California Petroleum Market
Trends for Crude Oil and Refining

Crude Oil Quality Association
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California Energy Commission

- Primary energy policy and assessment agency for the State of California
- Has several divisions covering: Energy Assessments; Energy Research and Development; Energy Efficiency; Fuels and Transportation; Renewables; Siting, Transmission, and Environmental Protection (power generation licensing)
- Transportation Fuels Data Unit
  - Energy Assessments Division
  - Administers the Petroleum Industry Information Reporting Act (PIIRA)
    - PRC Division 15, Chapter 15, Sections 25350 – 25366
    - CCR Title 20, Chapter 3, Article 3
- PIIRA company level information is confidential
  - Business sensitive
  - Largely immune to Freedom of Information Act and public records requests
California Crude Oil Trends
California Refinery Oil Sources (1982–2016)

1.65 million barrels per day in 2016 – foreign receipts expected to grow.

- **Foreign**: 328.5 Million Barrels (54.5%)
- **Alaska**: 68.8 Million Barrels (11.4%)
- **California & Other Domestic Lower 48 Sources**: 205.6 Million Barrels (34.1%)

Sources: DOGGR, Energy Information Administration, Class 1 Railroads and the California Energy Commission.
Millions of Barrels per Year

Cumulative Crude Oil Production
29.76 Billion Barrels, Equivalent to 10.1 Months of 2016 Global Demand of 96.60 Million Barrels Per Day

Peaked in 1985 at 424 Million Barrels

Crude oil production for over 150 years in California. Declining output now at a level last seen in 1934.

194 Million Barrels in 2016
Annual Crude Oil Imports into California

Diversity of foreign sources increasing.

Sources: Energy Information Administration and the California Energy Commission.
Californian Imported Crude Oil Properties

Since 1992, the weighted average API specific gravity of imported crude oil has been 28.85 degrees, roughly similar to Alaskan North Slope.

Since 2010, the weighted average sulfur content of imported crude oil to California has been 1.7 percent.

Sources: Energy Information Administration
U.S. crude oil production has changed from 5.390 million barrels per day in January 2010 to 8.835 million barrels per day during January 2017.

U.S. crude oil production is 0.792 million barrels per day lower than the near-term peak of April 2015.

California & Alaska oil production continue declining.

Source: Energy Information Administration.
Lifting of oil export restrictions has enabled record exports.

Export restrictions lifted.

Record level of 1.116 million barrels per day exported.

Source: Energy Information Administration.

Crude-by-rail volumes include oil from U.S. production and Canadian rail imports.

Source: Energy Commission analysis of data from the Energy Information Administration.

Expanded crude oil pipeline takeaway capacity has allowed oil producers to shift away from more expensive rail transport back to pipeline movements. Domestic oil “discounts” have narrowed.
Crude by rail increased in late 2016, early 2017, but has since returned to smaller volumes. 2016 CBR volumes represented less than 0.4 percent of California crude oil supply.
California Refinery Operations
California Refineries - Overview

• Refineries are a primary hub of logistical activity
  • 15 refineries processed 1.612 million barrels per day of crude oil during 2016
  • 13 facilities produced California fuels

• Crude oil during 2016 received by
  • Marine vessels (foreign) – 887.5 TBD
  • Marine vessels (Alaska) – 188.0 TBD
  • California source via pipelines – 558.5 TBD
  • Rail/truck – 3.0 TBD

• Process units operate continuously at or near maximum capacity, except during periods of planned maintenance or unplanned outages
Refinery Locations – Northern California

Sources: Oil Change International map, Energy Information Administration refinery data, and Energy Commission analysis
Northern California refiners all own their marine terminals, whereas the marine terminal docks in Southern California are owned by the cities of Los Angeles and Long Beach and leased to the refining & logistics companies (such as Kinder Morgan).
Product Slate of California Refineries (2016)

*Note: Does not include ethanol.

Source: California Energy Commission
Although finished gasoline consumption declined 8.9 percent between 2004 and 2012, strong recovery from the recession and continued population growth have pushed consumption up by 6.9 percent between 2012 and 2016, edging closer to a record high.

Ethanol use has increased from an average concentration of 3.75 percent by volume in 2003 to 10.09 percent by volume during 2016.

Source: California Energy Commission analysis
Finished diesel consumption declined 15.9 percent between the peak in 2007 and the trough in 2009. The strong recovery from the recession and associated goods movement by truck and rail pushed consumption back up by 15.5 percent between 2009 and 2016.
Commercial jet fuel consumption declined 15.1 percent between the peak in 2007 and the trough in 2009 (same pattern as diesel fuel). The strong recovery from the recession and associated rebound in air passengers and cargo have pushed consumption back up by 29.9 percent between 2009 and 2016 to reach a new record high of 3.87 billion gallons.
California Gaseous Fuel Consumption

- The natural gas-based fuels usually displace diesel fuel
- Hydrogen transportation fuel usually displaces gasoline in light-duty vehicles
- Hydrogen consumption expected to rise through expanded fueling infrastructure & additional vehicle options

<table>
<thead>
<tr>
<th>Year</th>
<th>LPG¹ (Propane) Consumption Gallons</th>
<th>LNG² Consumption Gallons</th>
<th>CNG³ Consumption Therms</th>
<th>Hydrogen⁴ Consumption Kilograms</th>
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<td>2003</td>
<td>18,455,500</td>
<td>27,970,031</td>
<td>98,033,540</td>
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<td>2005</td>
<td>22,999,500</td>
<td>28,645,800</td>
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<td>2006</td>
<td>19,983,500</td>
<td>28,983,685</td>
<td>117,058,495</td>
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<td>2007</td>
<td>18,316,000</td>
<td>22,400,000</td>
<td>119,325,161</td>
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<td>2008</td>
<td>18,391,000</td>
<td>18,900,000</td>
<td>127,599,355</td>
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<td>2009</td>
<td>22,861,067</td>
<td>29,635,453</td>
<td>139,456,782</td>
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<td>2010</td>
<td>26,632,877</td>
<td>32,356,377</td>
<td>145,186,972</td>
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<td>2011</td>
<td>29,139,991</td>
<td>35,487,647</td>
<td>151,230,879</td>
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<td>2012</td>
<td>33,028,638</td>
<td>30,492,564</td>
<td>160,369,476</td>
<td>73,443</td>
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<td>2013</td>
<td>34,755,459</td>
<td>31,868,353</td>
<td>165,759,354</td>
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<td>2014</td>
<td>31,834,779</td>
<td>33,082,102</td>
<td>179,462,285</td>
<td>64,499</td>
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<td>2015</td>
<td>25,806,328</td>
<td>34,000,572</td>
<td>181,989,469</td>
<td>62,708</td>
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<td>2016</td>
<td>5,793,698</td>
<td>31,605,833</td>
<td>198,408,653</td>
<td>110,575</td>
</tr>
</tbody>
</table>

Preliminary Values

Notes
2. LNG data from verbal reports to CEC Reporting Unit by suppliers.
3. CNG data obtained from the annual California Gas Reports. Link to 1998-2016 reports: https://www.pge.com/pipeline/library/regulatory/cgr/index.page
4. National Transit Authority (NTA) annual reports & DMV fuel cell vehicle registrations. FCVs assumed driven 9,600 miles/vehicle/yr & EPA Adjusted Combined Cycle fuel economy. NTA Reports, Data Tables, Table 17, Energy Consumption, Other or Hydrogen Fuels
Importance of biomethane increasing under the Low Carbon Fuels Standard.
Light-duty vehicle electricity consumption has grown from 62.2 thousand MWh in 2012 to 727 thousand MWh by 2016, an increase of more than ten times within four years – a direct consequence of the growing purchase of battery electric and plug-in electric vehicles.
Transportation Fuel Supply Flows & Trends
Western States More Isolated than Rest of U.S.

West Coast petroleum product supply map

Product Supply – PADD 5 (West Coast)
- Bulk Terminal
- Refining center
- Refinery
- Product Pipeline
- Product Flows
- Urban Areas

Source: U.S. Energy Information Administration.

California Energy Commission
California Gasoline Market - Isolated

• California’s gasoline market is nearly self-sufficient, so supplies of gasoline from outside of California are not routinely needed to balance out supply with demand
  – Imports of gasoline and blending components account for only 3 to 6 percent of supply
• The California market is geographically isolated from other locations in the United States that produce refined products
• Pipelines connect California refining centers to distribution terminals in Nevada and Arizona, but these pipelines only operate in one direction – sending gasoline and other transportation fuels to these neighboring states
• California market is isolated by time and distance from alternative sources of re-supply during unplanned refinery outages
The pipeline infrastructure in California is controlled by a combination of common carrier and private companies.

Kinder Morgan is the sole common carrier of petroleum product pipelines in the State and transports the majority of fuels through its system every day.

Other companies, such as Chevron, ExxonMobil, Shell, and Andeavor operate proprietary systems or segments that handle the balance of transportation fuels.

Source: Energy Commission revision to Kinder Morgan map
Gasolines Flows – Northern California

- Net exporter
- Foreign imports rare
- Domestic imports from WA refiners – steady
- Imports from S. Calif. intermittent & small – refinery outages
- Pipeline exports to Reno
- Foreign exports growing
- Domestic exports to PNW declined – replaced by WA refiners
- Exports to S. Calif. normal portion of their supply – volumes fluctuate based on refinery outages

Source: California Energy Commission
Diesel Flows – Northern California

- Large net exporter
- Foreign imports rare
- Domestic imports from WA refiners – not needed
- Imports from S. Calif. Intermittent & small – refinery outages
- Pipeline exports to Reno
- Foreign exports growing
- Domestic exports to PNW small – replaced by WA refiners
- Exports to S. Calif. unusual

Source: California Energy Commission
• Southwestern system includes portions to deliver transportation fuels into Southern Nevada and Arizona
  • NV – Over 85% of supply
  • AZ – Over 45% of supply
• Dependency on Southern California refineries lessened by deliveries from West Texas and Utah
Gasolines Flows – Southern California

- Net importer via marine
- Usually close to balance
- Foreign imports when needed & economic
- Domestic imports rare
- Imports from N. Calif. normal portion of their supply – volumes fluctuate based on refinery outages
- Pipeline exports to NV & AZ
  - 5 times N. Calif. volumes
- Foreign exports minimal
- Domestic exports eliminated
- Exports to N. Calif. rare – volumes fluctuate based on refinery outages

Pipeline Exports out of Southern California averaged roughly 2.4 million barrels per month over the entire time period.

Source: California Energy Commission
Diesel Flows – Southern California

- Large net exporter
- Foreign imports when needed & economic
- Domestic imports rare
- Imports from N. Calif. Related to refinery outages
- Pipeline exports to NV & AZ
  - 3 times N. Calif. volumes
- Foreign exports declined
- Domestic exports eliminated
- Exports to N. Calif. rare – volumes fluctuate based on refinery outages

Pipeline Exports out of Southern California averaged roughly 1.8 million barrels per month over the entire time period. Diesel pipeline exports appear to be decreasing from a rough average of 2 million barrels in 2007 to 1.5 million in 2016.

Source: California Energy Commission
Net Californian Gasoline Flows

Over the entire time span, both Northern and Southern California have on average been net exporters since 2007, averaging roughly 1.9 million and 300 thousand barrels respectively.

Source: California Energy Commission
Both Northern and Southern California are consistent net exporters of diesel product.
SCAQMD Proposed Rule 1410
Refining & Alkylation

- Alkylation unit most important gasoline blending component source in refinery
- Catalyst used to convert petroleum feedstocks to higher-value gasoline
  - Sulfuric acid
  - Hydrofluoric acid (HF)
- Only 2 refineries use HF in Calif.
  - PBF Torrance
  - Valero Wilmington
- Concerns raised regarding potential for HF vapor cloud to form if containment systems breached

Source: Reactor-Resources.com
Global Alkylation Technology & Capacity

- Much greater portion of alkylation units in world use HF compared to California
  - UOP & COP use HF
  - Other technology providers use sulfuric acid
Proposed Rule 1410

• South Coast Air Quality Management District (SCAQMD) has proposed a rule that has the potential to eliminate HF use at refineries in Southern California.

• PR 1410 has three possible outcomes:
  – No ban (maintain technology neutral policy)
  – Performance-based structure
  – Ban of HF (SCAQMD staff appear to be pursuing this option)

• Performance-based structure could expand on safety measures
  – Both refineries already utilize Modified HF (MHF) techniques
    • Chemical used in catalyst to reduce ability to form vapor cloud
    • Additional equipment in place to douse alkylation unit in water intended to reduce ability of vapor cloud forming
HF Ban Implications

• The concern is that the incremental impacts on gasoline costs for consumers and businesses could be as bad as or worse than those of experienced for the duration that the Torrance ESP was out of operation.
  – Gasoline prices averaged 26 cents per gallon above normal for 17 months
  – Equates to incremental costs of $5.6 billion for motorists & businesses

• Refiners are unable to simply replace one catalyst with another.

• Alkylation units would have to be replaced.
  – Uncertainty regarding:
    • Ability to continue operating modified HF units
    • Timing & outcome associated with permit process
    • Cost and economic viability of HF alkylation replacement requirement
Ability to Maintain Operations

• Continuing operation of MHF alkylation units at Torrance and Wilmington will be determined by:
  – Sufficient space for such a project within the refinery
  – Location is appropriate for engineering and safety needs
  – If such available space is not feasible,
    • Existing MHF alkylation units will first have to shut down
    • Demolished to make way for new construction
  – Loss of alkylation output (and reduced production from other refinery process units) will decrease local supply refined products for a period of at least two years
  – Impact on gasoline prices expected to be worse than those associated with the Torrance Refinery ESP explosion
Timing & Outcome of Permit Process

• Before replacement work could commence, refiners would need to obtain all necessary permits through the CEQA process
  – Outcome is uncertain
  – It is possible that such permits will ultimately be denied
    • Valero Benicia crude-by-rail permit denial recent example
  – Even if granted, timeline could be extensive
    • Chevron Richmond refinery modernization permit approval, 9+ years
    • Initially submitted to City of Richmond during 2006
    • Final approval received April 2015
Cost and Economic Viability

• If an HF ban were compelled it is uncertain if either or both companies would elect to make such changes to their facilities
  – Alkylation process unit projects are extremely expensive
    • A recent project approved for the Valero Houston refinery is estimated to cost $300 million for an alkylation unit with a capacity of 13,000 barrel per calendar day
    • Capacity of the alkylation units at Valero Wilmington and PBF Torrance are 22,000 and 24,200 barrels per day capacity, respectively
    • These alkylation unit capacities are each nearly twice the capacity, meaning the potential costs for such projects at the two California refineries could, at a minimum, easily approach or exceed $500 million per facility
  – These estimated costs for such a replacement project could be at or near the value of the refinery when one considers that ExxonMobil sold the entire Torrance refinery to PBF Energy for $537.5 million
    • It would therefore be uncertain as to whether such an expenditure could be justified by either or both companies should an HF alkylation ban ultimately be approved by the SCAQMD
More information on Rule 1410

• More information about Rule 1410 Meetings can be found at:
  http://www.aqmd.gov/home/regulations/rules/proposed-rules/proposed-rule-1410

• No recordings of meetings

• SCAQMD is posting copies of presentations and related back-up material.

• Next meeting scheduled: October, 2017
Fuel Set-Aside Program
Energy Commission Responsibilities in an Emergency (Energy Supply Shortage)

- In a large scale emergency events, California’s Office of Emergency Services (OES) becomes California’s lead agency
- The Energy Commission role is to monitor, assess, and provide energy supply expertise (for all energy sources)
- For petroleum fuels, the Energy Commission becomes transportation fuel supply management center
- Refining is a privately-owned industry, no utility oversight
Fuel Set Aside Program

Two versions of the “Fuel Set Aside Program”: Informal and Formal

• Informal version: short term emergencies
  o Recently used for the Northern California fires
  o Energy Commission’s role to identify fuel sources for emergency services
  o Facilitate communications for a normal market transaction

• Formal version: Used for a prolonged and widespread shortage or emergency
  o Requires Governor Emergency Order directing FSAP implementation
  o Energy Commission authorized to redirect fuels as directed by the Chairman of the Energy Commission or the designated representative (Fuel Set Aside Officer / FAO)
  o Formal fuel requests submitted directly from Cal OES or via the internet
  o Requests can be made by the public, but no guarantee that fuel will be provided
Fuel Set Aside Business Process

1. Cal OES Tasking Operations
2. Energy Commission Fuel Set Aside Website
3. Fuel Specialist Review and Recommendation
4. FAO Review & Coordination with CalOES Director
5. Fuel Accounting System (Data Analysts)
6. Refiners and other fuel sources

10/5/2017

California Energy Commission
Energy Commission
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Transportation Fuel Data Unit
PIIRA Data Collection and Products

- Energy Commission Energy Emergency Website: http://www.energy.ca.gov/emergencies/
- PIIRA forms: http://www.energy.ca.gov/piira/
- Weekly Fuels Watch: http://www.energy.ca.gov/almanac/petroleum_data/fuels_watch/
- Transportation Fuel Outlook, 2017: http://www.energy.ca.gov/2017_energypolicy/documents/#07062017