Transportation Fuel Issues

2017 IEPR Commissioner Workshop on
Transportation Energy Supply Trends

July 6, 2017

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Presentation Topics

- Transportation fuel issues
  - SCAQMD proposed Rule 1410
  - BAAQMD – proposed GHG caps for individual Bay Area refineries
  - IMO 2020 – sulfur reduction for marine vessel fuel

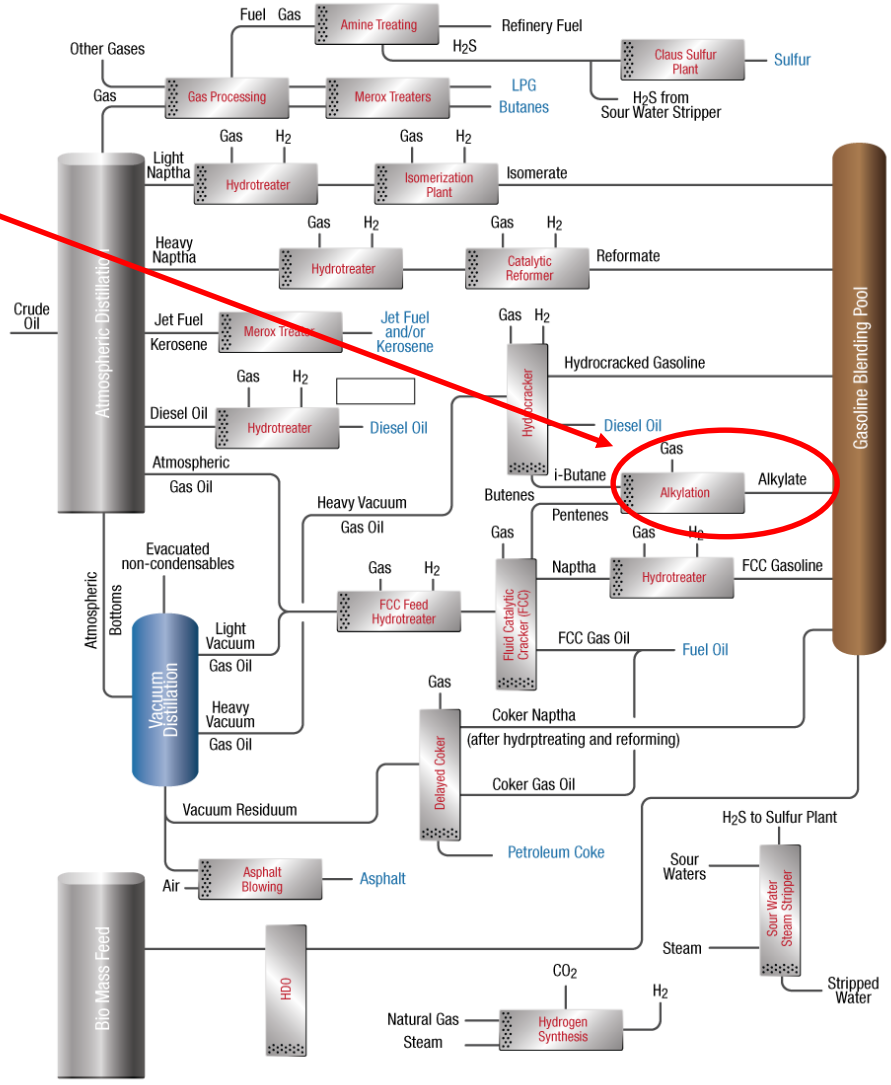
Issues in Focus

- Integrated Energy Policy Report (IEPR) – every two years
- Issues are highlighted that have the potential to impact supply and availability of transportation fuels over the near to mid-term period
- These are not the only “issues” associated with transportation fuels, yet are ones deemed at this time to have greater potential for supply impacts
- IEPR process is intended to properly characterize these potential issues, as well as have other relevant concerns brought to the forefront through submittal of comments and material to the docket

SCAQMD Proposed Rule 1410

Refining & Alkylation

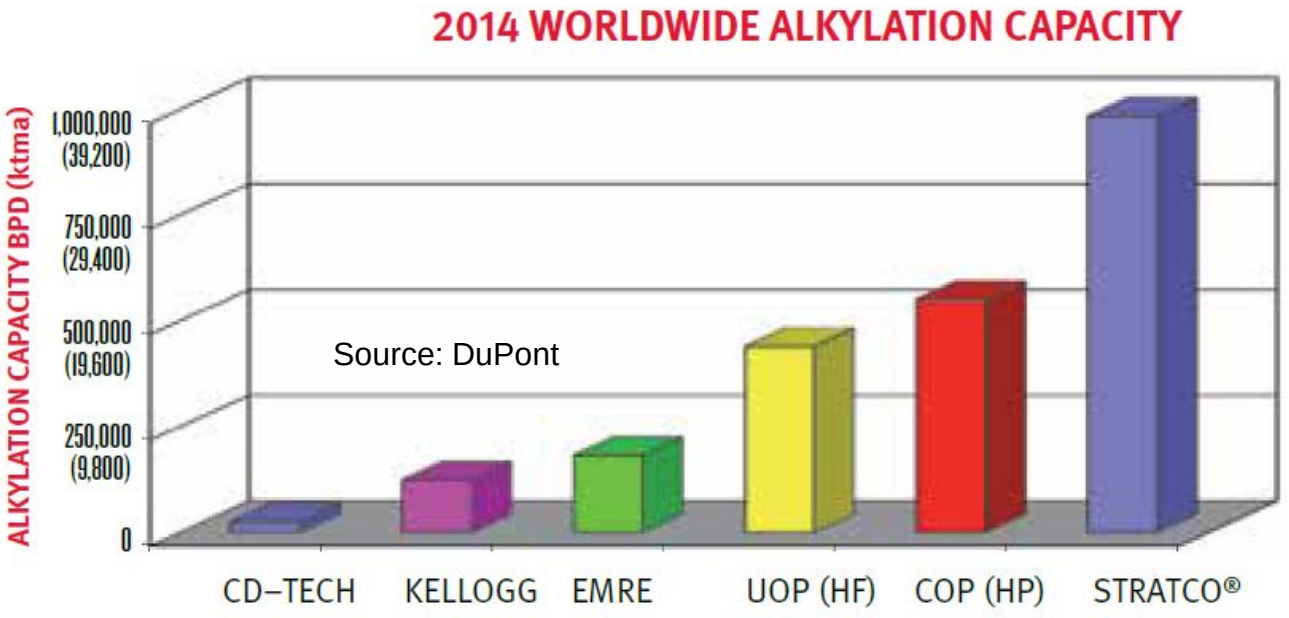
- Alkylation unit most important gasoline blending component source in refinery
- A catalyst is used to convert petroleum feedstocks to higher-value gasoline
  - Sulfuric acid
  - Hydrofluoric acid (HF)
- Only 2 refineries use HF in Calif.
  - PBF Torrance
  - Valero Wilmington
- Concerns have been raised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



Source: Reactor-Resources.com

Global Alkylation Technology & Capacity

- Much greater portion of alkylation units in world use HF when 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 1401 has three possible outcomes:
  - No ban (maintain technology neutral policy)
  - Performance-based structure
  - Ban of HF
- 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 greater than 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:
  - Availability of sufficient footprint for such a project within the refinery fence line and in a location properly designated for appropriate engineering and safety rationale
  - If such available space is not feasible, existing MHF alkylation units will first have to shut down and demolished to make way for construction of replacement alkylation units using commercially-available technology
  - Loss of alkylation output (and reduced production from other refinery process units) will decrease local supply of gasoline (and other refined products) for a period of at least two years
  - Impact on gasoline prices expected to be worse than those associated with the ExxonMobil 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 of this process is uncertain
  - It is possible that such permits will ultimately be denied
    - Valero Benicia crude-by-rail permit denial recent example
  - Even if permits are 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

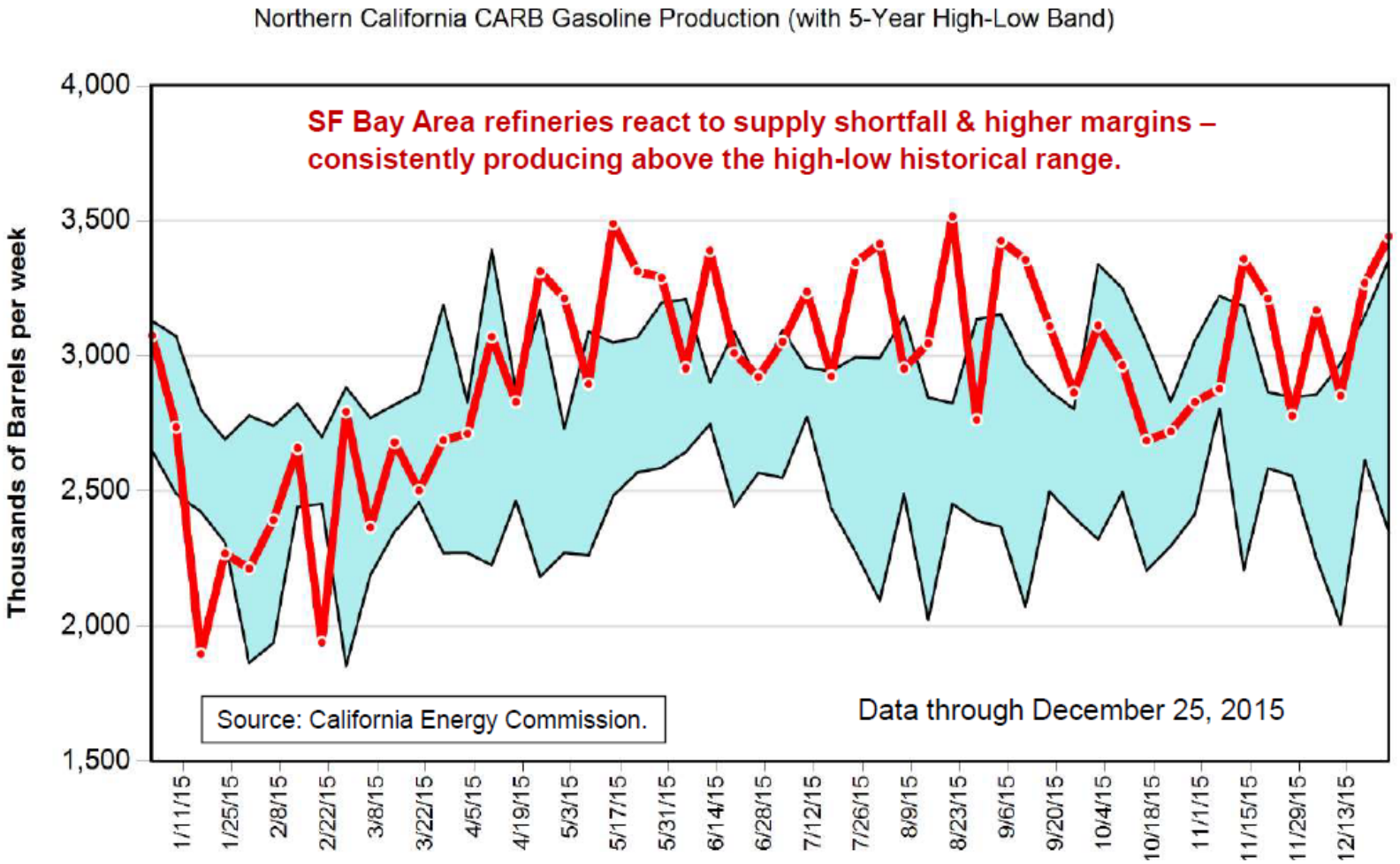
- If an HF ban were compelled it is uncertain if either or both companies would elect to make such changes to their facilities
  - Alkylation process unit projects are extremely expensive
    - A recent project approved for the Valero Houston refinery is estimated to cost $300 million for an alkylation 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

BAAQMD – Proposed GHG Caps for Individual Bay Area Refineries

Potential GHG Caps

- Bay Area Air Quality Management District (BAAQMD) has recently revised a proposed rule that is designed to limit greenhouse gas emissions for individual refineries operating in the greater San Francisco Bay Area, referred to as Regulation 12, Rule 16
  - If approved by the Board, the regulation is scheduled to be in effect by January 1, 2018
  - Concern is the potential impact greenhouse gas caps could have on the ability of the SF Bay Area refineries to respond to temporary supply imbalances created by significant unplanned refinery outages
  - It should be noted that this proposed regulation may continue to be modified and might not yet have all details in their “final” form that would go before their Board

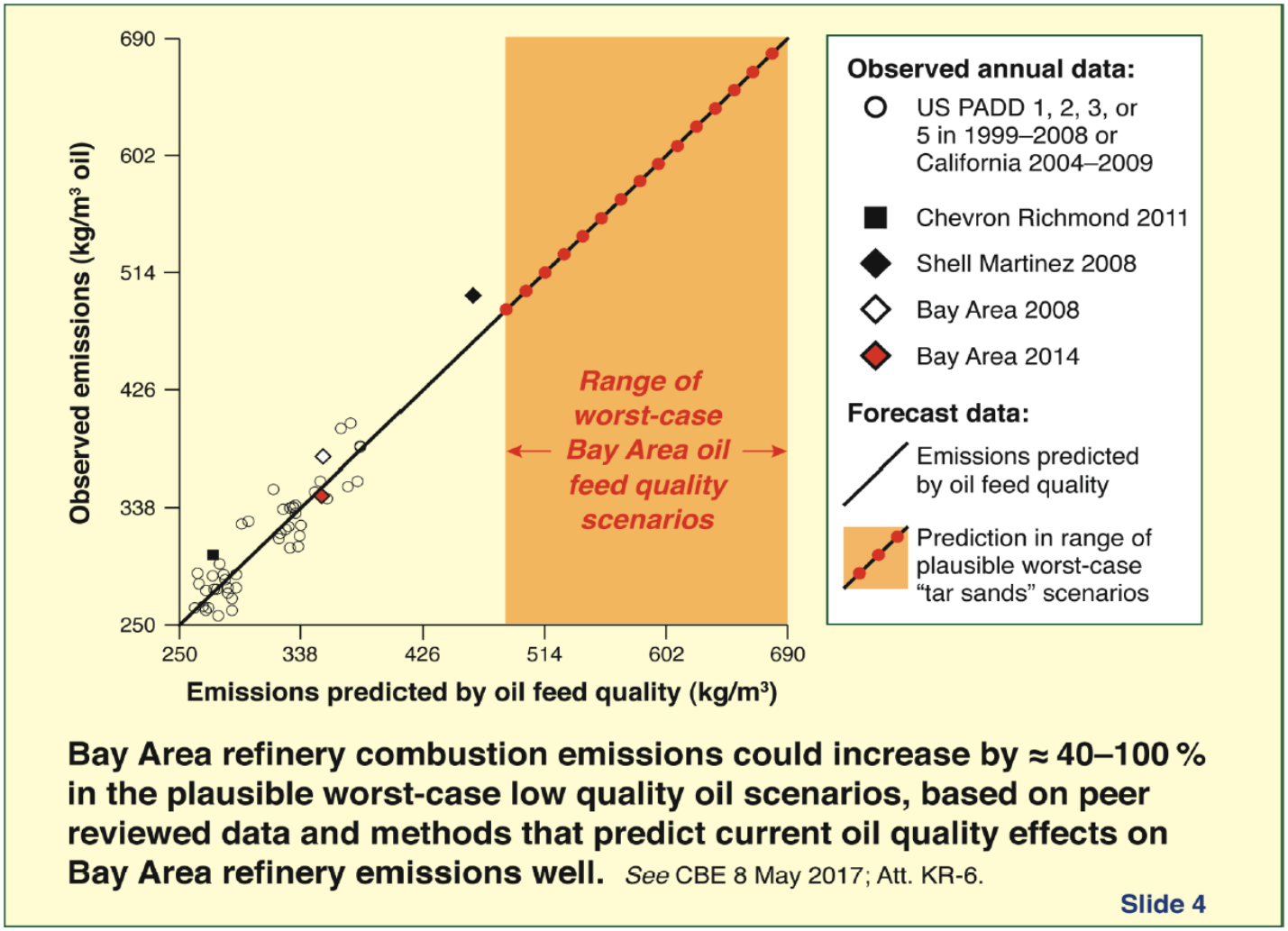
Refiners – Surge Production Capability



Potential GHG Caps

- To what extent the proposed regulation, if approved, could impact refinery operational flexibility is dependent on how low the caps are set relative to sustained peak refinery transportation fuel production periods
- However, the need for such refinery-specific GHG cap limits could be diminished for two reasons:
  - It is highly improbable that the average carbon intensity of crude oil used by refiners will significantly worsen from near-term conditions based on operational limitations and preferred envelope of properties for crude oil processed at refineries
  - California Air Resources Board already has regulations in place that ensure any increased carbon intensity of crude oil used by refiners, if it were to occur, would have to be offset, thus keeping any potential crude oil-related carbon intensity increases in check

Concern Raised of Worsening Oil Quality

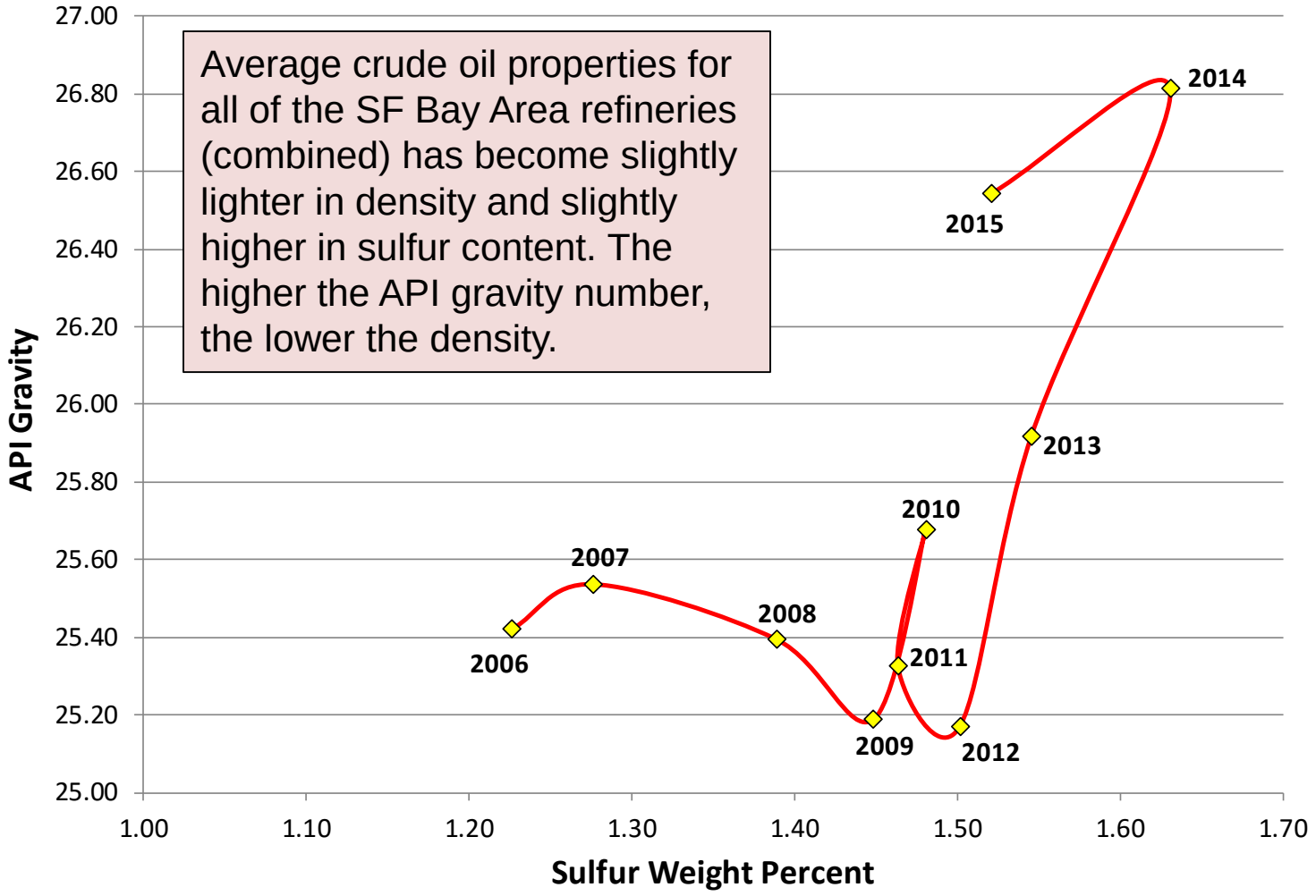


Bay Area refinery combustion emissions could increase by ≈ 40–100 % in the plausible worst-case low quality oil scenarios, based on peer reviewed data and methods that predict current oil quality effects on Bay Area refinery emissions well. *See* CBE 8 May 2017; Att. KR-6.

Slide 4

Source: Communities for a Better Environment (CBE)

SF Bay Area Refineries – Crude Oil Properties

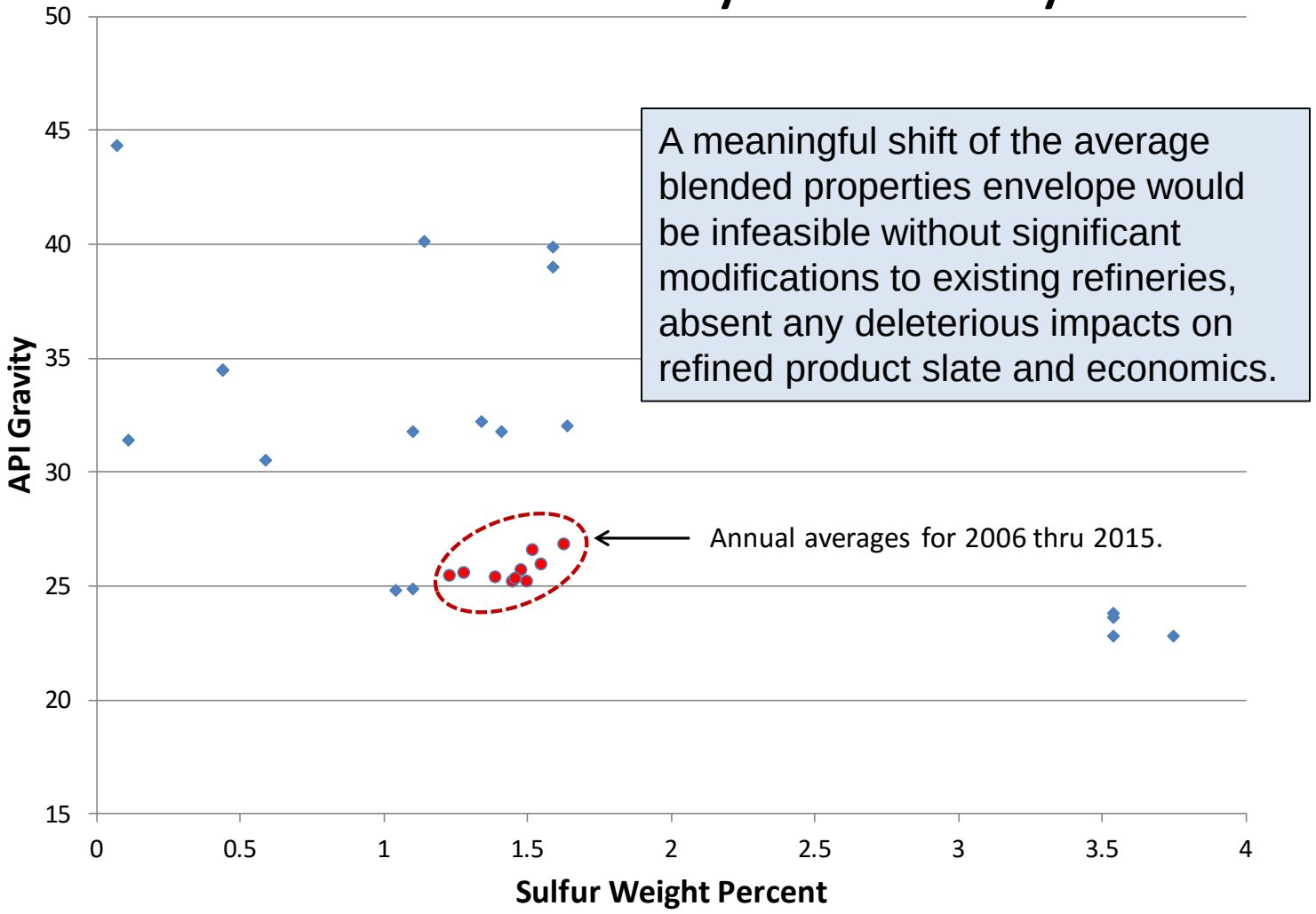


Source: California Energy Commission analysis of PIIRA data

Crude Oil – Targeted Properties

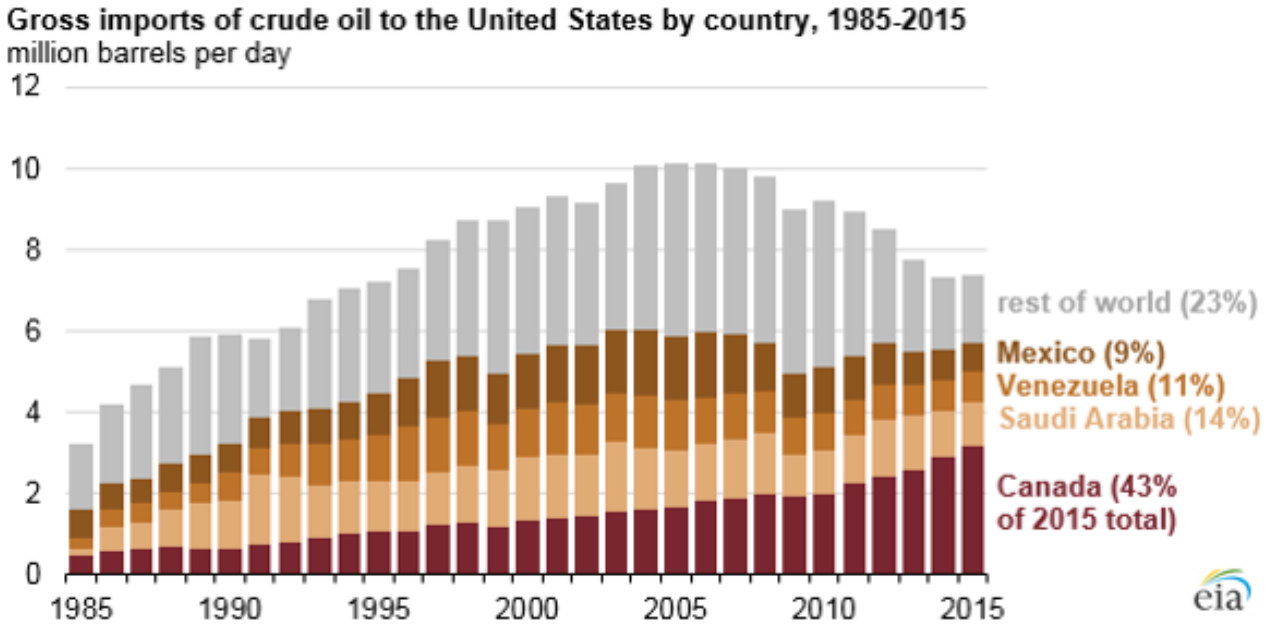
- As a general practice, refiners blend various types of crude oil together prior to processing in their facility for purposes of maintaining a steady overall quality of crude oil that helps to better control refinery operations and regulation the different ratios and types of transportation fuels produced from one month to the next
- Although the year-to-year variability of the average sulfur and density properties does shift, the degree of change is rather modest when the scale is adjusted to include properties of various types of Canadian crude oil processed in California

Canadian Crude Oil Import Properties versus Annual Refinery Variability



Sources: California Energy Commission analysis of PIIRA and EIA data

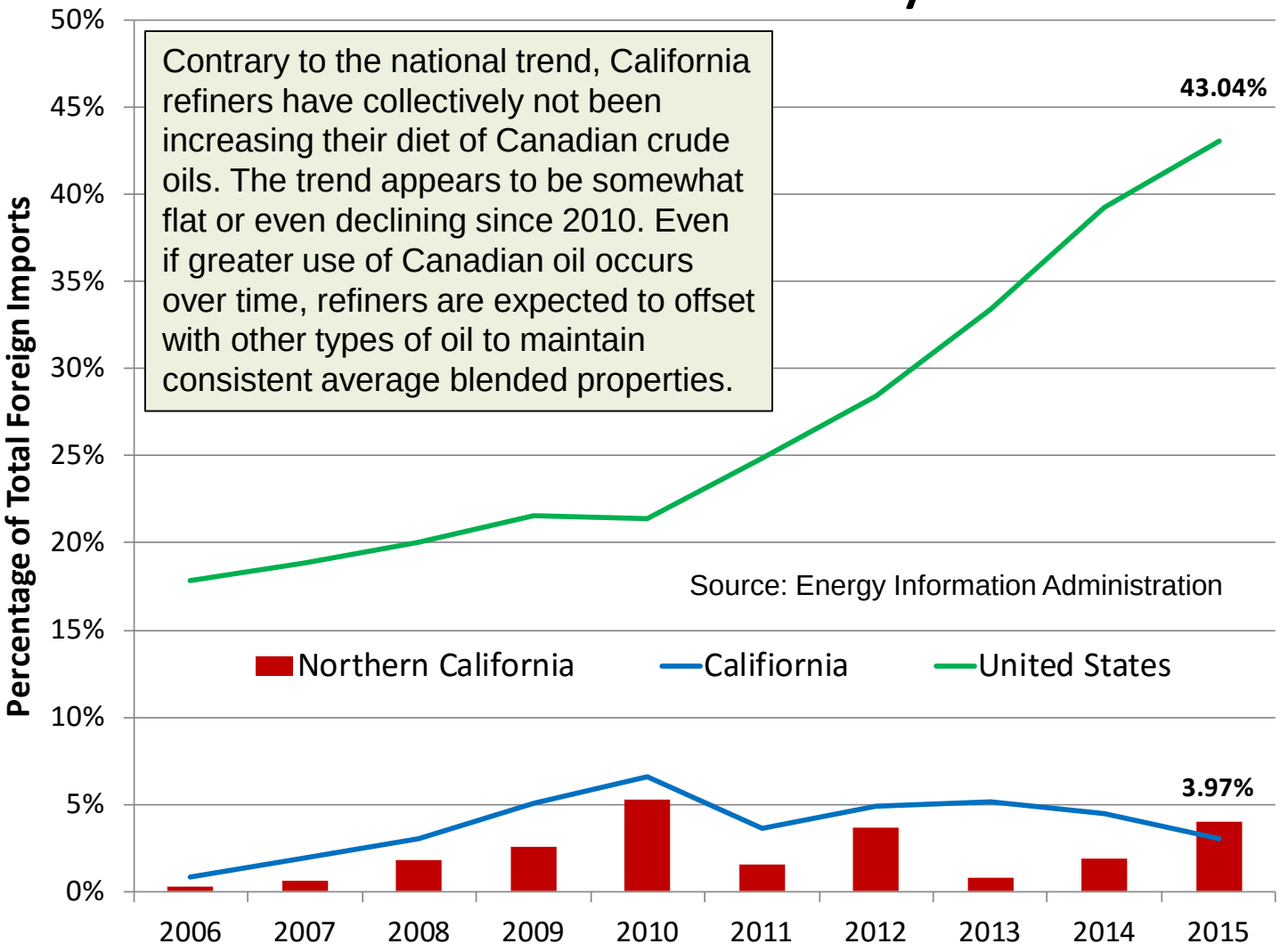
Canadian Crude Oil Imports – United States



Source: Energy Information Administration

For the United States, imports of crude oil from Canada have been rising as the U.S. is a natural destination for higher Canadian crude oil production due to the close proximity of refining customers and the adequacy of infrastructure to deliver the crude oil across the border.

Canadian Crude Oil Imports – California & SF Bay Area



IMO 2020 – Sulfur Reduction for Marine Vessel Fuel

Marine Fuels – Changes Ahead

- International Maritime Organization (IMO) oversees the development and standards designed to reduce harmful emissions to the environment from shipping activities
- International convention was adopted in 1997 specifically designed to reduce air pollution from marine vessels on a global scale, referred to as the MARPOL Convention
- Part of Annex VI to this convention is designed to decrease emissions of SO_x from marine vessels by limiting the amount of sulfur that exists in their primary transportation fuel referred to as bunker fuel
- Target level is for all bunker fuels to have a sulfur content limit of no more than 0.50 percent by weight by January 1, 2020
- Concern is that lower sulfur limits may be met, at least initially, by blending ultra-low sulfur CARB diesel fuel with other distillates, thus placing an additional demand on diesel fuel for California
  - Uncertain refinery operational changes & impacts

Annex VI Sulfur Limits & Deadlines

Outside an ECA established to limit SOx and particulate matter emissions	Inside an ECA established to limit SOx and particulate matter emissions
4.50% m/m prior to 1 January 2012	1.50% m/m prior to 1 July 2010
3.50% m/m on and after 1 January 2012	1.00% m/m on and after 1 July 2010
0.50% m/m on and after 1 January 2020*	0.10% m/m on and after 1 January 2015

* depending on the outcome of a review, to be concluded by 2018, as to the availability of the required fuel oil, this date could be deferred to 1 January 2025. MEPC 70 (October 2016) considered an assessment of fuel oil availability to inform the decision to be taken by the Parties to MARPOL Annex VI, and decided that the fuel oil standard (0.50% m/m) shall become effective on 1 January 2020 (resolution MEPC.280(70)).

The ECAs established are:

1. Baltic Sea area – as defined in Annex I of MARPOL (SO_x only);
2. North Sea area – as defined in Annex V of MARPOL (SO_x only);
3. North American area (entered into effect 1 August 2012) – as defined in Appendix VII of Annex VI of MARPOL (SO_x, NO_x and PM); and
4. United States Caribbean Sea area (entered into effect 1 January 2014) – as defined in Appendix VII of Annex VI of MARPOL (SO_x, NO_x and PM).

Source: International Maritime Organization

Marine vessels operating off the coast of California already have had to comply with an even lower 0.10 percent sulfur limit for bunker fuel consumed within the North American ECA since January 2015. But the volume of bunker fuel distributed to marine vessels in the California ports that meets this standard is a *subset* of all bunker fuel sales that can have the higher sulfur content of 3.50 percent by weight because the marine vessel operators are allowed to burn the other higher-sulfur bunker fuels once they depart the ECA zone.

CE Delft Study on Supply Availability

The main result of the assessment is that in all scenarios the refinery sector has the capability to supply sufficient quantities of marine fuels with a sulphur content of 0.50% m/m or less and with a sulphur content of 0.10% m/m or less to meet demand for these products, while also meeting demand for non-marine fuels (see Table 3).

Table 3 Global Refinery Production (2012 and 2020) - million tonnes per year

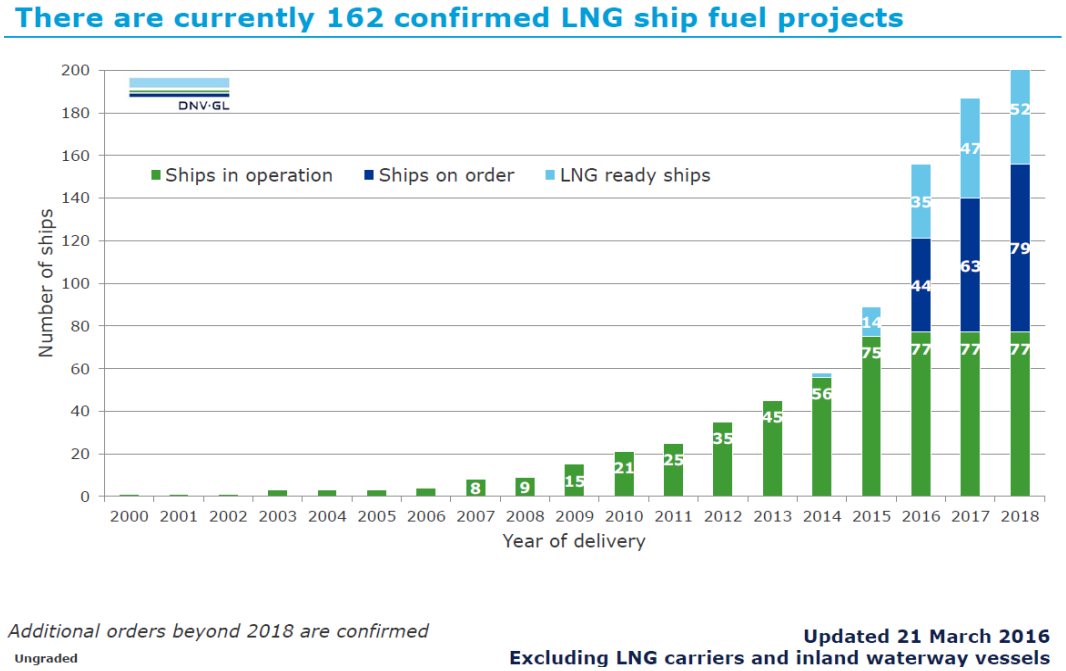
	Production in 2012	Production in 2020
Gasoline	963	1,086
Naphtha	256	305
Jet/Kero Fuel	324	331
Middle Distillate	1,316	1,521
MGO	64	39
Total Marine Heavy Fuel Oil (HFO)	228	269
Marine HFO (S ≤ 0.50% m/m)	0	233
Marine HFO (S > 0.50% m/m)	228	36
LPG	113	110
Other	784	537
Total	3,984	4,159

Source: CE Delft

Turner Mason company has reviewed this study and details a number of concerns that can call into question the overall conclusion that the refining sector will be able to adjust by the 2020 deadline. If the MARPOL Convention participants conclude that sufficient supplies of lower sulfur bunker fuel will not be available by January 2020, the compliance deadline can be extended to 2025.

IMO 2020 – Compliance Flexibility

- Compliance with the regulation can also be achieved through other means such as:
  - Installing scrubbers to take SO_x exhaust emissions below the standard
  - Retrofitting ship engines to run on lower-sulfur fuels such as natural gas
  - Building new marine vessels with dual fuel capability or natural gas engines only



Additional Q & A

Source: Huffington Post