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Impact of an HF Ban on Southern California Transportation Fuels Supply

prepared by

Stillwater Associates, LLC

Irvine, California, USA

Agenda

1. **Key Points**
2. Regional supply and demand overview
3. Why is alkylation important?
4. Base year supply/demand balances
5. Replacement of current HF Alkylation units
6. Modified operations without alkylation
7. Shutdown of impacted refineries
8. Summary

Key Points

1. Alkylation is an important refining process. CARBOB cannot be produced by SoCal refineries without alkylate
2. Should HF be banned, it appears unlikely that impacted refiners would replace current process units, due to the high cost
3. The impacted refineries are unlikely to be viable without alkylation
4. Should the impacted refineries cease operations, 25% of regional demand would have to be imported
5. With only three fuels refiners left in SoCal, the market will have less competition
6. Offshore refiners will produce the products and ship them half way around the world to the California market
7. As a result, average spot prices could rise 25 cpg or more, and ultimately the California consumer would pay the price

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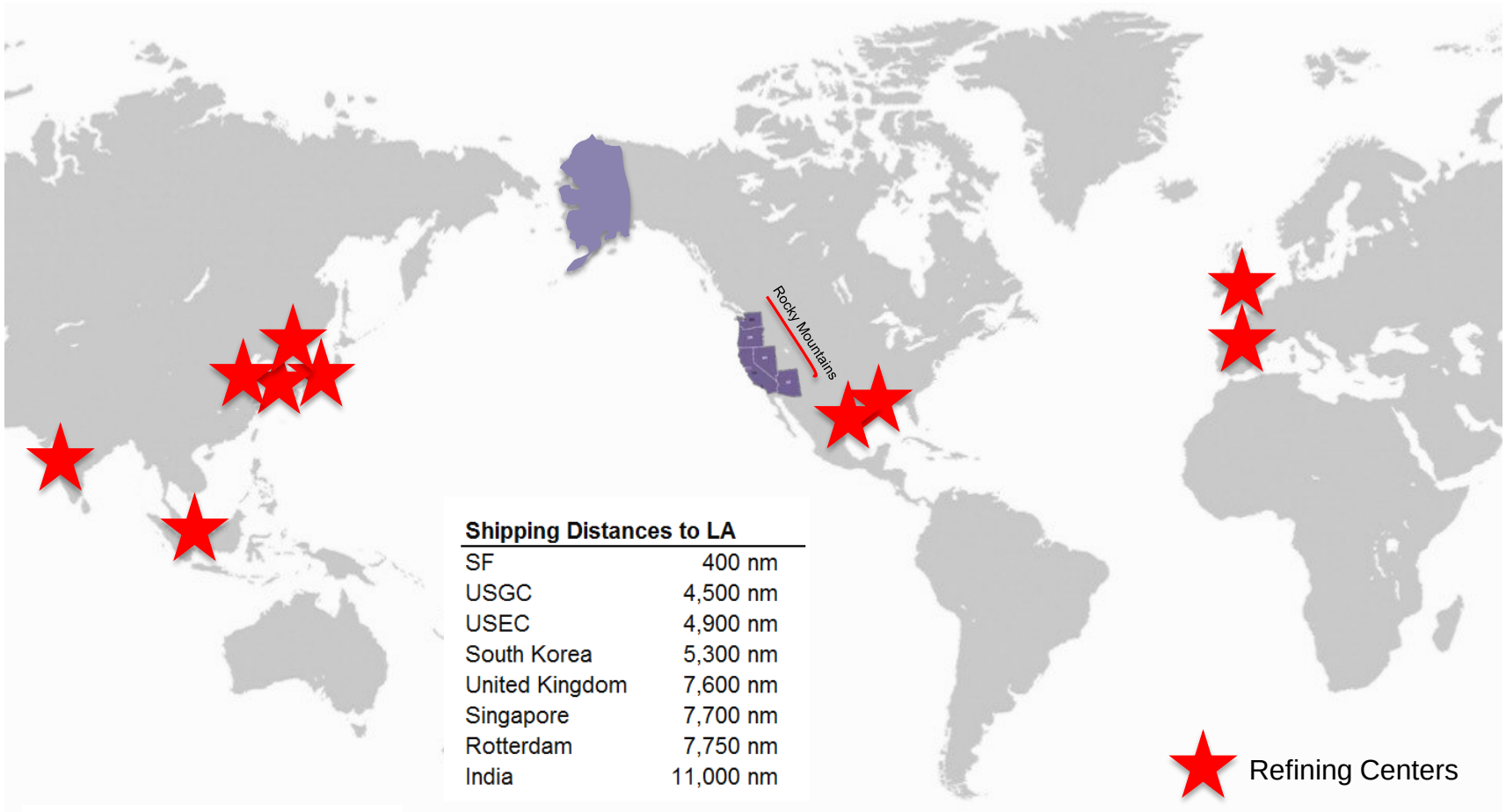
PADD 5 & SoCal market description

1. The Petroleum Administration for Defense District (PADD) 5 is comprised of Arizona, California, Nevada, Oregon, Washington Alaska and Hawaii
2. PADD 5 is comprised of three supply regions characterized by a concentration of refineries, including SoCal, Northern California and the Pacific Northwest
3. Generally, production from the PNW and NoCal regions supplement production in SoCal
4. The gasoline producing refineries in California are highly sophisticated full conversion facilities
5. California refiners have made sizable investments to convert California crude into clean transportation fuels, while complying with stringent California environmental standards

Bounded by the Pacific and Rocky Mountains…



Shipping Distances to LA	
SF	400 nm
USGC	4,500 nm
USEC	4,900 nm
South Korea	5,300 nm
United Kingdom	7,600 nm
Singapore	7,700 nm
Rotterdam	7,750 nm
India	11,000 nm

Source: Stillwater analysis

PADD 5 is geographically isolated from the rest of the US and the world

PADD 5's refining centers are not interconnected

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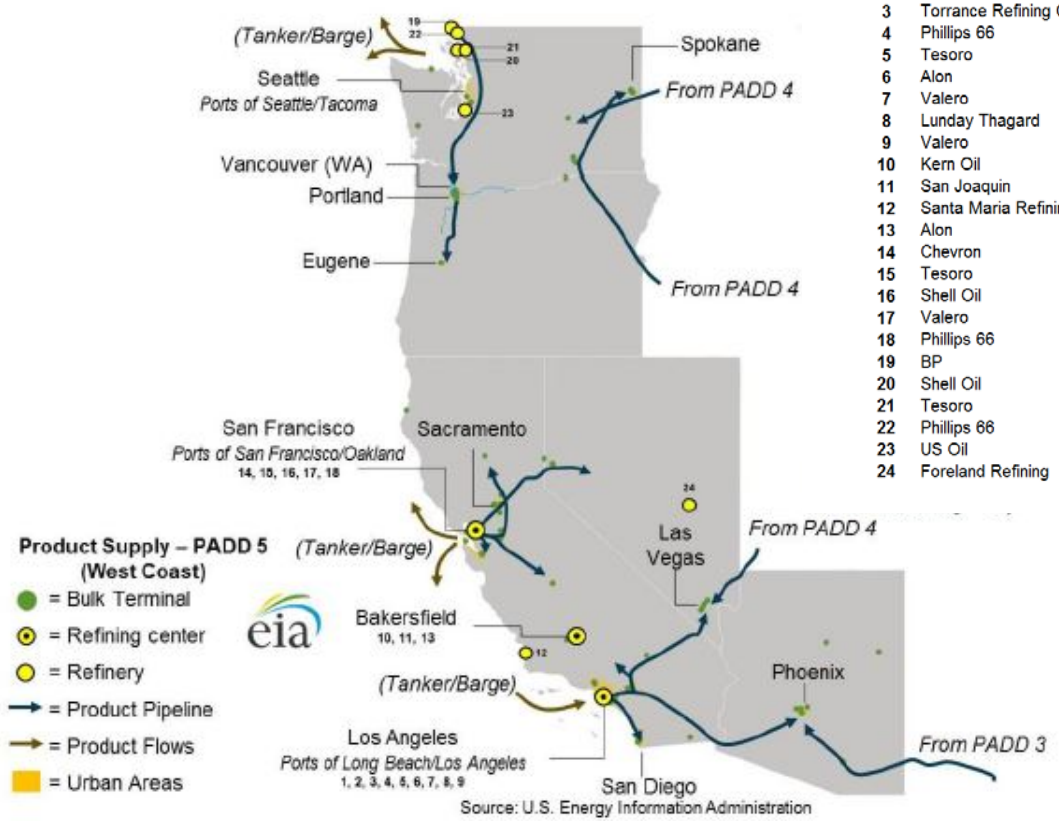
Figure 5. PADD 5 mainland refineries and product flows

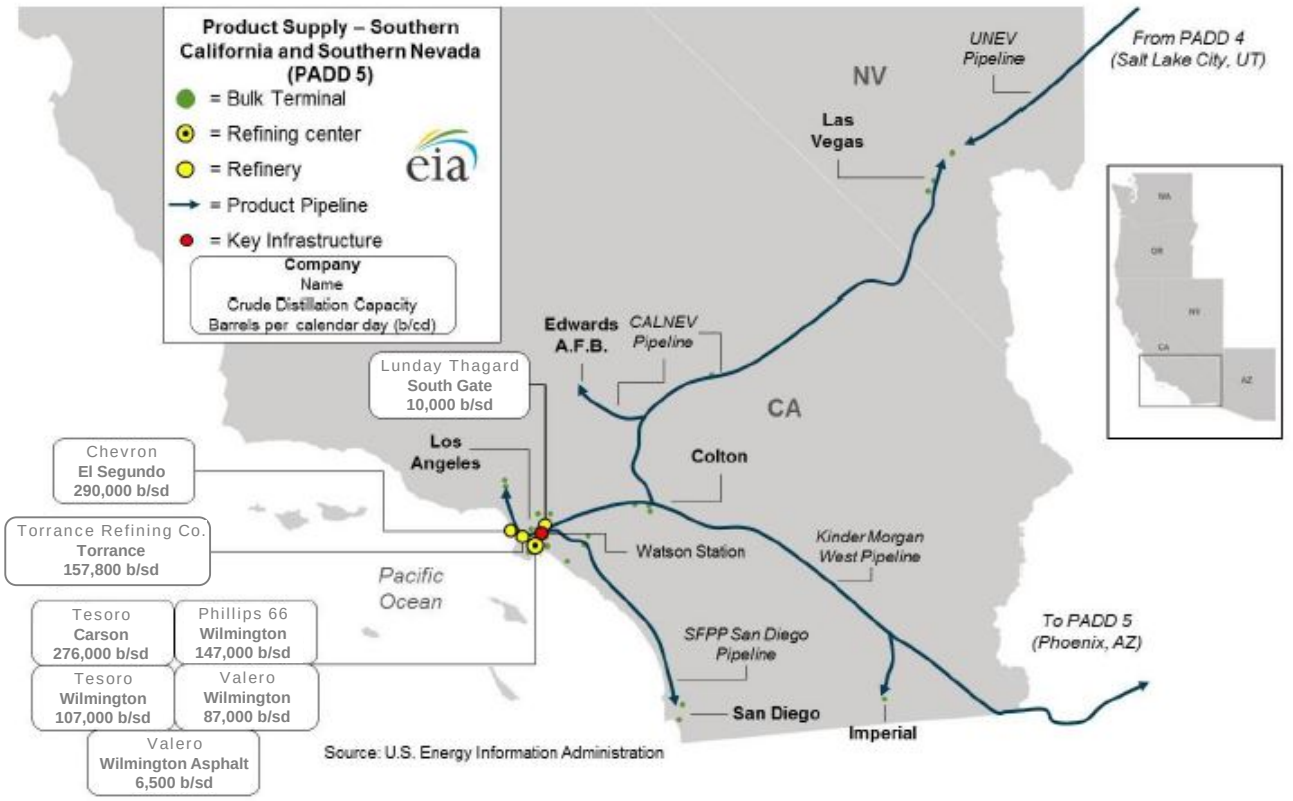


Source: U.S. Energy Information Administration

Num	Corporation	Site Name	Capacity B/SD
1	Chevron	El Seguno	290,000
2	Tesoro	Carson	276,000
3	Torrance Refining Co.	Torrance	157,800
4	Phillips 66	Wilmington	147,000
5	Tesoro	Wilmington	107,000
6	Alon	Paramount	100
7	Valero	Wilmington	87,000
8	Lunday Thagard	South Gate	10,000
9	Valero	Wilmington	6,500
10	Kern Oil	Bakersfield	27,000
11	San Joaquin	Bakersfield	25,000
12	Santa Maria Refining	Santa Maria	10,000
13	Alon	Bakerfield	0
14	Chevron	Richmond	257,200
15	Tesoro	Martinez	170,000
16	Shell Oil	Martinez	158,000
17	Valero	Benecia	145,000
18	Phillips 66	Rodeo	128,000
19	BP	Ferndale	236,000
20	Shell Oil	Anacortes	149,000
21	Tesoro	Anacortes	125,000
22	Phillips 66	Ferndale	107,500
23	US Oil	Tacoma	42,000
24	Foreland Refining	Ely	5,000

The SoCal supply region has 6 fuels refineries…

Figure 9. Southern California and Southern Nevada refineries and petroleum product flows



… supplying transportation fuels to SoCal, Las Vegas and Phoenix

CA product specs are the most stringent in the world…

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1. The table below shows several gasoline standards with key properties
2. California's low olefin, benzene, aromatics and distillation characteristics are difficult to meet by refineries that are not designed to produce the CARB specification
3. California also has unique diesel specifications that exceed the quality of diesel across much of the world

Selected Gasoline Properties	Summer RVP	Ethanol	Oxygenate	Sulfur Content	Olefins	Benzene (1)	Aromatics	Regular Grade Octane	Distillation	
	psi	vol%	type	ppmw	vol%	vol%	Vol%	(R+M)/2	T(°F)@50%	T(°F)@90%
CARB Gasoline (flat spec)	6.9	10.0%	ethanol only	10	6.0%	0.6%	25.0%	87	213	305
US Conventional (2015 average)	9.13	9.5%	ethanol only	30	na	0.6%	21.3%	87	na	na
Euro V	8.7	allowed	alcohols & ethers	10	18.0%	1.0%	35.0%	90	na	na
China V	9.5		MTBE & ethanol	10	25.0%	1.0%	40.0%	84	na	na
India Bharat IV	8.7		ethanol	50	21.0%	1.0%	35.0%	86	na	na
(1) US requires an annual average of 0.62% by supplier										

Source: Stillwater research

…further increasing California's isolation

Due to its isolation, PADD 5 is exposed to product shortages

1. When a product like gasoline has more demand than can be locally supplied, it is deemed “short”
   a. When “short” the price needs to be high enough to attract product from other areas to fulfill the short position
   b. Depending on the magnitude of the “short”, the most attractive product available may be exhausted causing product from more distant and costlier sources to fulfill the “short”
2. California’s unique gasoline and diesel specifications limit the potential sources of gasoline and diesel
   a. The refineries in the world that can produce a CARB spec gasoline are limited
3. We have seen an example of the difficulty of supplying the “short” in California when the Torrance refinery was down for an extended period

California is short when unplanned refinery outages occur- when the outages are planned, refiners prepare their supply chain for the outage

PADD V Net Gasoline Imports (KB/month)

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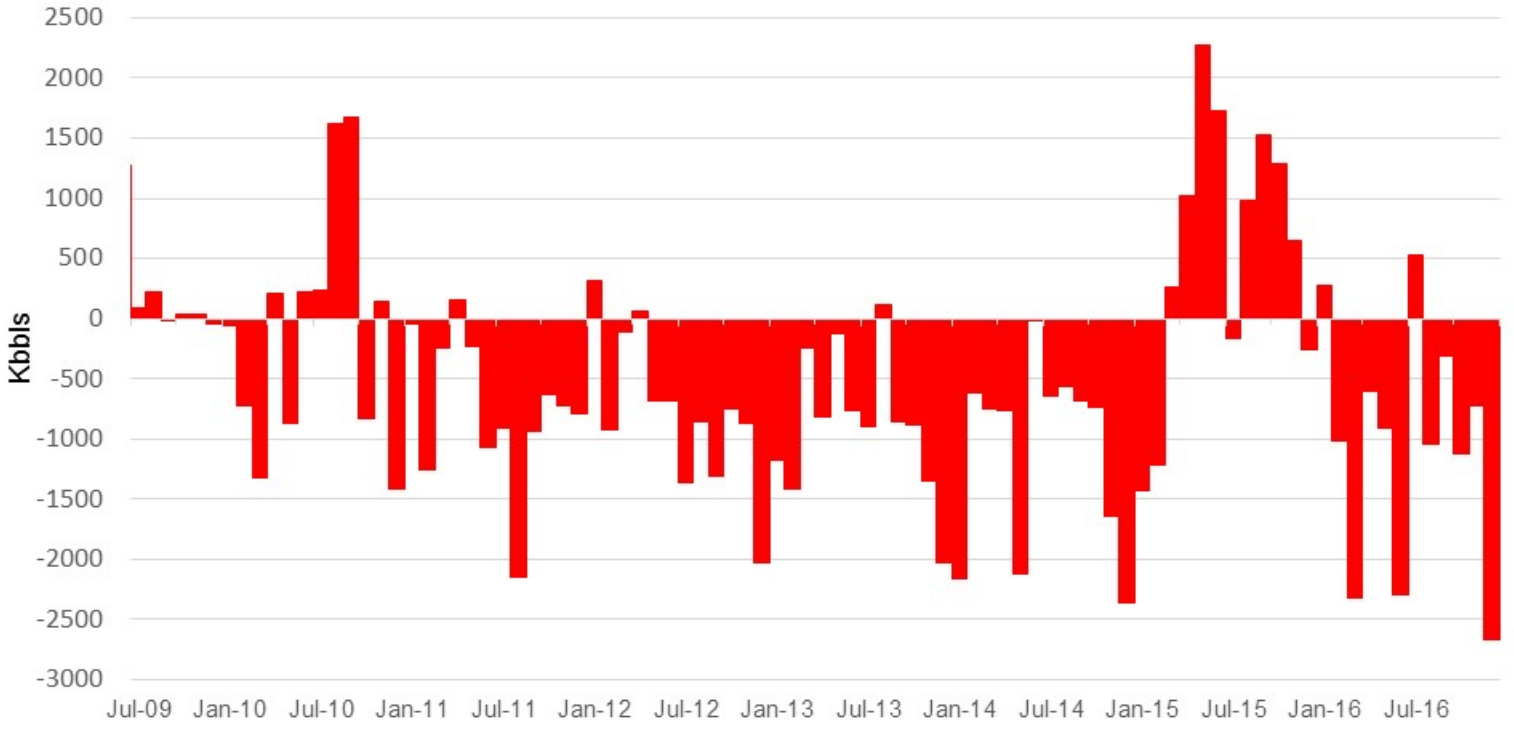

Source Stillwater analysis, EIA data

PADD 5 shifted from an exporter of gasoline in 2014, to an importer in 2015, coincident with unplanned refinery outages

Where have imports to SoCal come from?

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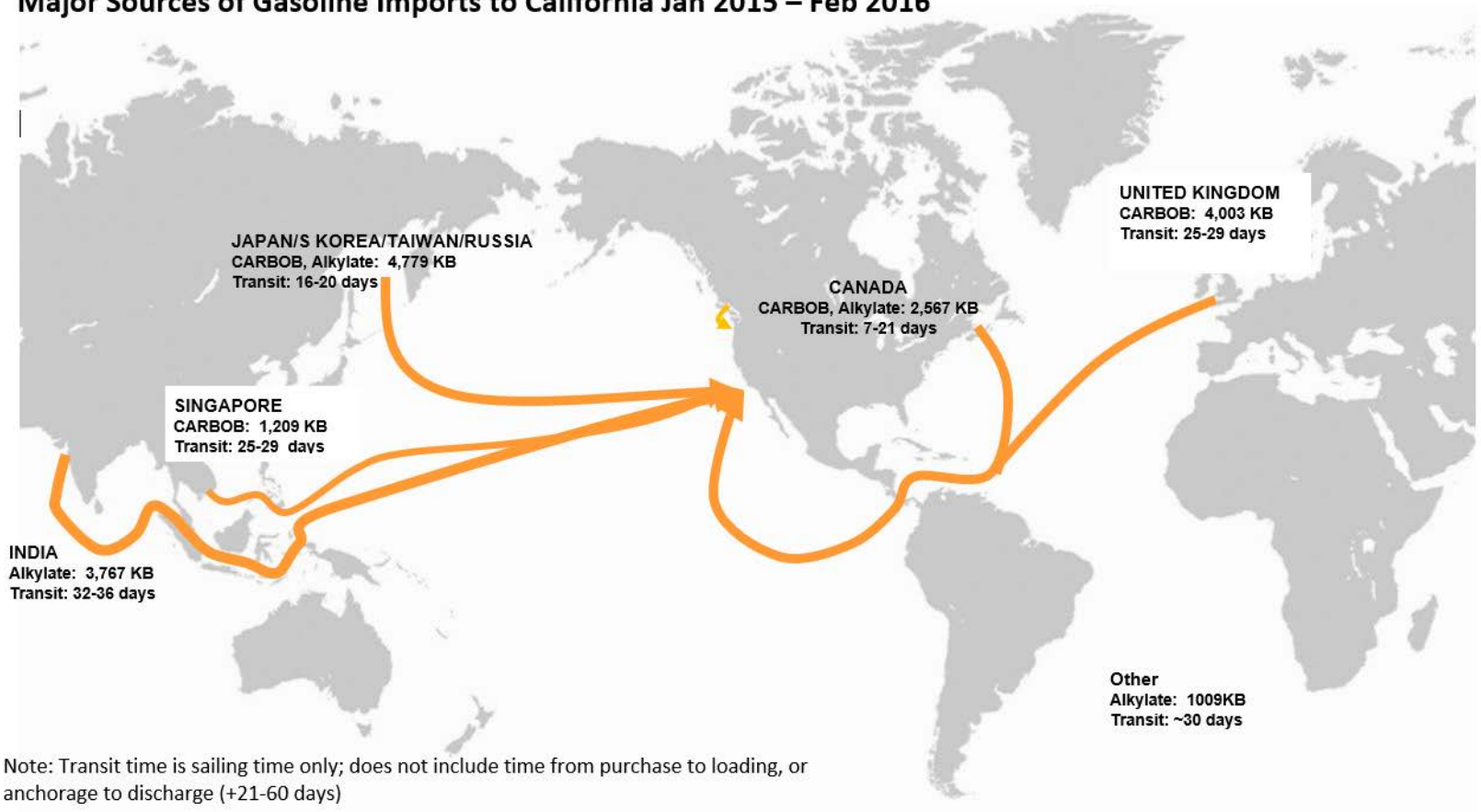
Major Sources of Gasoline Imports to California Jan 2015 – Feb 2016

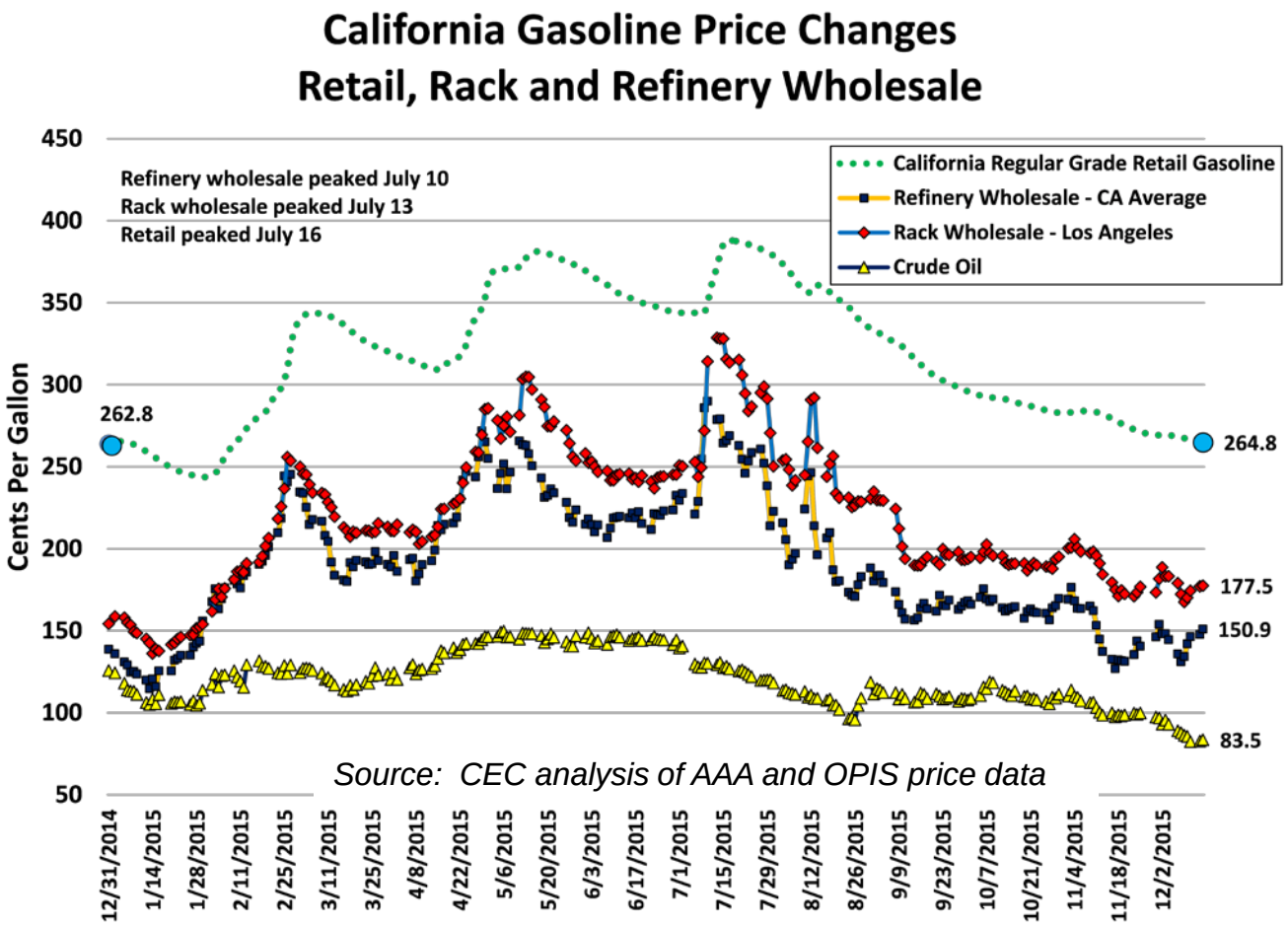


Note: Transit time is sailing time only; does not include time from purchase to loading, or anchorage to discharge (+21-60 days)

Source: Stillwater analysis

The time for these supplies to be shipped to SoCal was 30-60 days

The gasoline market reacts to unplanned changes in supply



Source: CEC analysis of AAA and OPIS price data

The shortage of PADD V gasoline that began in February 2015 was met by imports, and drove spot, rack and retail prices up

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First, a little organic chemistry…

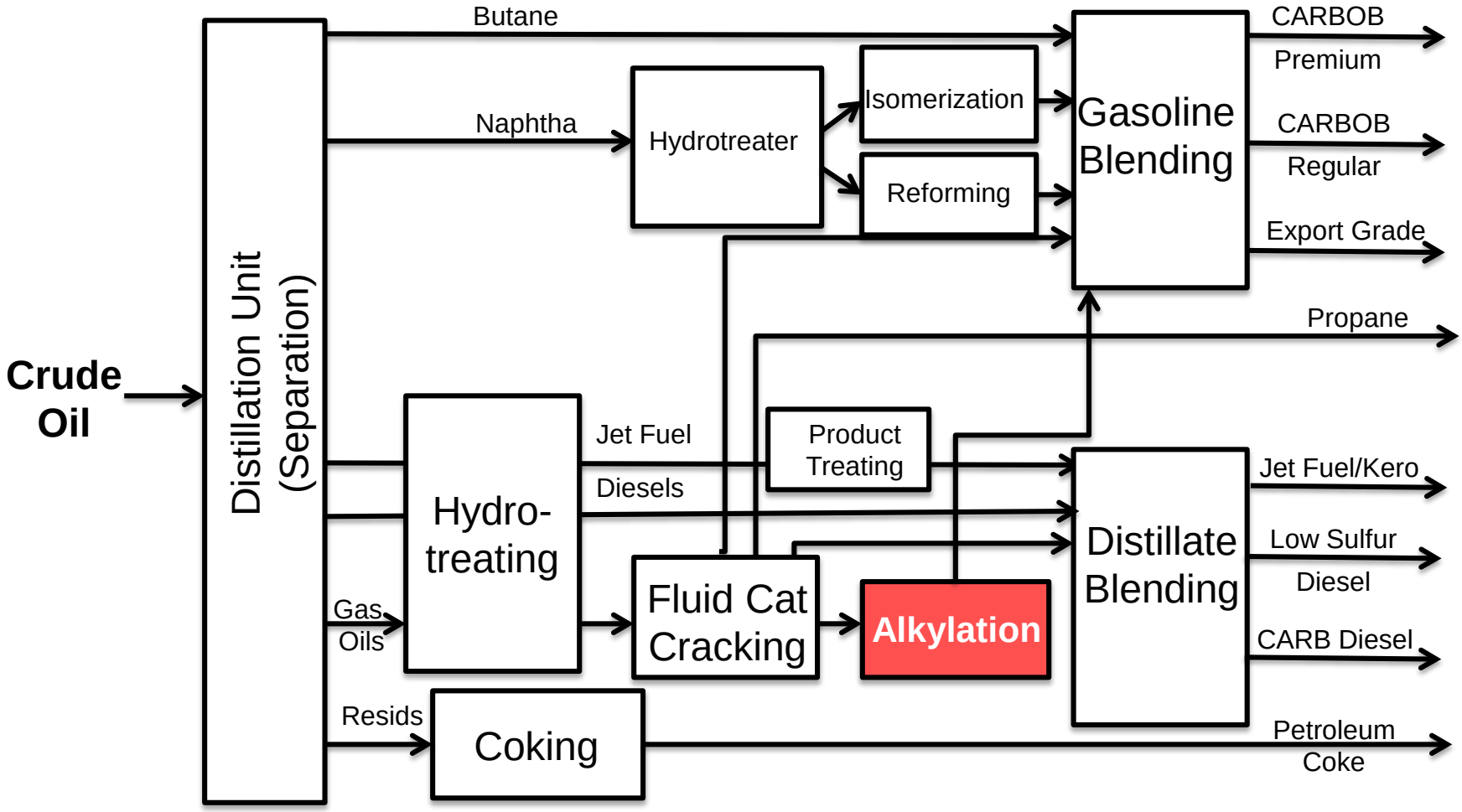
Hydrocarbon	Carbon Count	Use
Methane	1	Natural Gas
Ethane	2	Natural Gas/Chemicals
Propane	3	Heating
Propylene	3	Alkylation Feedstock
Butane	4	Gasoline/Heating
Butylene	4	Alkylation Feedstock
Pentane	5	Gasoline
Hexane	6	Gasoline
Octane	8	Gasoline

The three and four carbon molecules are important to alkylation

Fuels are defined by the size of their molecules

Fuel	Carbon Count Range
Natural Gas	C1 & C2
Liquified Petroleum Gas (LPG)	C3 & C4
Gasoline	C4 - C10
Jet Fuel & Kerosene	C11 - C15
Diesel & Heating Oil	C16 - C22
Fuel Oil & Asphalt	greater than C22

The first thing a refinery does is separate hydrocarbon molecules by their size

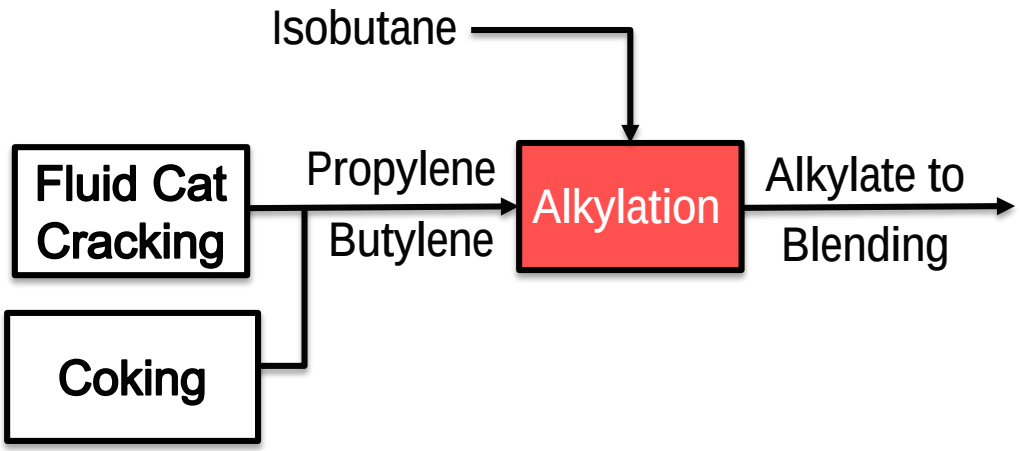


Then the refinery upgrades, cracks, and recombines the molecules

Alkylation is an essential refinery process…

…that converts low valued propylene and butylene from catalytic cracking and coking into a high octane, clean gasoline blending component

- The process combines isobutane with the mixture of propylene and butylene (commonly referred to as olefins) in the presence of a strong acid catalyst such as hydrofluoric or sulfuric acid to initiate the reaction



Refinery propylene and butylene have limited markets on the West Coast

Alkylate – The Essential California Gasoline Blend Stock

Stillwater Associates LLC

1. The table below shows the typical properties of various refinery produced gasoline blending components
2. The red numbers show the problematic properties of the various blending components for blending CARB gasoline
3. All alkylate blending properties exceed the specifications of CARB gasoline and its high octane make it indispensable for blending the other components to specification

	RVP	Sulfur	Olefins	Benzene	Aromatics	Road Octane	Distillation, deg F	
Blending Component	**psi**	**ppmw**	**vol%**	**vol%**	**Vol%**	**RdON**	**50%**	**90%**
Butane	52.0	1	0.0	0.0	0.0	91.7		
Lt Gasoline (Treated)	8.3	1	0.1	0.5	0.5	77.0	118	156
Hvy Naphtha (Treated)	2.0	1	0.1	0.1	8.0	68.8	241	280
Reformate	2.5	1	0.0	1.5	57.2	89.5	272	337
Lt FCC Gasoline	7.0	15	18.0	1.0	23.0	87.0	203	305
Hvy FCC Gasoline	0.5	50	2.2	0.0	80.0	92.6	365	405
Alkylate	**5.0**	**2**	**1.0**	**0.0**	**0.0**	**90.2**	**211**	**305**
CaRBOB Reg.(Summer)	5.85	10	10	0.5	17	83.2	220	330
CaRBOB Prem. (Summer)	5.85	10	10	0.5	17	87.9	220	330

Source: Stillwater analysis

SoCal refineries cannot blend CARBOB without alkylate

Alkylation Capacity in the LA Basin

Stillwater Associates LLC

1. Total Alkylation capacity for the 6 major LA Basin refineries is 124 KB/SD
2. Four refineries use sulfuric acid (H2SO4) alkylation technology totaling 78 KB/SD
3. Two refineries utilize hydrofluoric acid (HF) alkylation technology totaling 46 KB/SD

SoCal Fuels Refinery Capacities[1]

Company	Location	Crude KB/SD	Coker KB/SD	FCC KB/SD	Alklation, KB/SD	
					H2SO4	HF
Chevron	El Segundo	290.0	74.7	73.8	32.2	
Torrance Refining	Torrance	157.8	53.0	87.8		24.2
Phillps 66	Wilmington	147.0	53.2	51.6	16.0	
Tesoro	Carson	276.0	67.1	102.5	17.0	
	Wilmington	107.0	42.0	35.0	12.5	
Valero	Wilmington	87.0	28.8	56.3		22.0

[1] Excludes Valero (Wilmington) and Lunday Thagard (South Gate) asphalt refineries.

Source: Stillwater analysis, EIA 2016 Refinery Capacity Survey data

Torrance Refining Co. and Valero refineries would be impacted by a ban on use of HF

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PADD 5 supply/demand in 2014 was “stable”

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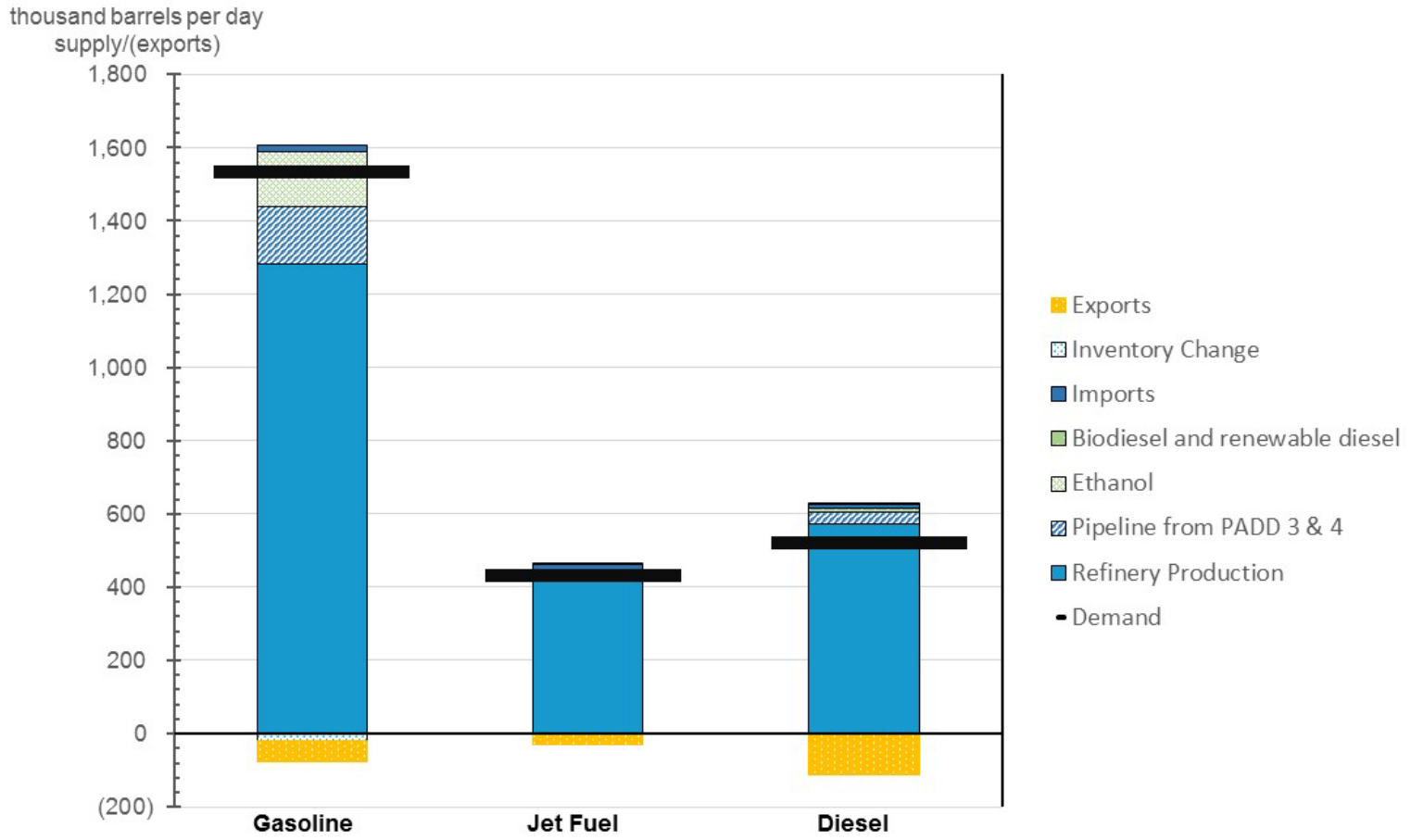
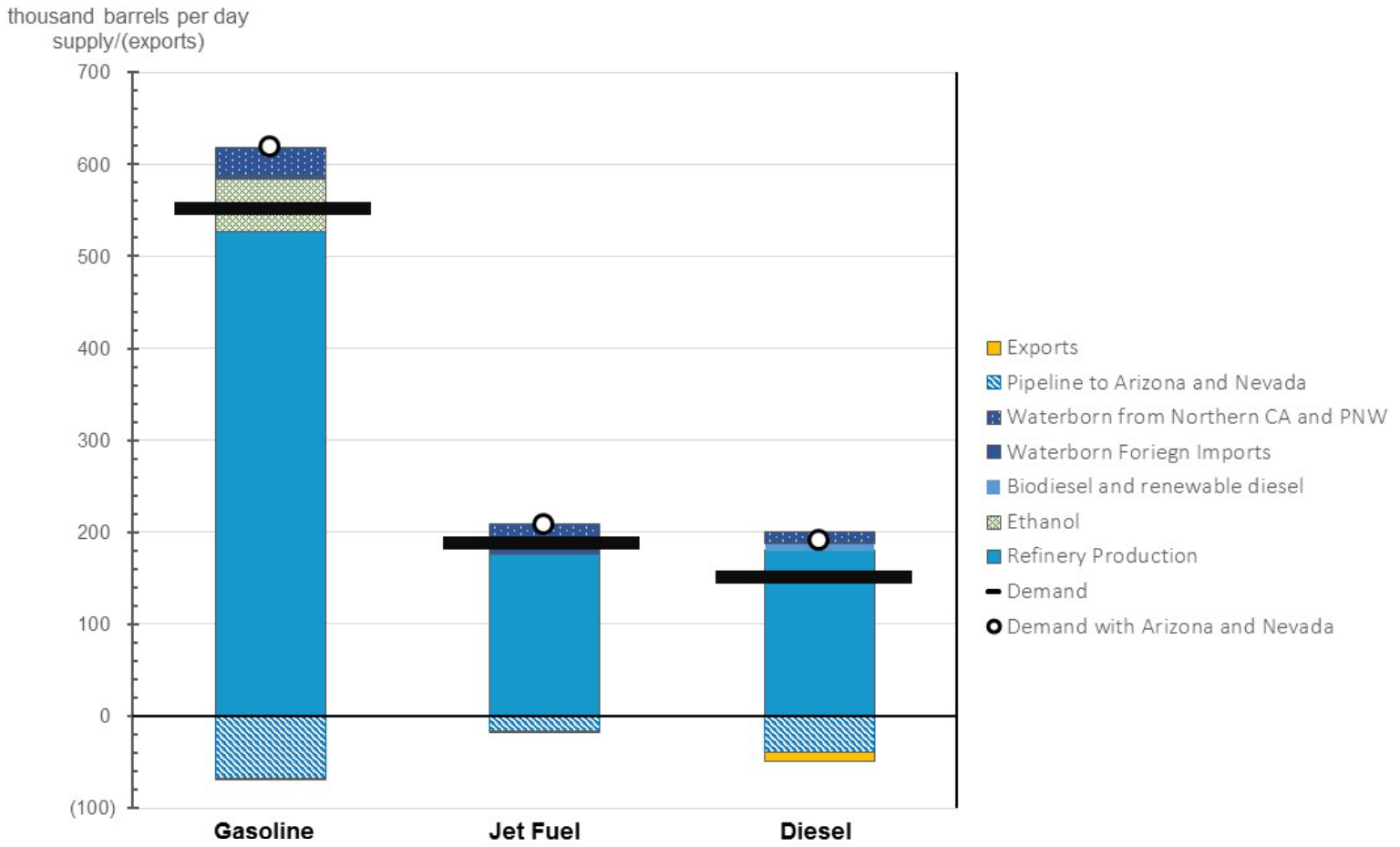


Source: Stillwater analysis, EIA data

Because of its isolation, PADD 5 is an effectively self sufficient supply/ demand region with enough extra capability to cover minor disruptions

SoCal supply/demand in 2014 was also “stable”

Stillwater Associates LLC



Source: Stillwater analysis

SoCal depends on Northern California and the PNW to meet the demand for gasoline plus imports to meet the demand for jet

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Hydrofluoric (HF) Alkylation Replacement Overview

Stillwater Associates LLC

1. Estimated cost to replace the two HF alkylation units with Sulfuric Acid alkylation and on-site acid regeneration facilities is in the range of $1.8 billion (1) for both refineries
2. Replacement with Sulfuric Acid alkylation would have little effect on the overall SoCal supply and demand balance
3. Refiners would see somewhat higher operating costs
4. With other capital intensive environmental mandates on the horizon, such as NOx shave and various GHG reduction initiatives, it is unlikely that the impacted refiners would opt to make an investment of this size

(1) Source: Burns & McDonnell "Report Brief Alkylation Study & Estimate" June 2017, TORC data, Stillwater analysis

Replacement of HF alkylation with Sulfuric acid technology appears to be cost prohibitive

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Refinery Operation Without Alkylation

1. Alkylation feedstock would have to be removed from the impacted refinery by truck or rail and sent to other markets, most likely the US Gulf Coast
2. Truck and rail volume out of the refineries is limited, so production of feedstocks must be reduced down to the loading capacity
3. FCC throughput reductions to minimum sustainable rates would be necessary to accomplish this
4. Lower crude runs and reduced FCC feedstock purchases are needed to operate at minimum FCC rates
5. Imported alkylate would be needed to facilitate blending the remaining refinery produced gasoline stocks to California grade specifications

As a result, production of California grade gasoline, jet fuel and diesel are reduced

Refinery input would be reduced by 27% with alky shutdowns

Stillwater Associates LLC

1. Impacted refineries would be limited by Alky Feed loading capacity
2. Modified operation reflects 21 KBD of Alky Feed outhauls
3. Finished gasoline production will be 55 KBD lower, assuming 16 KBD of alkylate can be imported
4. Jet fuel and diesel production will be 6 KB/D and 15 KBD lower, respectively

Thousand Barrels /Day	Base	Alky Shutdown	Net Change
Refinery Input			
Crude - Domestic	140	140	0
Crude - Foreign	60	10	(50)
Imported FCC Feed	32	13	(19)
Imported Alkylate	1	17	16
LPG/Other	17	3	(14)
Total Input	**250**	**183**	**(67)**
Refinery Production			
Alky Feed	0	21	21
Gasoline	153	98	(55)
Jet Fuel	26	20	(6)
Diesel	46	31	(15)
LPG/Other	12	6	(6)
Total Liquid Products	**237**	**176**	**(61)**
Memo: Total G+J+D	**225**	**149**	**(76)**
Key Unit Rates			
Coker	51	38	(13)
HDC	20	17	(3)
FCC	126	71	(55)
Alky	39	0	(39)

Source: Stillwater analysis

Alky shut down would adversely affect refinery viability…

Stillwater Associates LLC

1. Two major economic impacts for shutting down the alkylation units come from reduced utilization of the refineries and loss of alkylation upgrading capability
2. Refinery crude runs are reduced while refinery fixed operating costs (personnel, maintenance, insurance, etc.) remain relatively unchanged, resulting in lost gross margin
3. The alkylation unit is extremely valuable to the refinery as it converts low value alkylation feedstock into high value, clean gasoline blending component required to make CARB gasoline

Lower refinery throughput and loss of alkylation unit uplift make it unlikely that these refineries would remain viable

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If the impacted refineries shut down:

1. Prices in SoCal have to increase to incentivize foreign and USGC refiners to produce and dedicate product for the California market
2. Availability of domestic and foreign sourced CARB gasoline to replace all of the lost production is uncertain
3. Limited SoCal logistics infrastructure for importing the products could result in routine system-wide supply disruptions
4. Increase in the concentration of suppliers to the SoCal market as gasoline refiners are reduced from five to three
5. NoCal refineries may not be able to respond if their potential expansion is limited by proposed regulation from BAAQMD

…increasing risks of supply disruptions and associated price spikes

Refinery shutdowns would result in lost production…

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1. Loss of 225 KBD of G+D production represents about 25% of regional demand
2. Finished gasoline production will be 153 KBD lower and require foreign imports
3. Jet fuel production will be 26 KBD lower and require foreign imports
4. Diesel production will be 46 KBD lower and require some foreign imports
5. Estimate 140 KBD of domestic crude production will need to find a new home

Thousand Barrels /Day	Base	Refinery Shutdown	Net Change
Refinery Input			
Crude - Domestic	140	0	(140)
Crude - Foreign	60	0	(60)
Imported FCC Feed	32	0	(32)
Imported Alkylate	1	0	(1)
LPG/Other	17	0	(17)
Total Input	**250**	**0**	**(250)**
Refinery Production			
Alky Feed	0	0	0
Gasoline	153	0	(153)
Jet Fuel	26	0	(26)
Diesel	46	0	(46)
LPG/Other	12	0	(12)
Total Liquid Products	**237**	**0**	**(237)**
Memo: Total G+J+D	**225**	**0**	**(225)**

Source: Stillwater analysis

…that would have to be replaced with imports from around the world

Foreign imports of gasoline, jet fuel and diesel will increase

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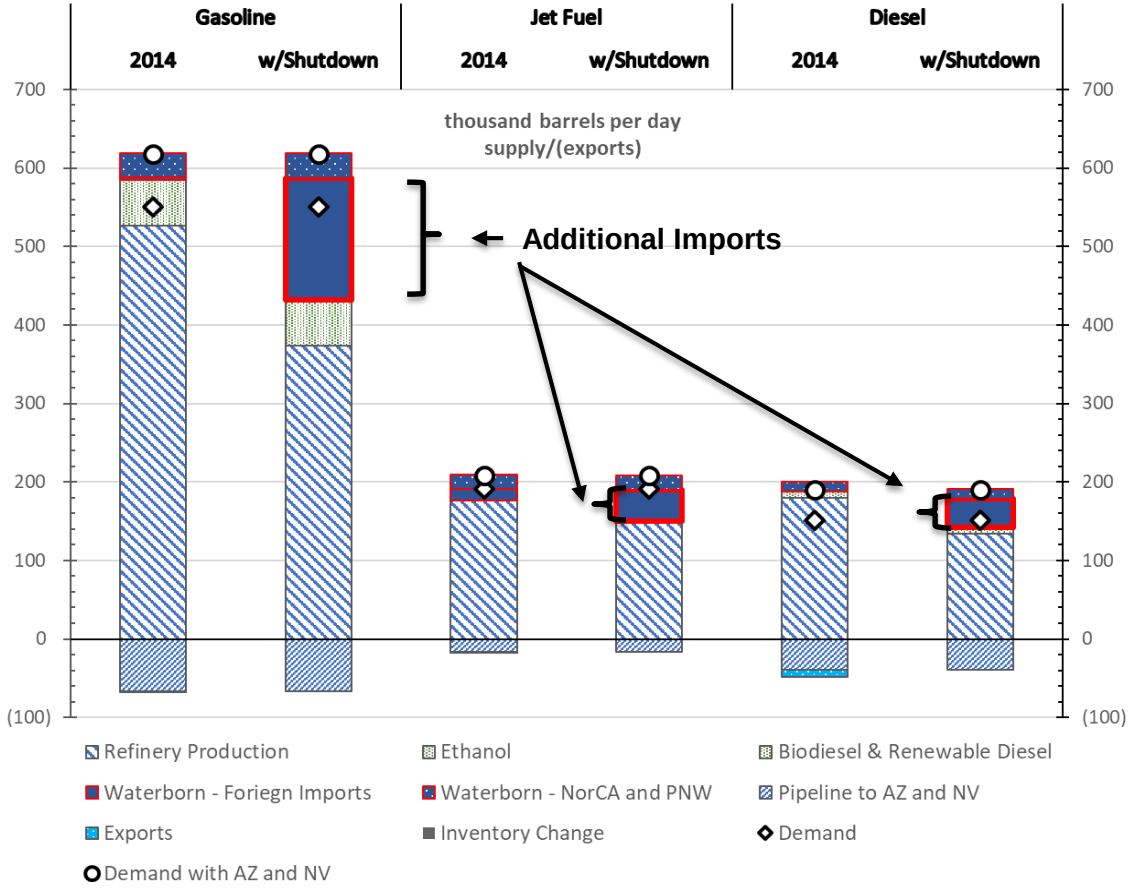

Source: Stillwater analysis

To meet demand for LA, Santa Barbara, San Diego, Las Vegas and Phoenix

Marine traffic in Greater LA will increase

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1. There are 13 liquid bulk marine facilities in the Port of Los Angeles (POLA), Port of Long Beach (POLB) and Chevron El Segundo, but only 8 that handle clean products
2. These terminals have 14 berths where vessels can be moored for unloading gasoline, jet fuel and diesel
3. Chevron and Tesoro facilities have the only deep water berths that allow vessel sizes greater than 80,000 DWT
4. The remaining terminals are generally limited to small long range (LR1) tankers less than 80,000 DWT. However, most vessel calls at these terminals are medium range (MR) sized tankers in the range of 25-50,000 DWT, ocean-going tug barges up to 180 KB capacity, and local harbor barges making small deliveries
5. Approximately 2/3 of the shore tank capacity in POLA and POLB harbors is owned by four refiners (Phillips 66, Valero, Torrance Refining Co., and Tesoro)

Imports would be manageable through POLA/POLB

Stillwater Associates LLC

1. The Torrance Refining Co. and Valero terminal facilities remain in operation and investments are made to connect them into the pipeline distribution system. Assuming berth utilization rates in the mid-30%, these two facilities could handle approximately 50% of the required imports if properly configured
2. The Shell terminal facilities are assumed to handle approximately 30% of the imports and the remaining 20% distributed between the Phillips 66 and Tesoro facilities
3. Kinder Morgan current marine volumes are assumed to be routed through the ChemOil berth facilities. The Kinder Morgan terminal facilities are due to be shutdown and remediated in the future

Projected	Chevron	Kinder Morgan	Phillips 66	Nustar Energy	Valero	Shell Oil	Vopak Terminal	TORC	Chemoil	Petro Diamond	Tesoro T78	Tesoro T84	Tesoro T121
Cargo Volume, KBbls													
Gasoline	2,102	0	8,794	0	6,570	25,433	0	16,425	2,723	32	9,367	964	0
Jet Fuel	1,237	0	0	0	0	12,046	2,493	0	3,988	0	1,420	0	0
Diesel	1,644	0	2,339	0	10,950	393	395	5,840	1,398	0	2,653	645	0
Other Clean	1,235	0	209	240	0	0	285	0	350	0	614	306	0
Dirty	9,502	0	3,964	859	0	0	20,162	0	17,792	0	6,649	5,239	0
Crude	57,577	0	0	0	0	0	192	0	0	0	4,398	22,463	104,521
Tanker Calls	220	0	31	3	19	13	75	0	122	0	94	116	206
Barge Calls	26	0	172	17	61	55	819	0	675	1	76	79	0
Total Vessel Calls	246	0	203	20	80	68	894	0	797	1	170	195	206
Berth Utilization	34%	S/D	24%	4%	31%	33%	88%	36%	85%	0%	16%	19%	46%

Source: Stillwater analysis. State Lands Commission data

Terminal capacity is concentrated with the remaining 3 fuels refiners

Product supply for California will shift offshore…

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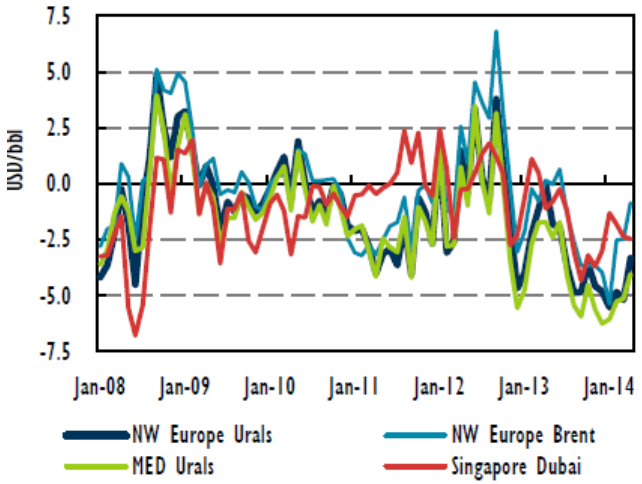
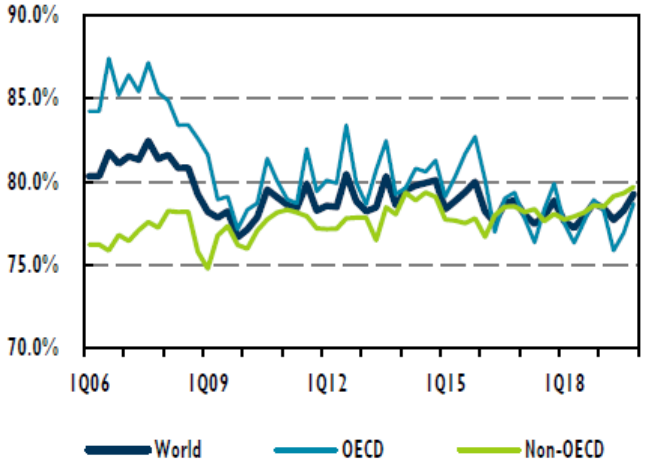
1. California refineries are cleaner and more efficient than refineries around the world. They have been specifically designed to make California products
2. Roughly 300 KBD of additional crude runs will be required elsewhere in the world to replace the products lost from the shutdown of the two refineries- the barrels of crude run will be refined in a much less efficient mode to produce CA-grade products, and then transported half way around to world to the CA market
3. CA spot product prices will increase considerably

Benchmark Simple Refinery Margins



Refinery Utilization

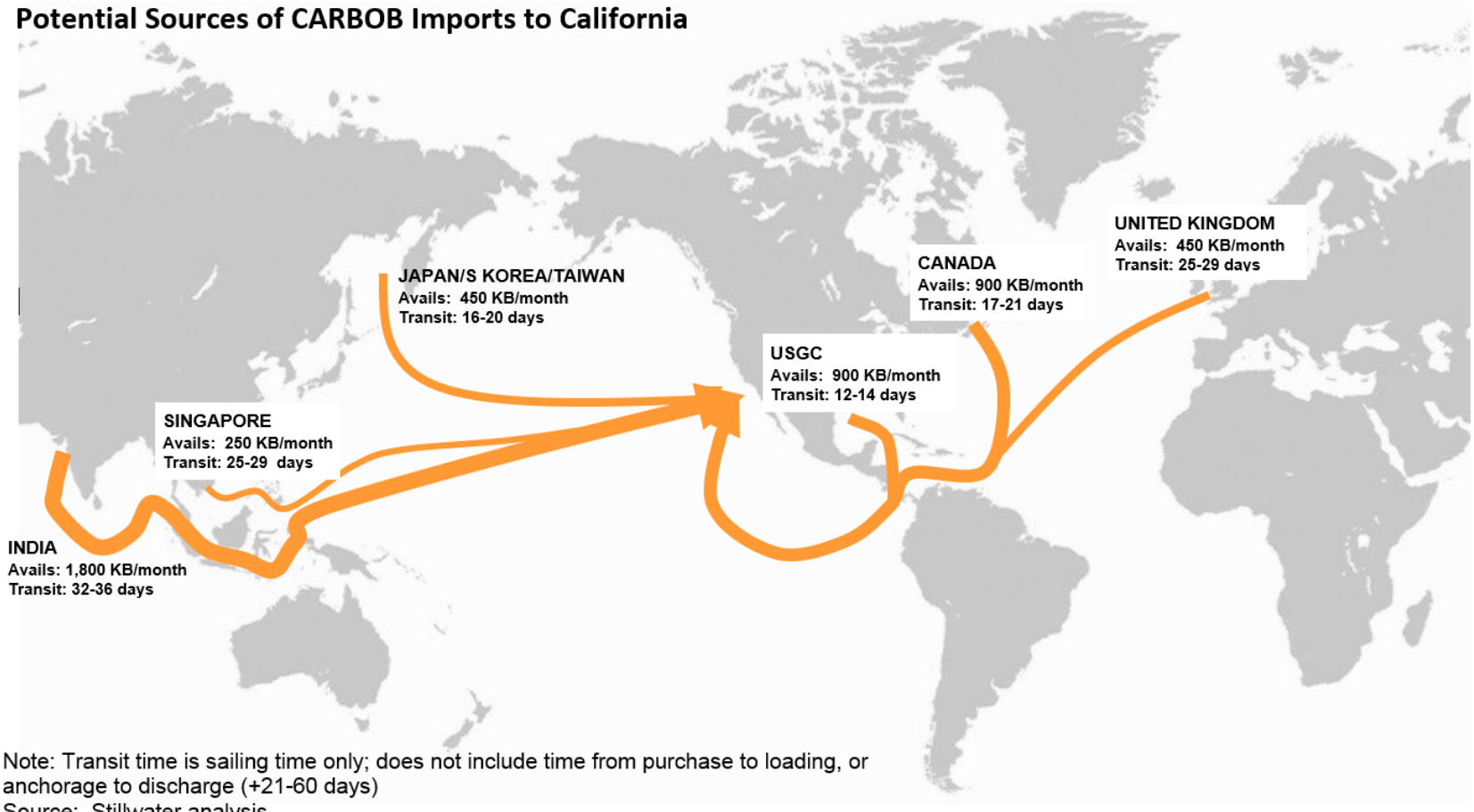


Source: EIA analysis

…raising greenhouse gas and criteria pollutant emissions worldwide

And supply lines will be extremely long…

Stillwater Associates LLC



Note: Transit time is sailing time only; does not include time from purchase to loading, or anchorage to discharge (+21-60 days)
Source: Stillwater analysis

Source: Stillwater analysis

…exposing the SoCal supply system to delays and disruptions

The California consumer will pay the price…

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1. If reinvestment or operation without alkylation are not economically viable options, then impacted refineries are more likely to cease operations should HF use be banned
2. The considerable loss in gasoline, jet fuel, and diesel supply in PADD V would shift the market from excess production to a shortfall, especially in gasoline
3. The resulting effect on spot, wholesale, and retail gasoline sales in California would conservatively increase gasoline prices by 25 cents per gallon (cpg)
4. We estimate that other environmental mandates, like LCFS and Cap & Trade, would cost California consumers an additional 28 cpg in 2020

Combined, these would raise California gasoline prices by 53 cpg, costing consumers an additional $7 to $8 billion annually

Retail gasoline prices will increase in the future

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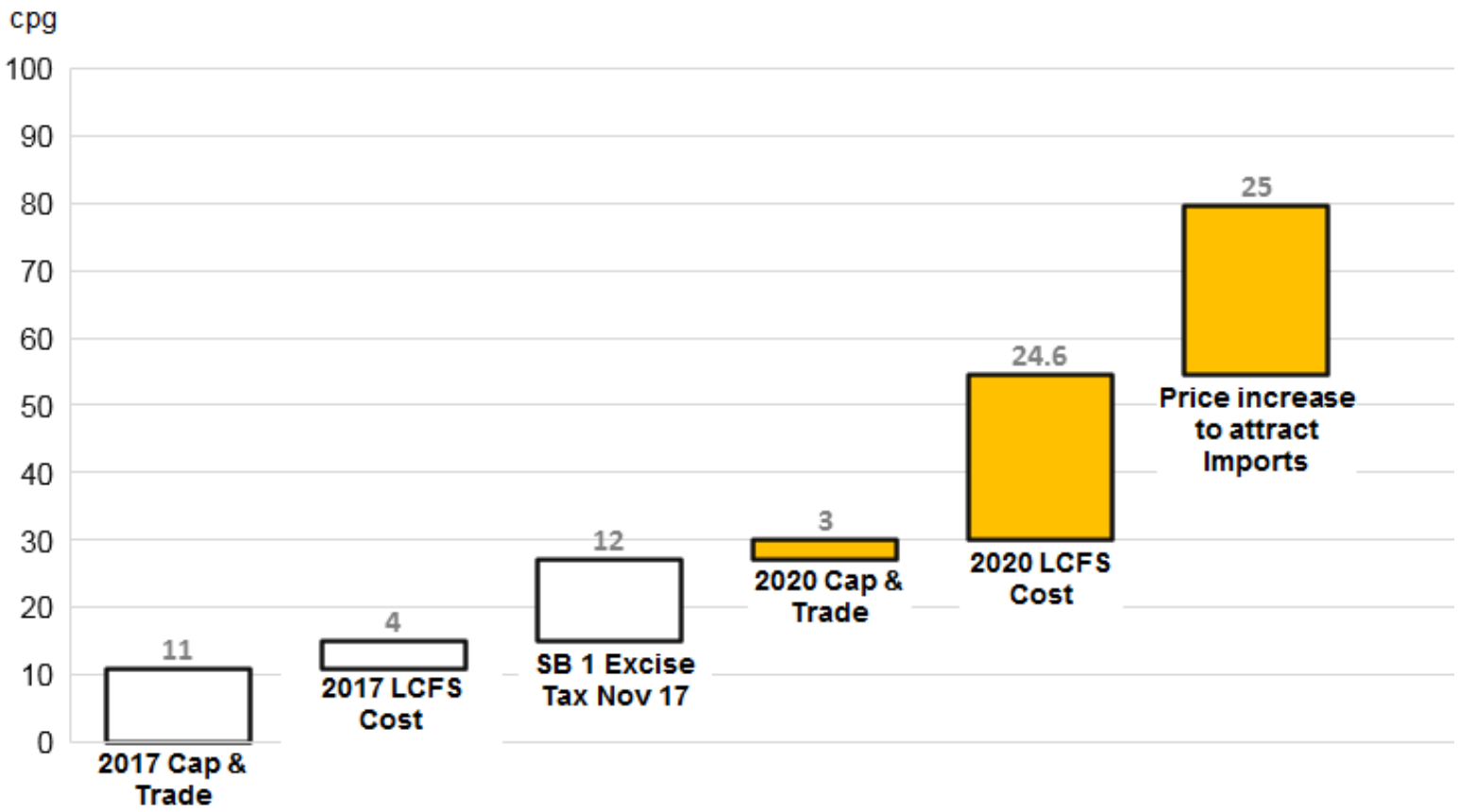

Source: Stillwater analysis

The price increase to attract imports to SoCal will be on top of SB 1 & AB 32 program costs that will be increasing through 2020

The risk of even higher prices…

Key factors potentially impacting SoCal gasoline pricing	with all current refineries	impacted refineries closed
Global competition for products intensifies		↑
SoCal gasoline demand continues to increase	↑	↑
Unplanned refinery outages	↑	↑
Planned refinery shutdowns		↑
Delays and disruptions in cargo offloading		↑
Summer demand peak		↑
Increased concentration of suppliers in SoCal		↑

↑ higher prices

↓ lower prices

Source: Stillwater analysis

…increases significantly with the two refineries closed

Agenda

1. Key Points
2. Regional supply and demand overview
3. Why is alkylation important?
4. Base year supply/demand balances
5. Replacement of current HF Alkylation units
6. Modified operations without alkylation
7. Shutdown of impacted refineries
8. **Summary**

Summary

1. Alkylation is an important refining process. CARBOB cannot be produced by SoCal refineries without alkylate
2. Should HF be banned, it appears unlikely that impacted refiners would replace current process units, due to the high cost
3. The impacted refineries are unlikely to be viable without alkylation
4. Should the impacted refineries cease operations, 25% of regional demand would have to be imported
5. With only three fuels refiners left in SoCal, the market will have less competition
6. Offshore refiners will produce the products and ship them half way around the world to the California market
7. As a result, average spot prices could rise 25 cpg or more, and ultimately the California consumer would pay the price

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...experience runs deep