Implications for Crude Oil Carbon Intensity Differentiation under the LCFS

California Air Resources Board
LCFS Periodic Review Advisory Panel
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Wood Mackenzie
downstream consulting

Summary Findings

- **The global crude oil market is large with Californian accounting for less than 2%**
  - High carbon crudes rejected by one market likely could supply other markets where no carbon cost exists – carbon leakage
  - Crude feedstocks change on a regular basis and California's changed significantly since 2006

- **Californian refineries are generally complex with a design to process heavy/medium crudes**
  - The LCFS / HCICO burden restricts crude feedstocks
  - Creates the potential to lower operational refinery efficiency

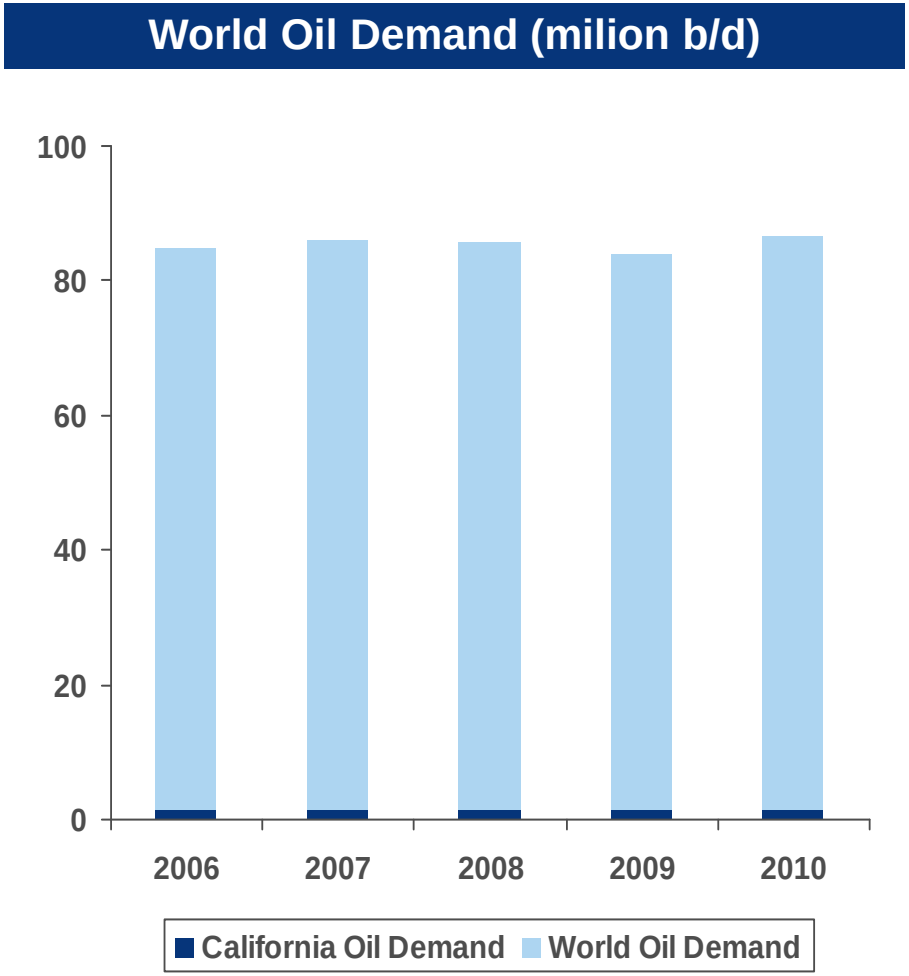
- **Crude oil markets are global and producers have alternatives to investment in GHG abatement, with unintended consequences, such as**
  - Increase in GHG emissions from crude oil "shuffling" as tankers passing each other with near-by "high intensity" crudes oils displaced by long-haul "low intensity"

- **Under the LCFS we expect refiners to prefer processing 2006 baseline crudes**
  - Results in a more restricted crude feedstock
  - Llikely to increase security of supply concerns as some 2006 baseline production declines

- **Cost of crude oil differentiation may…**
  - Not be borne by crude oil producers
  - Find its way into petroleum product consumer prices

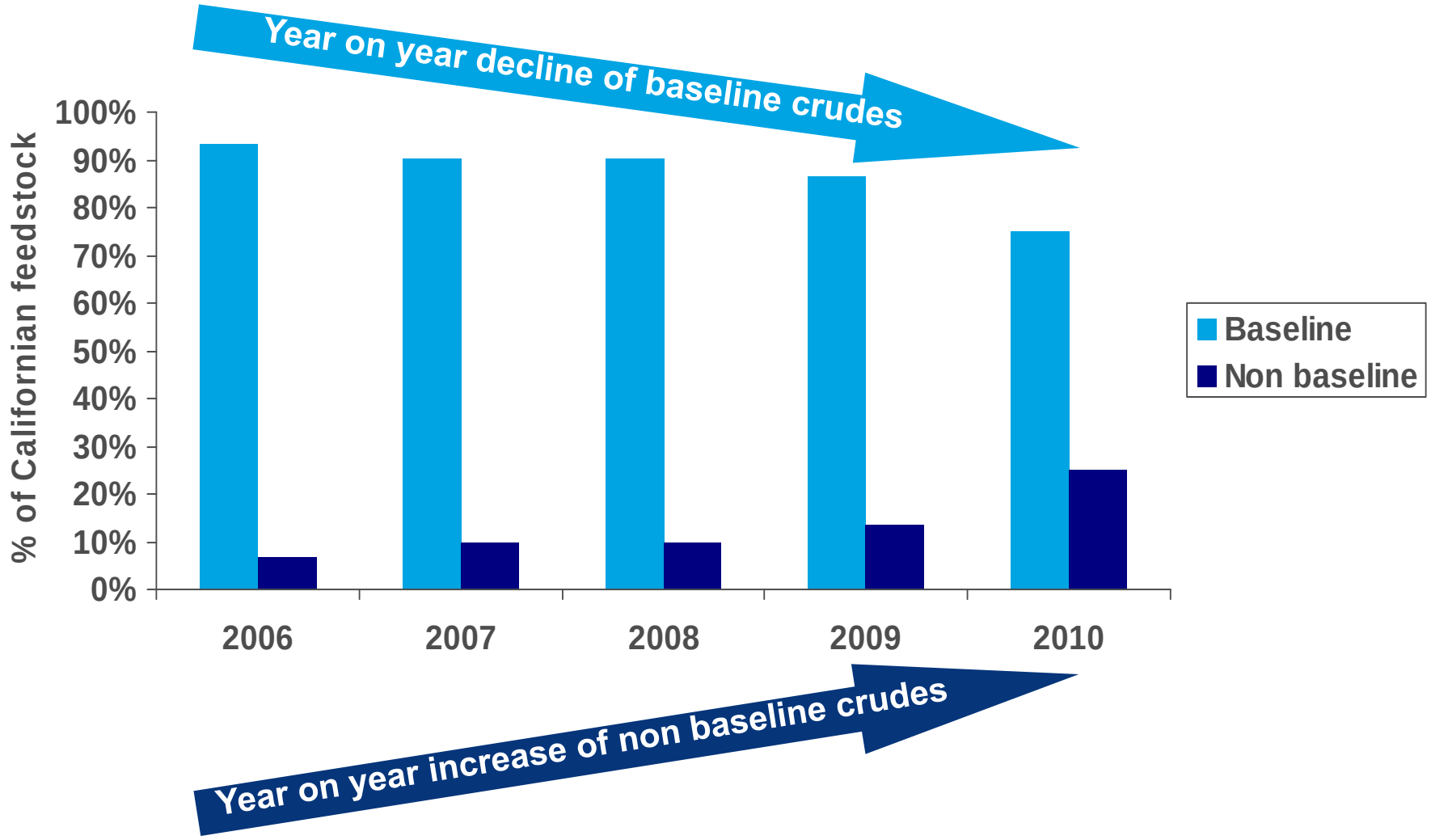
Global crude oil market is large and high carbon crudes rejected by one market are likely to supply markets where no carbon cost exists

- Total world demand for crude oil is approximately 85 million barrels a day
- Californian crude oil demand represents less than 2% of world demand
- High carbon crude oils, which could supply California but for the LCFS, will still be produced and instead supply markets where no such carbon policy exists



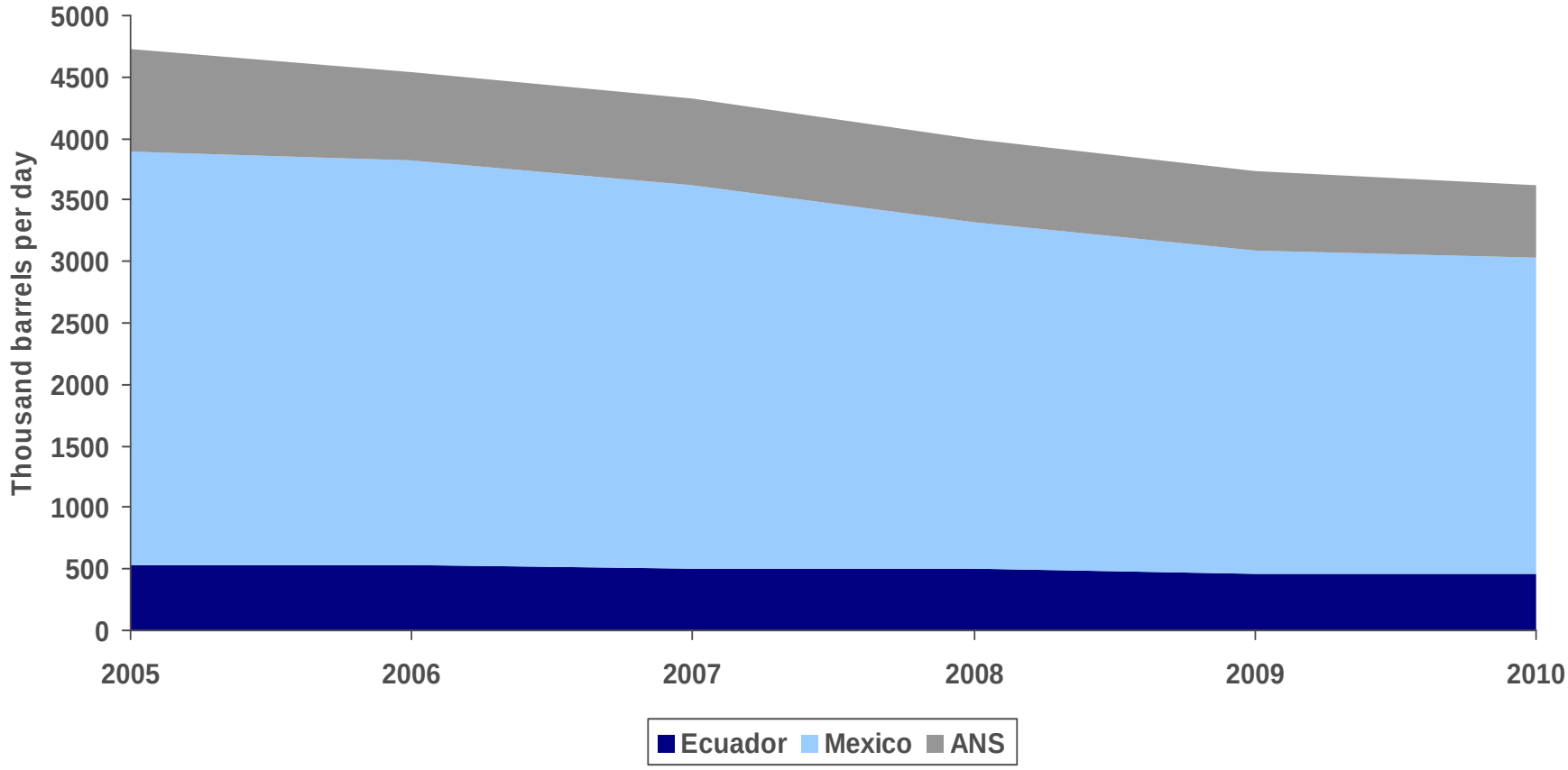
Source: Wood Mackenzie

Californian refineries increasingly are processing non-2006 baseline crudes



Source: IEA, CEC, Wood Mackenzie

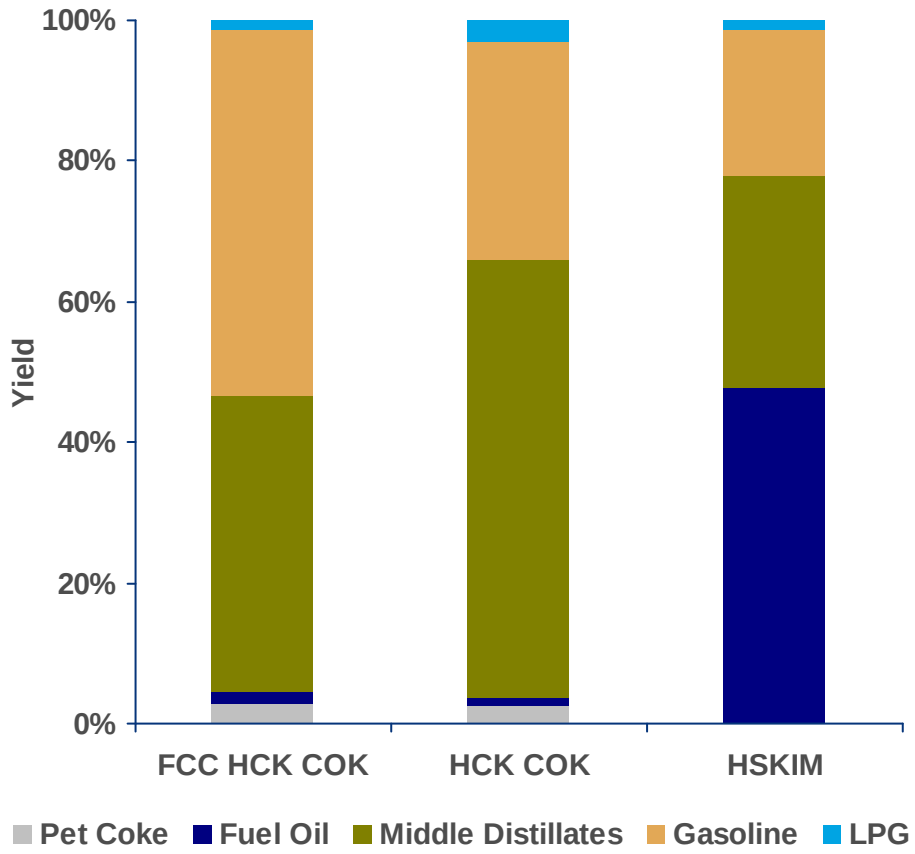
Declining production of some 2006 baseline crudes is a challenge



Many Californian refineries are designed to run heavy crude

- Complex refineries like some in California process heavy crudes which typically sell at a discount to lighter crudes due to their high fuel oil yield
- PADD V processes ~60% heavy, 40% medium
- Complex refineries upgrade low value fuel oil into higher value lighter oil products via their complex units such as cokers
- Running a light crude in complex refineries would be inefficient, depriving complex units of their feedstock and negatively affecting refining margins
- For Californian refiners to obtain value from their complex refining capacity they need to maintain a heavy / medium crude slate
- Potentially limits flexibility of refiners to replace high carbon intensity with lower carbon intensity crudes

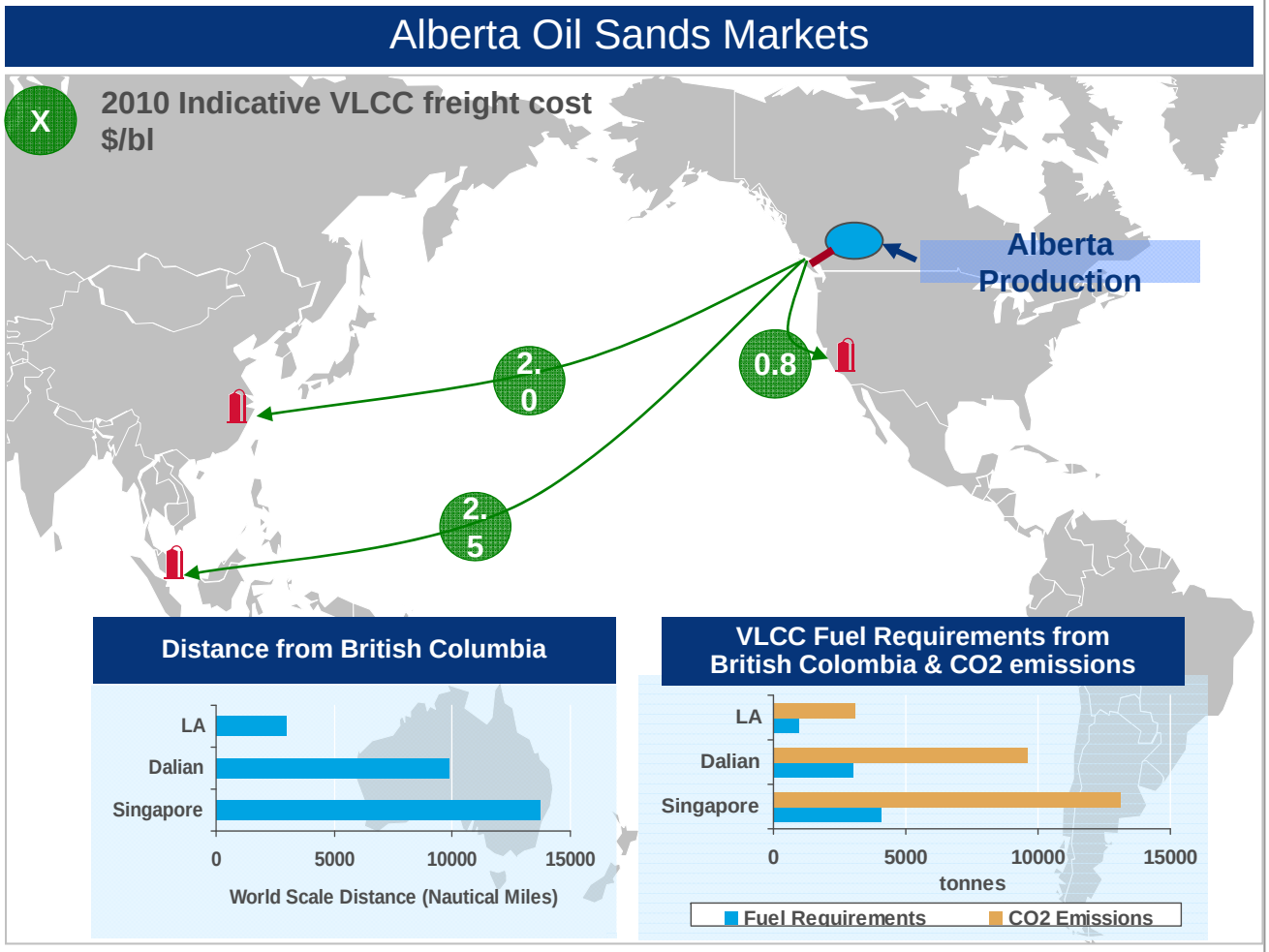
Typical Refinery Yields (~22 API Crude)



Source: Petroplan

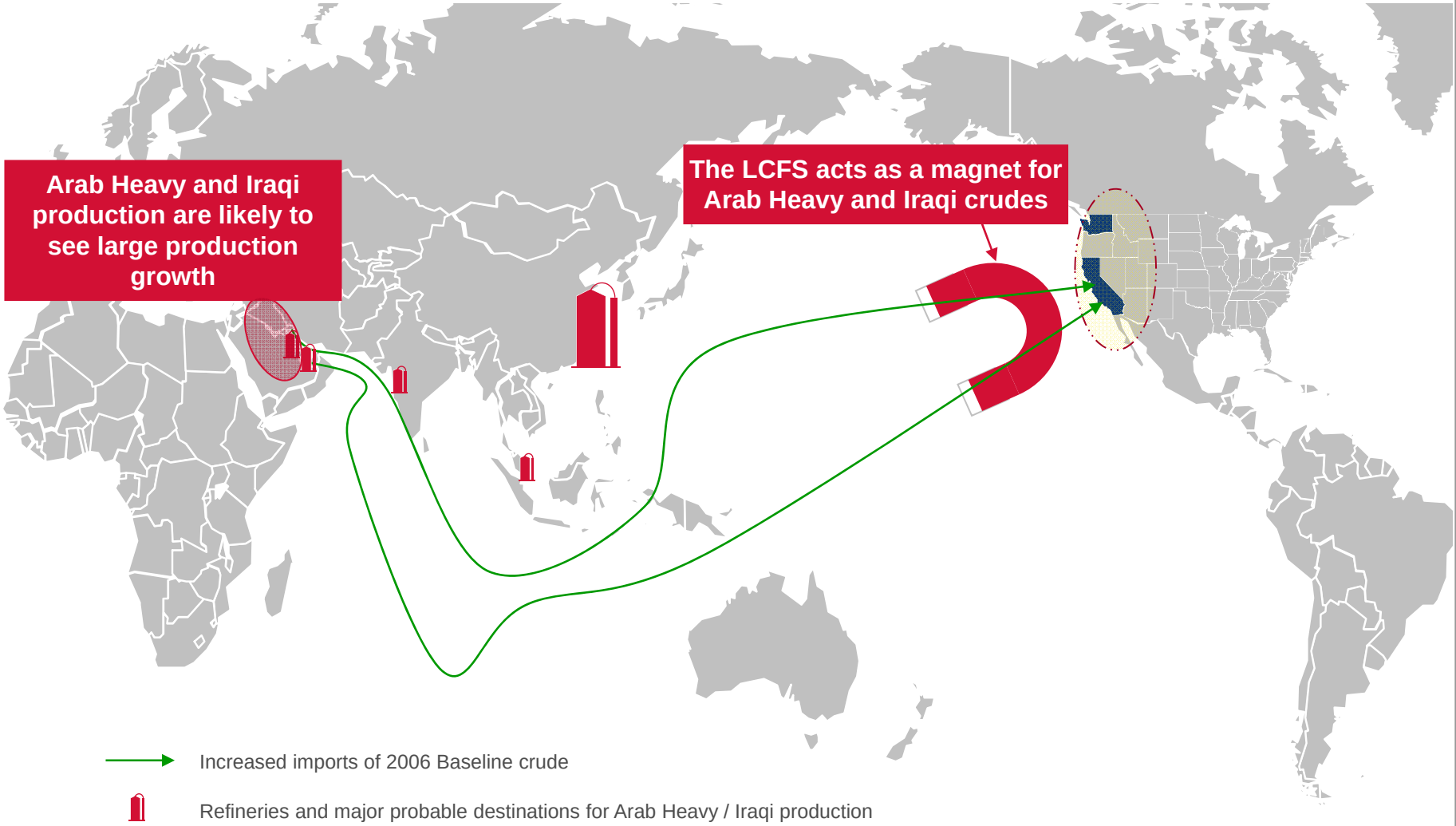
HCICO production from Canada is likely to be diverted to Asia, raising the carbon emissions from freight

- Carbon costs might push HCICO Canadian crudes out of the USWC market and towards markets with growing demand and no carbon penalty, such as China
- A VLCC sailing to China creates approximately triple the carbon emissions as sailing to Los Angeles due to greater freight distance

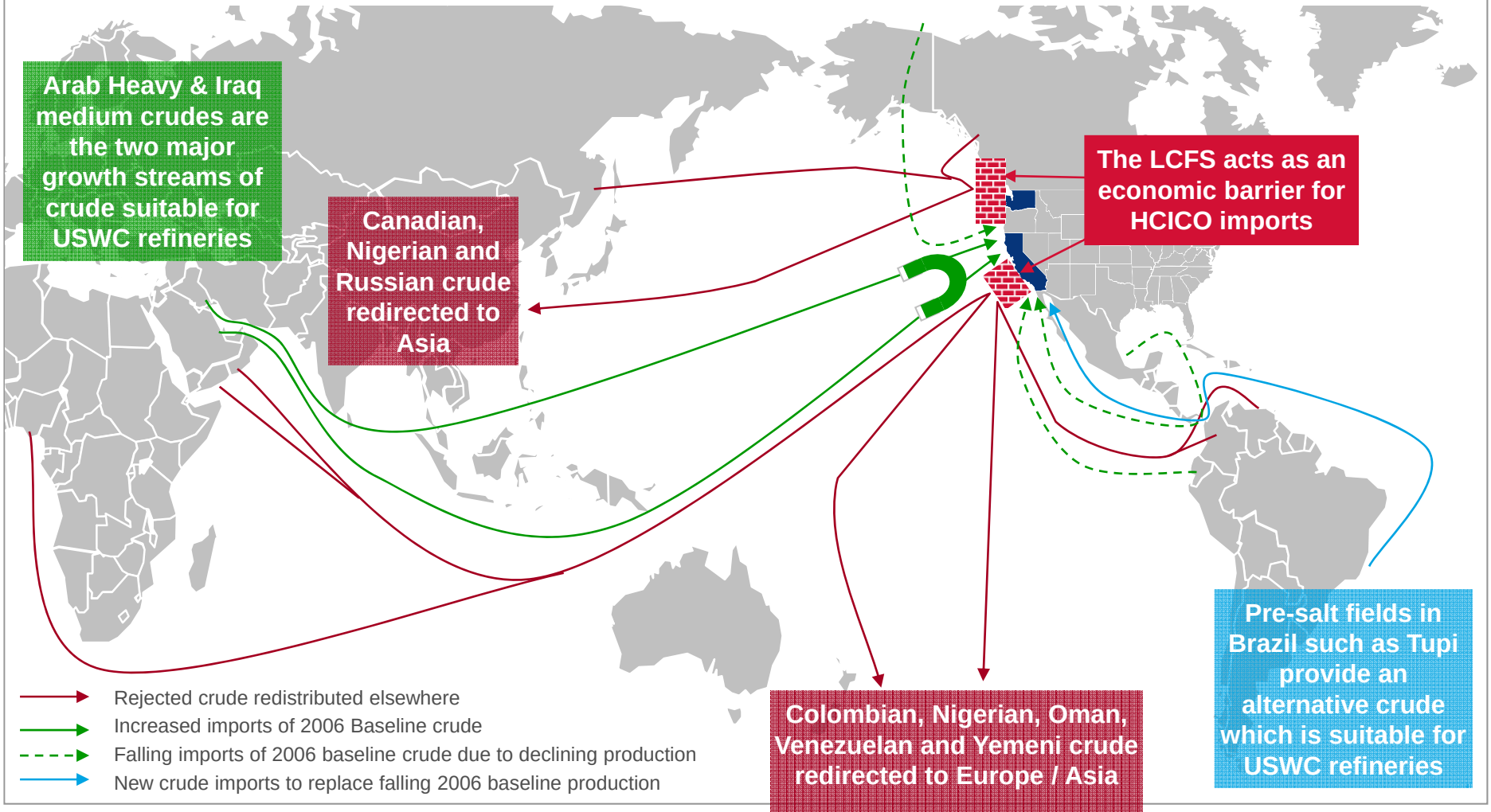


Source: Wood Mackenzie, Clarksons, Worldscale, National Energy Foundation

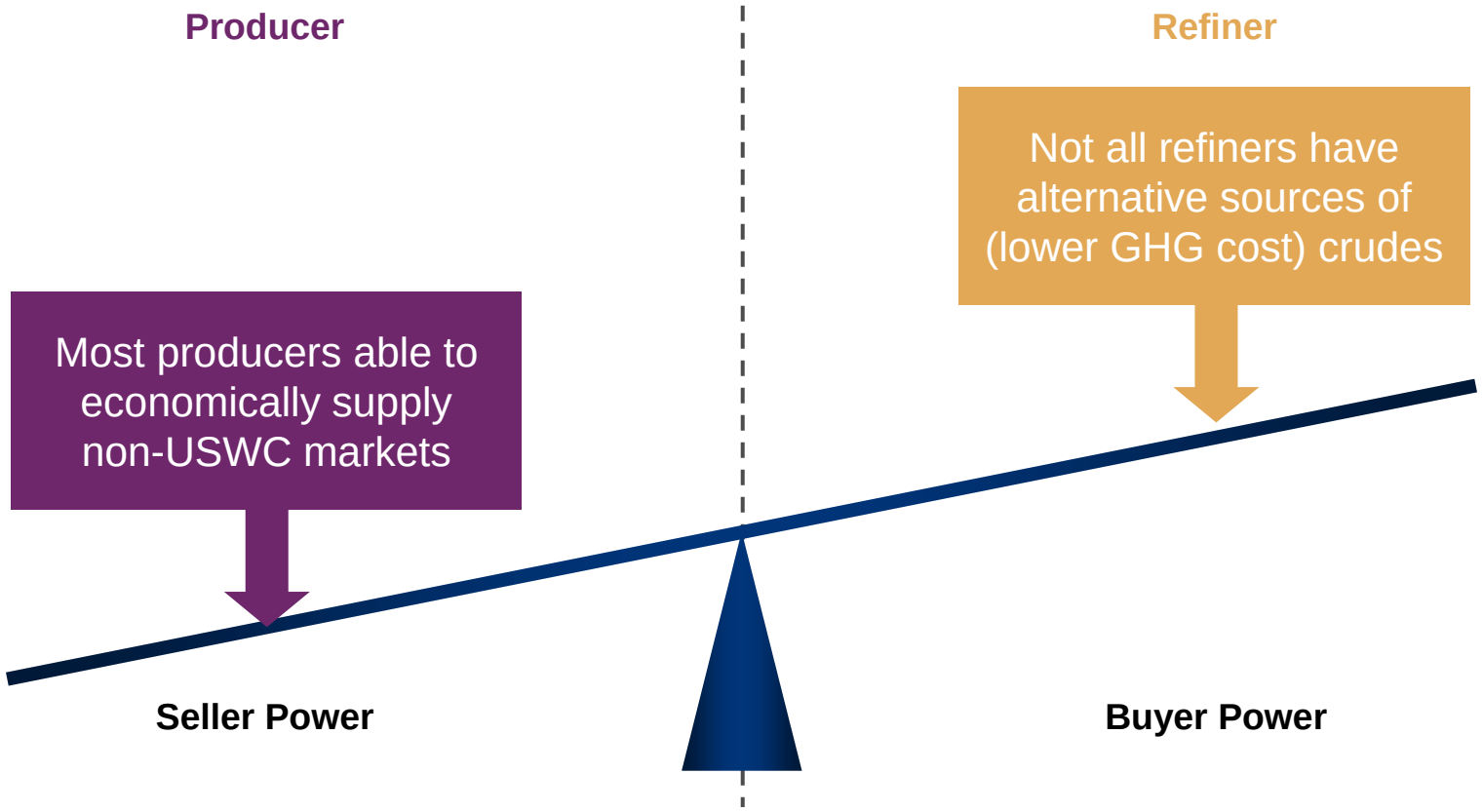
Demand for Middle Eastern 2006 baseline crude could rise, drawing crude from other markets and increasing GHG freight emissions



LCFS is likely to push regional HCICOs into Asia and increasingly draw in 2006 baseline crudes from the Middle East, increasing GHG freight emissions



Most crude suppliers to PADD V markets have other supply options so producers potentially are unlikely to pay all of the crude GHG burden

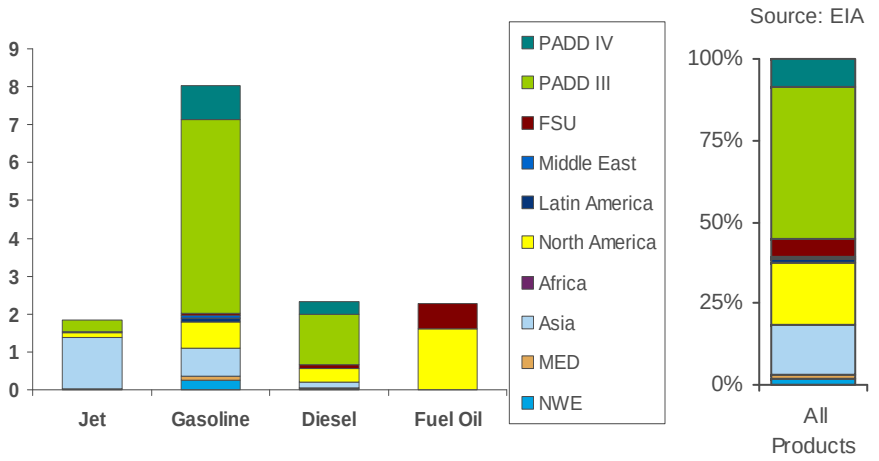


If producers have alternative markets, they might force the cost of compliance on refiners

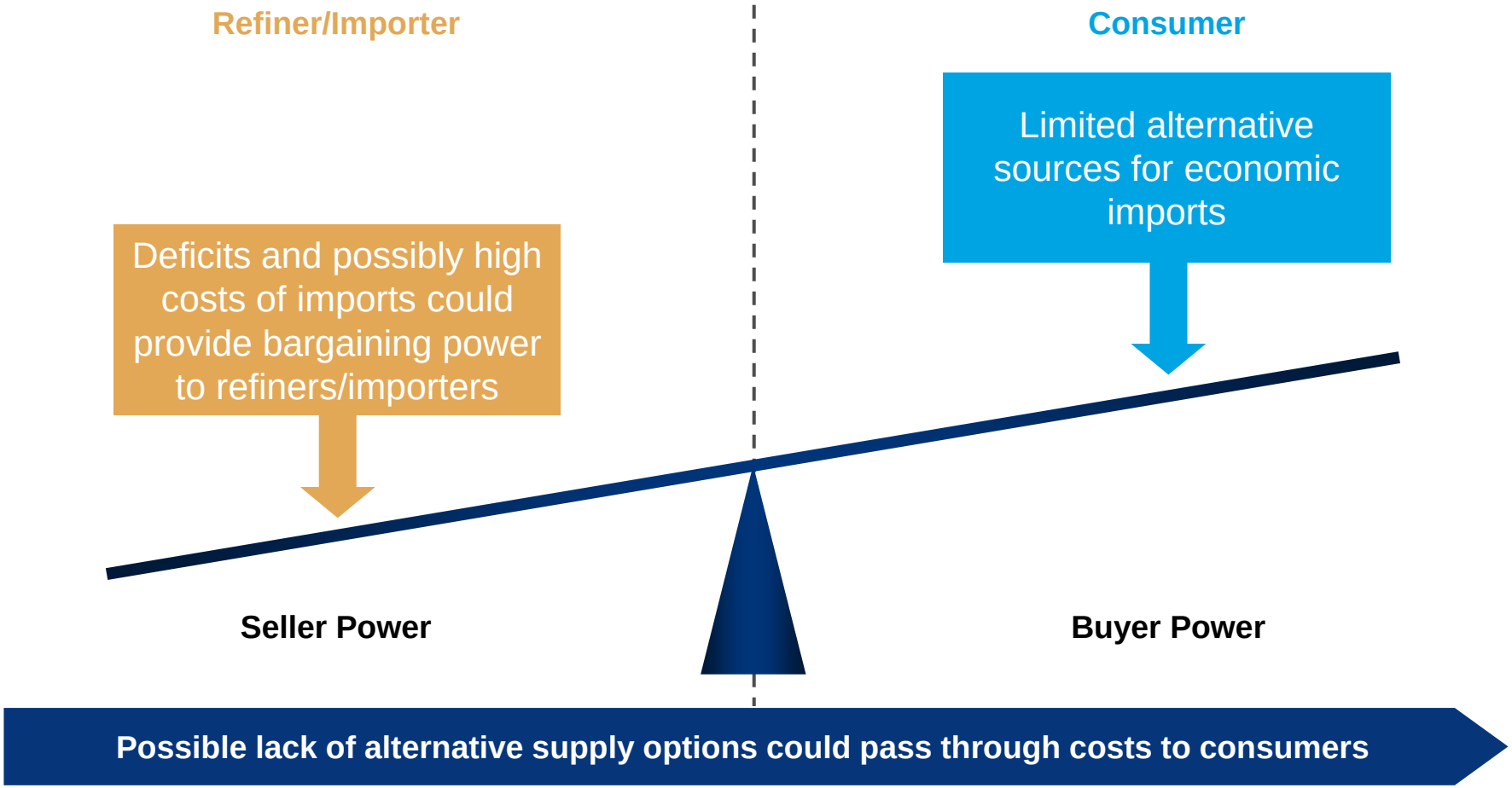
Carbon burden on California refineries could threaten security of supply

- **PADD V is a product deficit market**
  - CARB fuels are difficult to produce because of its complex specifications
  - Only a limited number of refiners outside PADD V can make CARB-compliant fuels
  - PADD V is geographically isolated; fuel supply from outside the region is difficult and costly
  - Asia has large and growing deficits for oil products, which further limits both crude and product availability for California
- **Assuming California demand is constant a carbon cost could**
  - Potentially reduce refinery margins leading to…
  - Potentially reduced refinery runs leading to…
  - Potentially creating a need for more imports…
  - Potentially resulting in a higher product price environment if incremental product imports come from farther distances

PADD V oil product imports 2009 (Mt)



Consumer prices in California possibly may rise from a CO2 burden



Conclusions

- Cost of crude oil differentiation could find its way into petroleum product consumer prices
- Crude oil differentiation likely to increase security of supply concerns as some 2006 baseline production declines
- Crude oil markets are global so high carbon crudes rejected by one market are likely to supply markets where no carbon cost exists
- Crude oil “shuffling” as tankers passing each other with near-by “high intensity” crudes oils displaced by long-haul “low intensity” could increase in GHG emissions

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