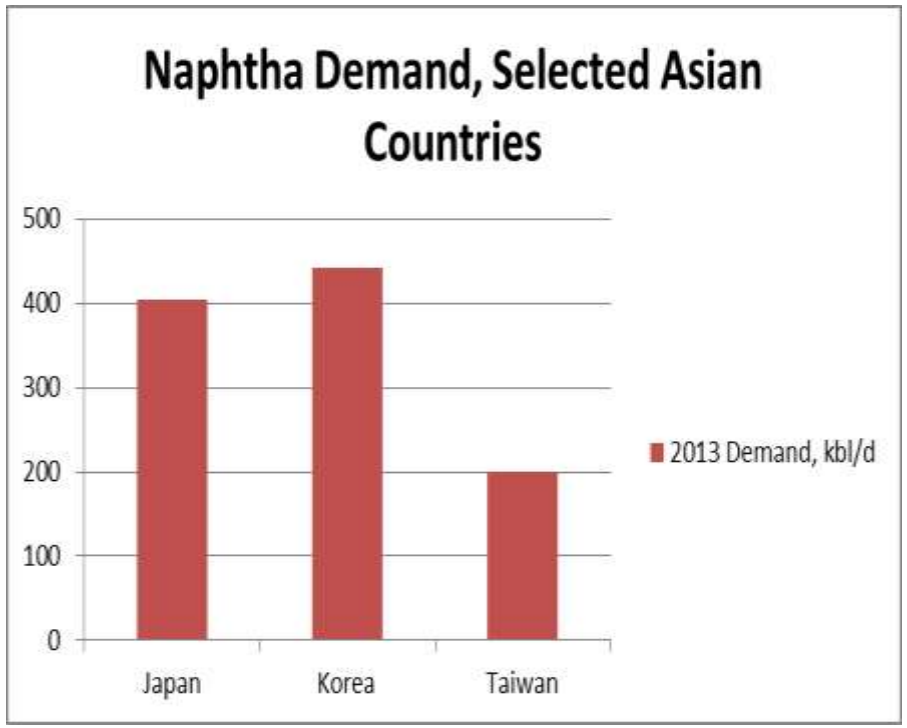
- Naphthas, condensates and natural gasoline can be used as diluents
  - Cochin/Northern Lights pipes
- CAPP estimates
  - About 270 kb/d imports needed in 2014
  - Rising to 500kb/d by 2021



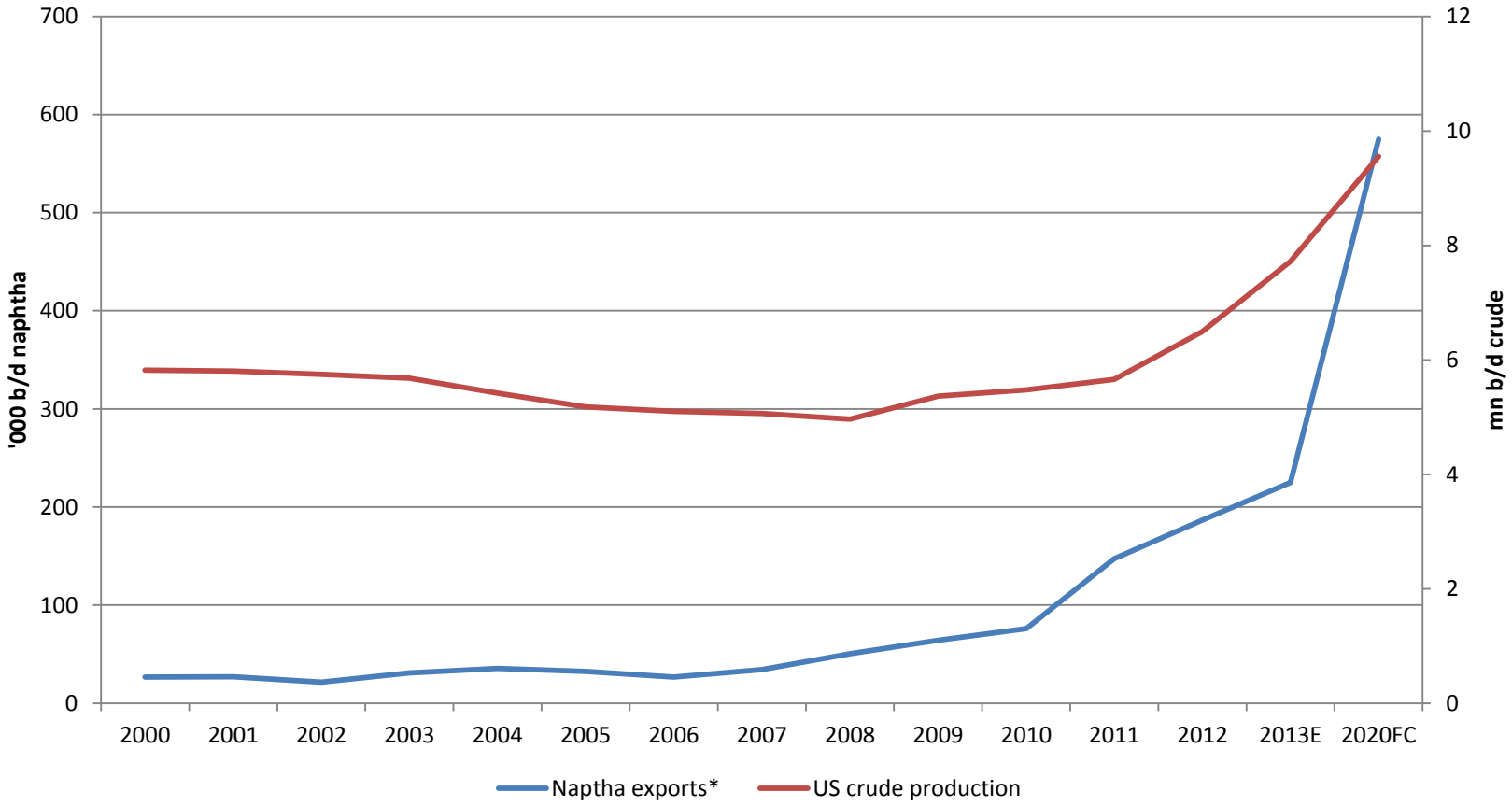
Source: CAPP Outlook and Argus DeWitt

Asia demand for naphtha, selected countries

- Combined, these countries imported more than 1.0 mmbl/d in 2013
- Suppliers
  - Middle East
  - Europe
  - US
- Japan should see falling demand, as petrochemical market is consolidating
- Taiwan could also face pressure in the future



Naphtha exports will track US crude output



Source: Argus DeWitt

Current US naphtha import/export markets

- Imports –
  - from Colombia, Peru, Venezuela, W. Africa and Europe (depending on arbitrage)

- Exports –
  - to Canada, Venezuela and Colombia as diluent;
  - to Mexico as petrochemical feed;
  - recent start of exports to the Asia Pacific for steam cracking.

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Global Naphtha Demand 2013 and 2019/2025

World Naphtha Consumption, 2013 and 2019/2025 Forecast

Region	2013 Consumption MMbl/day	2013 Length/Deficit	2019 Consumption MMbl/day	2019 Length/Deficit	2025 Consumption MMbl/day	2025 Length/Deficit
Americas	0.2	0.3	0.2	0.6	0.2	0.7
Europe	1.1	0.5	1.1	0.3	1.0	0.2
OECD Asia	1.8	(0.9)	1.9	(0.8)	2.0	(0.7)
Non OECD Asia	3.0	0.1	3.7	0.0	4.4	(0.2)
Total	6.1	0.00	6.9	0.05	7.6	0

OCED Asia includes Japan, Korea, Taiwan
Non-OECD Asia includes China and India
Source: IEA, OPEC and Argus Estimates

Based on current forecasts, there will be a slight surplus of naphtha by 2019

Petchem demand shrinking; will expansions help?

- More cheap ethane means lower C5/naphtha runs
- But lower C5 means lower co-products output
- Question:
  - What are the quality specs required by the petchems?

Company	Site	Expansions	New Builds
		2015	>2016
Westlake	Lake Charles, LA	114	
LyondellBasell	Channelview, TX	110	
LyondellBasell	Corpus Christi, TX	380	
CP Chem	Cedar Bayou, TX		1500
Formosa	Point Comfort, TX		1200
ExxonMobil	Baytown, TX		1500
Dow	Freeport, TX		1500
Shell	Northeast US		800-1200
Sasol	Lake Charles, LA		1500
Oxy/Mexichem			500
Aither	Mid Atlantic		300
Appalachian Resins	Mid Atlantic		225
Formosa	Louisiana		1200
Axiall + Lotte	Louisiana		1000

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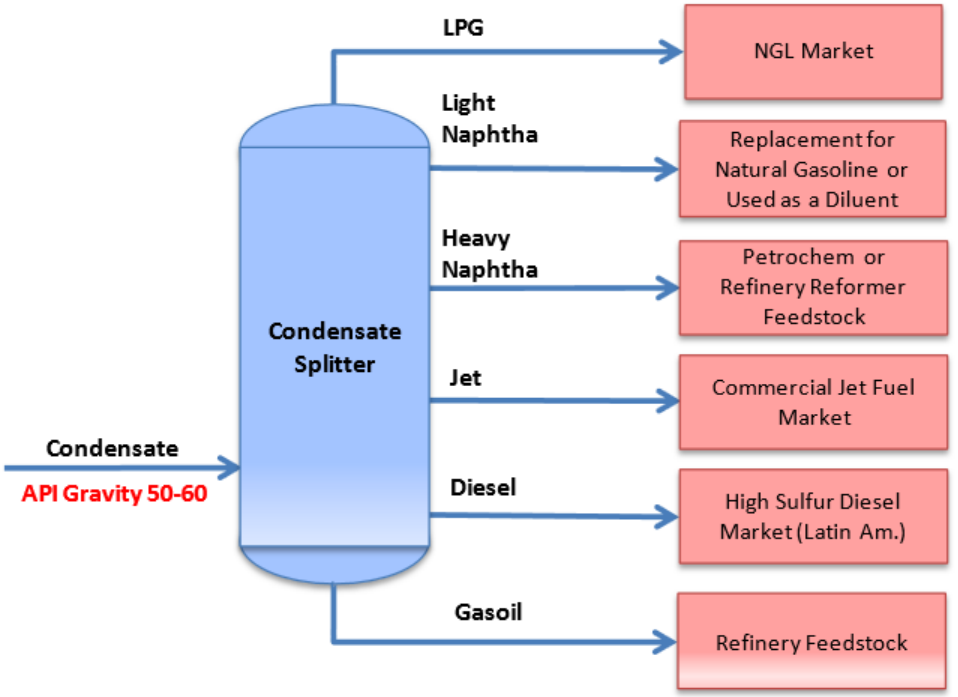
Condensate Exports

Splitters – next step up the processing chain

- Converts to exportable products
- Cost is $50-400mn
- Products are generally "off-spec"
- 30-40pc of yield is naphtha



Source: Magellan Midstream investor presentation 8/20/14

Asia building splitters too

- Asian adding 400kbd to splitter capacity by the end of 2014
  - Two new South Korean splitters
  - One new Singapore splitter
- New Chinese splitter already ramping up
- Korean and Singapore splitters 100pc import dependent

Asia Condensate Splitter Capacity

Country	Company	Capacity kb/d
Japan	JX,Kashima	95
	Taiypo, Kikuma	30
Korea	Samsung, Daesan	80
	Samsung-Total, Daesan	140
	S-Oil, Onsan	80
	SK Energy, Incheon	140
	Lotte, Daesan*	100
China	Sinopec, Tianjin	50
	Dragon Aromatics, Xiamen	90
	PC/Shell,Taizhou*	100
	CNOOC/Shell, Huizhou	80
	Sinopec, Shanghai	50
Singapore	PCS, Bukom	30
	Jurong Aromatics	100
Thailand	PTTAR, MTP	135
Indonesia	TPPI, Tuban	100
Qatar	Ras Laffan	150
	Ras Laffan*	110
Iran	Bandar Abbas	120
UAE	ENOC, Dubai	120
	Total	1900

Source: Argus DeWitt

What Asian markets want

- Feedstock for new splitters built to run on Iranian South Pars condensate
- 50-60 API condensate with some distillate and medium naphtha (capable of producing benzene, toluene and xylene) most desirable
- Supply source diversity
- Likely that early US condensate cargoes will go to refiners; petchems likely to watch quality closely before jumping in

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Any questions?