Renewable Biofuel Analysis
Refinery Conversions, Crack Spreads, & Risks
Q420

Michael Webber, CFA
Managing Partner
michael.webber@webberresearch.com
W: (646) 993-0693 M: (434) 409-8909

Greg Wasikowski, CFA
Associate Partner
greg.wasikowski@webberresearch.com
W: (646) 993-0694 M: (717) 919-3367

Chris Tsung, CFA
Associate Analyst
chris.tsung@webberresearch.com
W: (646) 998-8290 M: (646) 515-9957

Eric Smith
Managing Partner, EPC Risks
eric.smith@epcrisks.com
W: (346) 337-7788

Robert Meaney
Managing Director, EPC Risks
robert.meaney@epcrisks.com
W: (832) 368-8456

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Key Takeaways

Renewable Fuel Production… Just In Time Or Too Late?

- California & Oregon have mandated Carbon Intensity (CI) reductions in transportation fuels, which could increase demand by ~350%, from ~400MM gallons/year to 1,400MM by 2025. Ten other states are evaluating similar LCFS programs, which could potentially push U.S. demand toward 2,400MM gallons/year, up ~600%. *(Pages 7 & 8)*
- Biofuel crack spreads, based on feedstocks ratios of oil, grease, fat & hydrogen costs, have been comparable, if not more profitable, than recent trends in traditional refining. *(Pages 4-5, & 7)*
- However, as new biofuel units come online, market saturation and feedstock constraints could change the economics, which places even more emphasis on **speed-to-market**. *(Page 7)*

Refinery Conversions: FAME vs. HVO

- **Emerging trend in Biofuels:** a transition from **Fatty Acid Methyl Ester** (FAME) to Hydrotreated Vegetable Oil (HVO), *which provides biofuels a longer storage life & can be used in colder climates.* *(Page 10)*
- FAME & HVO biofuels are produced using a refinery's hydrotreater & isomerization, or a hydrocracking unit with a steady supply of hydrogen. *HVO economics are dependent on hydrogen prices & feedstock ratios.*

Hydrogen's Increased Demand In Biorefining

- As of early 2020, traditional oil refining consumed ~1/3 of the global Hydrogen demand.
- FAME biorefining requires similar Hydrogen consumption relative to traditional refining, but HVO biorefining uses *significantly more* Hydrogen depending on the process units (i.e. Hydrocracker – 3X H2 or Hydrotreater – 44X H2). *(Page 10)*

Speed To Market Matters: Owners, Operators, & Contractors

- ~10 years ago, companies were chasing another speed to market trend, NGL production and fractionation. Flexible and decisive companies (e.g. EPD, ET, etc.) quickly capitalized on this opportunity and captured market share.
- Large Energy companies (e.g. Exxon, Shell, etc.) are not typically structured to move quickly refining industry (VLO, PSX, MPC) and take on the speed to market risk. However, depressed refining margins are forcing some companies to move quickly into the biofuels arena due to their historical refinery investments.
- ***Early Leaders Of The Biofuel's Race:*** Valero (VLO), Renewable Energy Group (REGI), Holly Frontier (HFC), & Global Clean Energy Holdings (GCEH), with Primoris (PRIM) & Worley (XASX: WOR) positioned as contractors of choice.

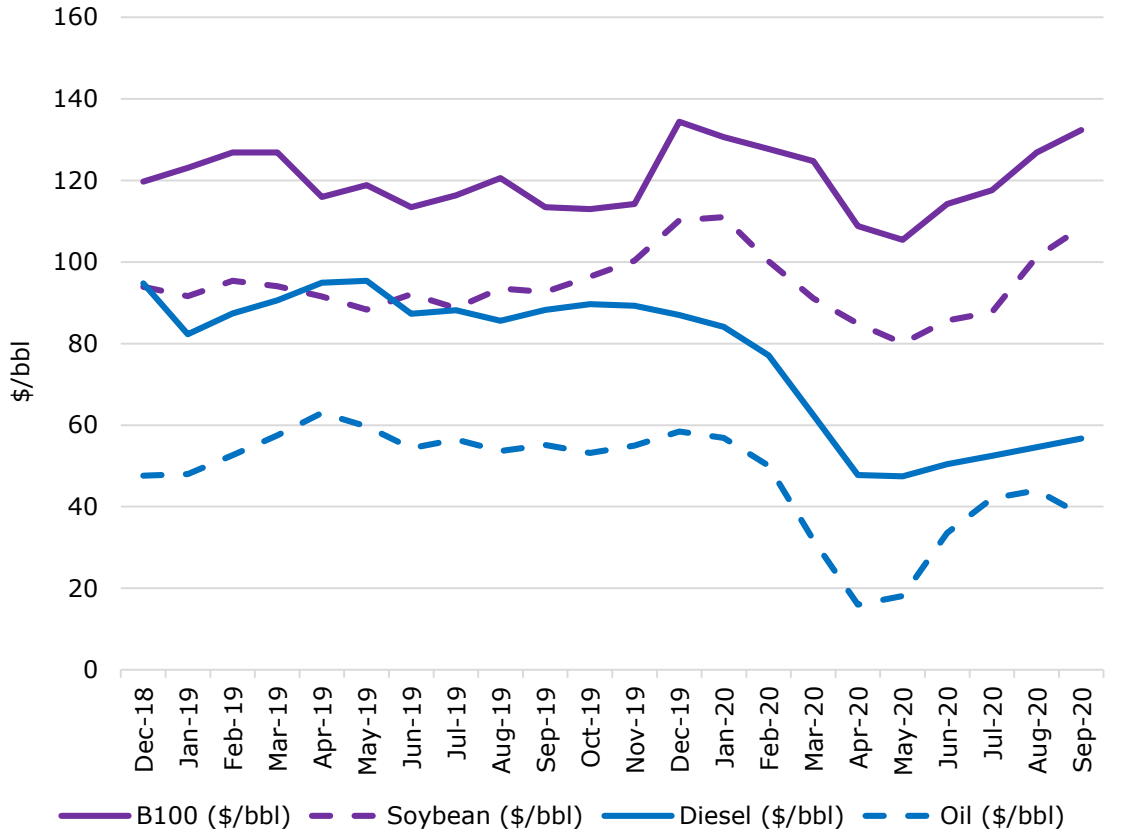
Biofuels: Costs, Risks, & Incentives

Renewable Fuels vs. Traditional Refining Economics

Overview

- **What Changed:** Industry demand for petroleum-based transportation fuels (i.e. diesel) has decreased due to COVID-19 impact & government regulations, i.e. California's Low Carbon Fuel Standards, (LCFS).
- **Why Does That Matter:** The LCFS provided two options for fuel producers: (i) higher taxes for petroleum fuels; or (ii) incentives for renewable fuel (e.g. B100 – Drop in biodiesel with no mixing), which has resulted in numerous renewable fuel projects announced and/or in construction. *(Page 8)*
- **What's The Impact**: Renewable diesel prices are recovering faster due to increased demand, which is changing transportation fuel market economics & the refining industry.
- **Key Thoughts & Takeaways**: In Sep 20, renewable diesel prices returned to 2019 levels; unlike Diesel, which is down ~40% from 2019 highs. Given the forecasted biofuel demand, prices could continue escalating until supply catches up.

Renewable (No Tax Incentives) vs. Traditional Fuels



Sep 2020 Biofuel Prices Are Back To 2019 Highs; Oversupplied Diesel Is Down ~40%.

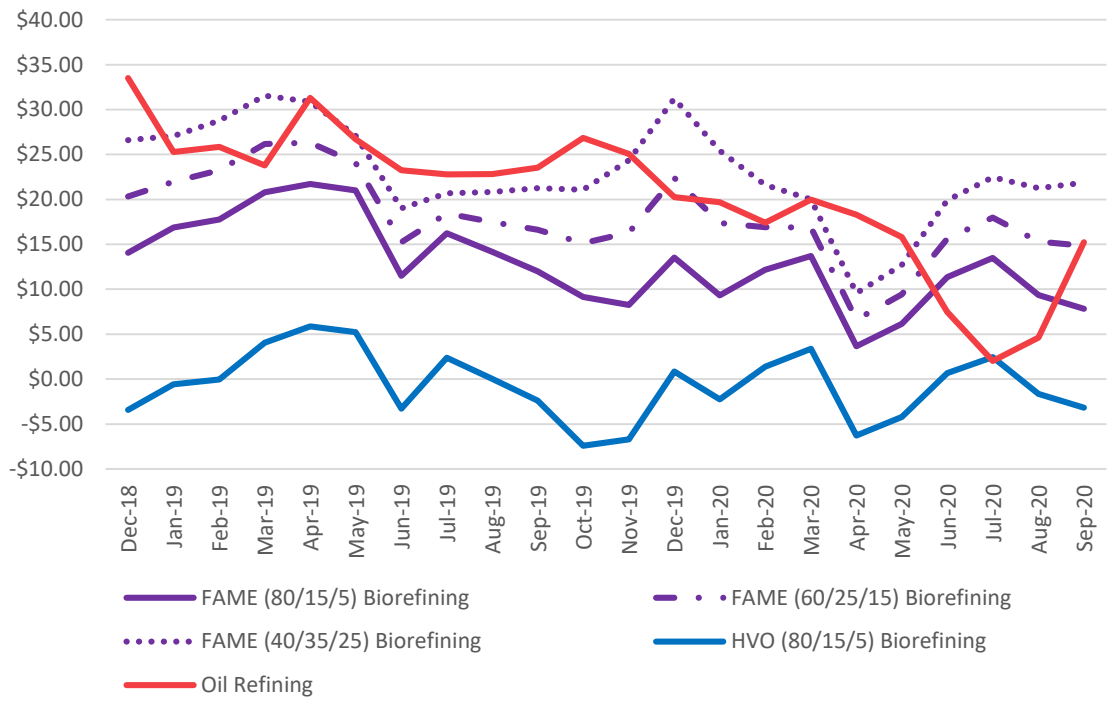
Source: USDA, EIA, Public Sources, Company & Regulatory Filings, W|EPC Analysis

Crack Spread Analysis – Ratios Matter

Overview

- **What Changed:** Crack spread is the difference between revenue from refined products & feedstock costs per barrel. Our case study analyzed the crack spreads (over the last 21 months) for an indicative 100K BPD refinery vs. a 45K BPD biorefinery ***including blue hydrogen costs***.
- **Why Does That Matter:** Biorefining has trended towards a higher crack spread without factoring in the federal & state tax incentives.
- **What's The Impact**: With tax incentives, the economics of biorefining have incentivized more companies to look at this industry, convert refineries due to increased biofuels demand, economics, etc.
- **Key Thoughts & Takeaways**: Our model shows variations of FAME production and how the crack spread changes based on the feedstock ratio of Soybean Oil, White Grease, & Yellow Grease. Biorefining that utilizes more White & Yellow Grease in their Feedstock will improve their crack spread.

100K bpd Refinery vs. 45K bpd Biorefining



Feedstock for FAME & HVO – (Soybean Oil / White Grease / Yellow Grease)

Feedstock Ratios Is A Major Factor In The Profitability Of Biorefining.

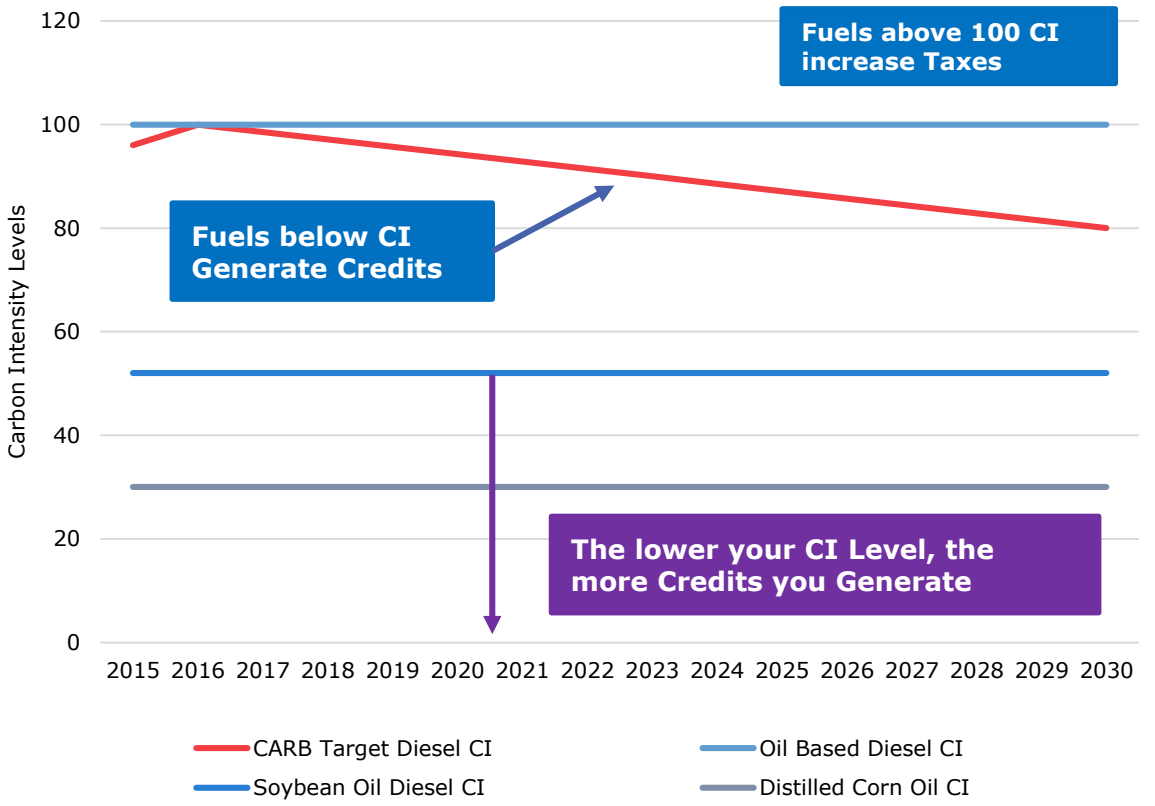
Source: USDA, EIA, Public Sources, Company & Regulatory Filings, W|EPC Analysis

The California Renewable Fuel Rush

Overview

- **What Changed:** California Air Resources Board (CARB) has set annual gasoline & fuel CI limits through 2030. CI is the total green house gas emissions (GHG) from feedstock through combustion.
- **Why Does That Matter:** Companies (refiners) have two options: (i) be taxed (aka, produce traditional diesel); or (ii) receive financial incentives for reducing their CI levels below state mandates (aka produce renewable diesel.
- **What's The Impact**: ~170-years ago, we had the California gold rush. In 2020, we have the ***California renewable fuel rush***.
- **Key Thoughts & Takeaways**: Companies (inside & outside California) are developing renewable fuel facilities due to increased demand, lucrative financial subsidies, & capture all-important market share.

Lower The CI More Tax Credits



The Lower The CI Levels, The More Tax Credits Generated.

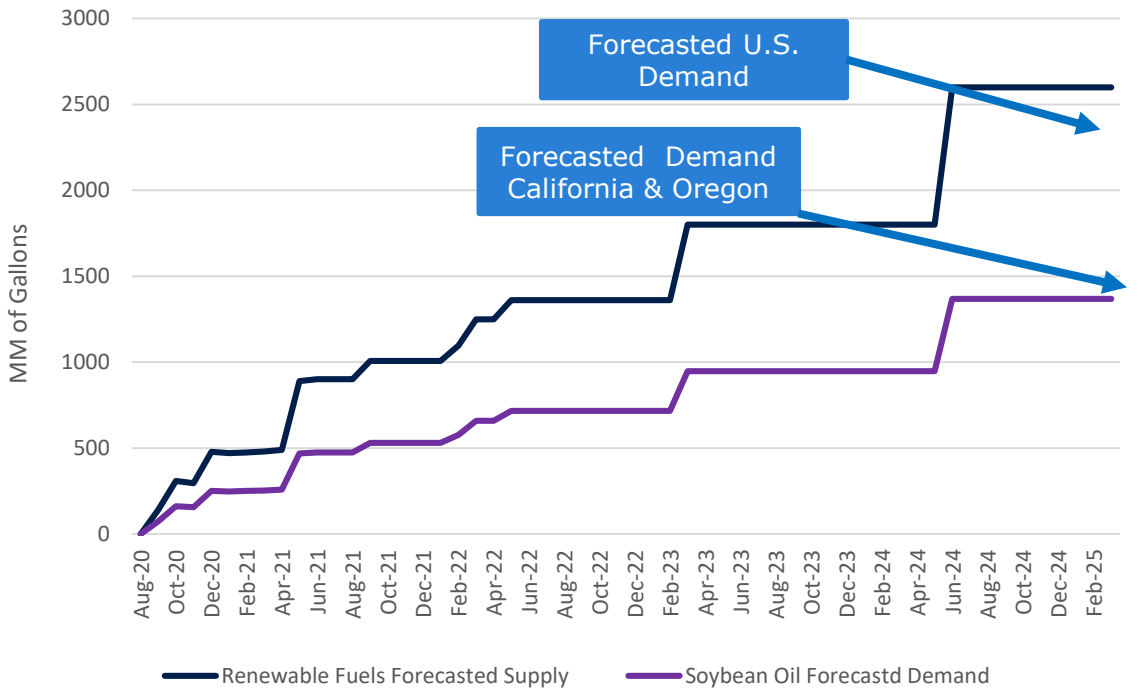
Source: Public Sources, CARB, Company & Regulatory Filings, W|EPC Analysis

Biofuels & Soybean Oil Supply/Demand

Overview

- **What Changed:** As of early Sep 20, only Oregon & California have LCFS mandated laws, which represents ~1,400MM gallons of biofuels demand by 2025.
- **Why Does That Matter:** (10) states are evaluating their own LCFS programs, which could increase the biofuels demand to ~2,400MM gallons by 2025.
- **What's The Impact**: We incorporated potential biofuel projects (page 8) & forecasted soybean oil demand using historic feedstock ratios. If soybean oil supply cannot keep up with biofuel demand, owners will need to hedge feedstock prices to protect from market volatility or use more white & yellow grease in their feedstocks.
- **Key Thoughts & Takeaways:** If future biofuel demand is delayed, projects that were already in construction should have first to market advantages. However, if large scale biorefineries are late to market they could undercut first to market smaller capacity biorefineries. Higher biorefining capacity provides production efficiency to offset market fluctuations and undercut smaller capacity competitor's pricing.

Government Mandates Drive Biofuel Supply



Increased Biorefining Could Result In Premium Prices For Feedstocks & Market Volatility.

Source: Public Sources, USDA, Company & Regulatory Filings, W|EPC Analysis

Biofuels Project Tracker

Owners	Location	Capacity (MM Gal/Yr)	FID	Completion	TIC ($M)
Marathon	North Dakota	291	Yes	2020	$470
Ryze Renewables	Las Vegas, NV	115	Yes	2020	$280
Ryze Renewables	Reno, NV	169	Yes	2020	$250
Global Clean Energy Holdings	Bakersfield, CA	291	Yes	2021	$400
CVR	Wynnewood, OK	107	No	2021	$100
Diamond Green	Norco, LA	675	Yes	2021	$1,100
Holly Frontier	Artesia, NM	110	Yes	2022	$360
Holly Frontier	Cheyenne, WY	90	Yes	2022	$175
PSX	Rodeo, CA	800	No	2024	$800
Diamond Green	Port Arthur, TX	400	No	2024	$2,000
Velocys	Mississippi	TBD	No	2025	TBD

The FID Project's Capacity Is ~1,700MM Gallons/Year, Which Is More Than CA & OR's Forecasted Demand.

Source: Public Sources, Company & Regulatory Filings, W|EPC Analysis

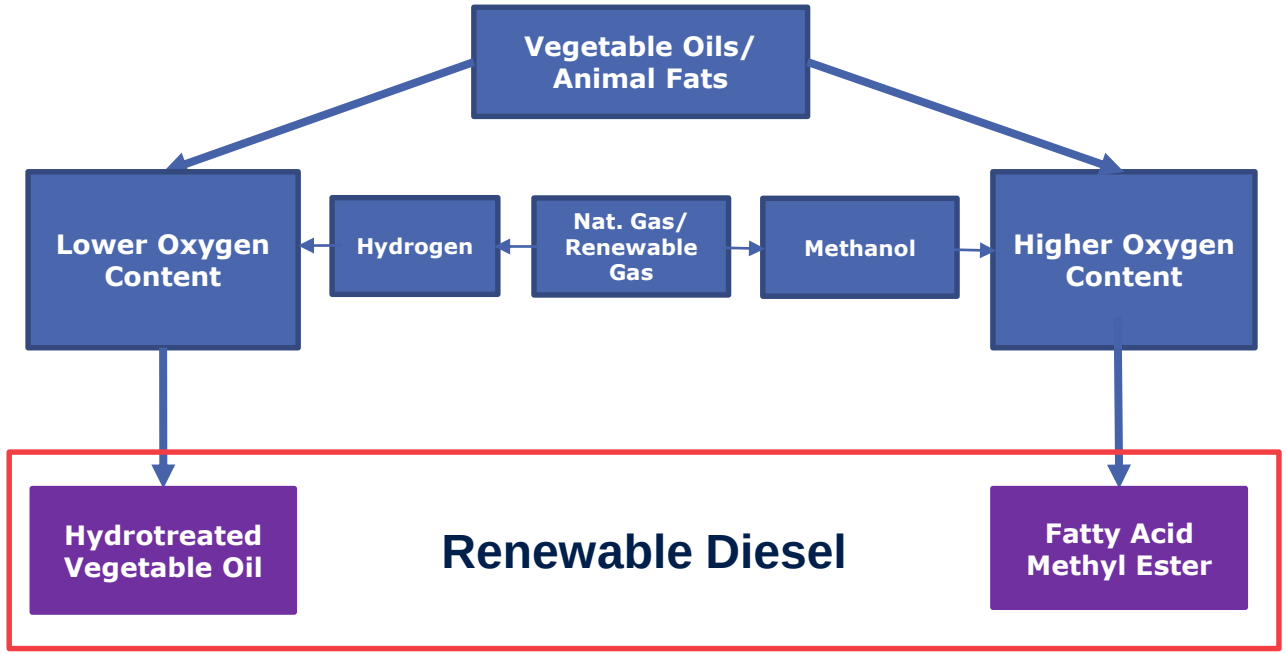
Hydrogen Increased Demand in Biorefining

HVO vs. FAME Biofuels

Overview

- **What Changed:** Renewable fuels can be produced as a Hydrotreated Vegetable Oil (HVO) or a Fatty Acid Methyl Ester (FAME).
- **Why Does That Matter:** Deoxygenated biofuel (HVO) creates more possibilities for the future biofuels. As an example, ***HVO's can be stored longer and perform in cold weather environments***.
- **What's The Impact**: The Hydrogen demand for a HVO facility is 3x higher in hydrocrackers and up to 44x higher in hydrotreaters. The Hydrogen demand reduces economic incentives for this type of facility.
- **Key Thoughts & Takeaways**: Companies like Haldor Topsoe (Industry Leader in Biorefinery conversion) are improving HVO Technologies to reduce Hydrogen needed and improve HVO economics. However, this has not stopped companies like Diamond Green Energy (Valero and DAR) from investing in this market. They recently commissioned a HVO unit in Norco, LA primarily with ***Yellow & White Grease (11% of U.S. production)*** and have plans to expand this unit and build another facility in Port Arthur, TX.

Renewable Fuels Paths



HVO Production Requires More Hydrogen, Which Provides Technical Benefits But Decreases Returns.

Source: Public Sources, PNNL, Company & Regulatory Filings, W|EPC Analysis

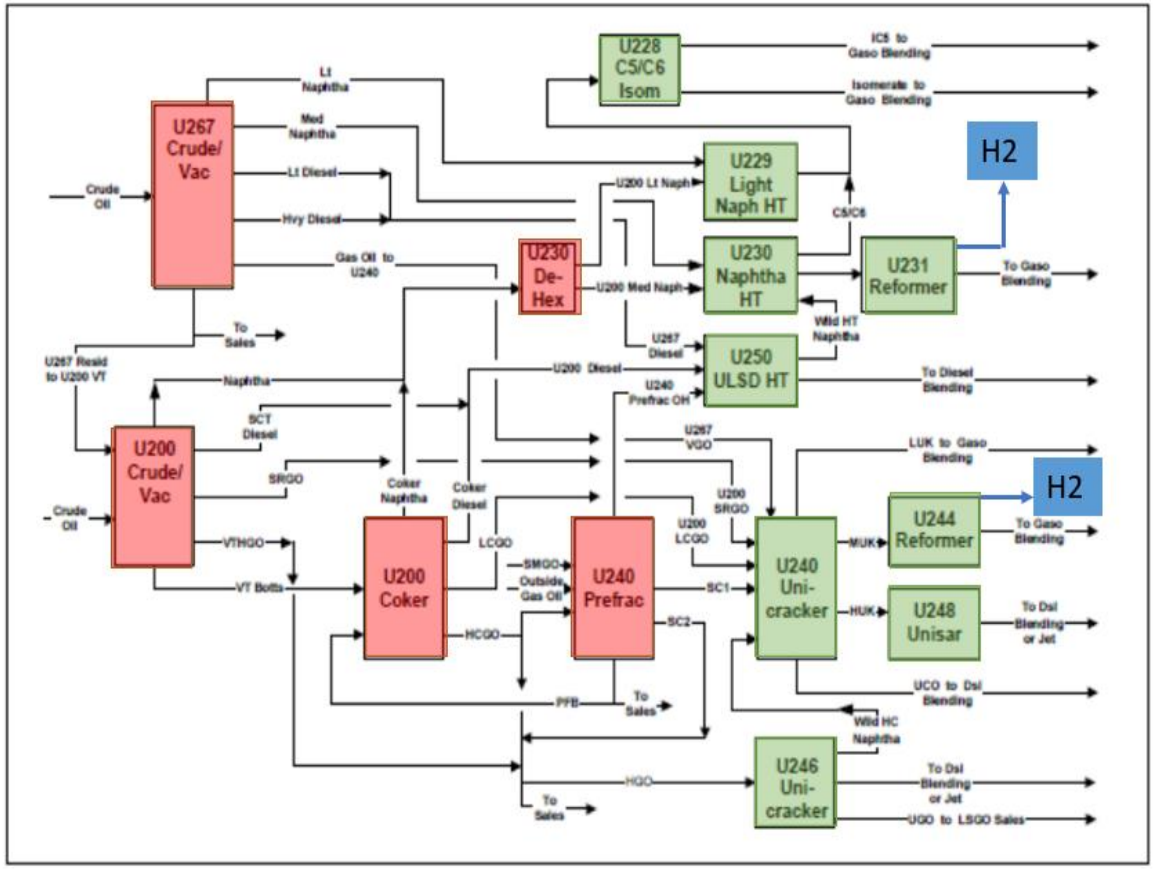
PSX’s Rodeo Refinery Conversion

Rodeo Refinery Conversion Overview

Overview

- **What Changed:** On Aug 12, 2020, PSX announced an ~$800MM project to convert their 140K bpd Rodeo Refinery to produce 45K bpd of renewable diesel, gasoline, & jet fuel.
- **Why Does That Matter:** The Rodeo Refinery conversion would create the largest renewable fuels unit in the U.S. and provide better economics (compared to smaller facilities).
- **What's The Impact**: The Rodeo refinery forecasted production could consume a large portion of biofuel demand & feedstocks supply.
- **Key Thoughts & Takeaways**: We analyzed the Rodeo Refinery configuration and the units that need decommissioned (red), reconfigured (green), and hydrogen's role (blue) to produce biofuels. If future biofuel demand is lower than expected and lowers the crack spread, larger capacity project's like the Rodeo Refinery, should be more profitable than smaller biofuel facilities.

Decommission vs. Reconfigure



The Rodeo Refinery Conversion Has The Infrastructure Necessary To Transition To HVO Or FAME.

Source: Company & Regulatory Filings, W|EPC Analysis

PSX Project Comp – WA vs. CA

Overview

- **What Changed:** In Nov 2018, PSX announced a renewable diesel plant in Washington, which was ultimately cancelled due to environmental permitting challenges. PSX has turned their attention to their California project.
- **Why Does That Matter:** California has a reputation for being a difficult permit/regulatory state for any hydrocarbon processing facility.
- **What's The Impact**: Delays in the Rodeo Refinery Conversion permitting process could open the door for additional out of state biofuel producers to capitalize on demand and beat California refiners to the market.
- **Key Thoughts & Takeaways**: As of mid-Sep 2020, PSX has not filed their permit application for the Rodeo Refinery conversion project which could delay their 2024 completion.

Philips 66 Biofuel Project Comps

	Biofuel Plant	Rodeo Refinery Conversion
Location	Ferndale, WA	Rodeo, California
Announced	Nov 2018	Aug 20
Type	Greenfield	Conversion
Capacity	16K BPD	45K BPD
Permit Status	Cancelled due to Permitting Challenges	Have Not Submitted Application
Estimated Cost	$1B	$500MM to $1B
Completion	n/a	2024

Permitting Risks Exist On The West Coast Even For Biofuel Facilities.

Source: Company & Regulatory Filings, W|EPC Analysis

Biofuel EPC Dynamics

EPC Contractor Rankings

Overview

- **What Changed:** Contractors are looking to position themselves to capture biorefining projects in order to become a leader in a growing market.
- **Why Does That Matter:** As Owners are looking to develop projects, choosing the right contractor is just as important as getting into the industry early.
- **What's The Impact**: Choosing the wrong contractor leads to poor design, schedule and cost overruns and lost production by owner/operators.
- **Key Thoughts & Takeaways**: There are many factors in choosing the right contractor based on the project's size, contract structure, & scope of work. The EPC industry has changed over the last 10 years. Many blue-chip EPC contractors have taken on their share of bad projects (i.e. Fluor, McDermott), which damaged balance sheets and has resulted in risk avoidance at all costs.

Key EPC Contractors

	Project Size ($MM)		EPC Contract Structure		Current Biofuels Project	Our Rankings	
	$0-$500	$500+	Lump Sum	Reimbursable		Engineering	Construction
Worley					Yes	1	6
RDS						2	2
Primoris						6	1
S & B					Unknown	4	4
Fluor						3	5
Kiewit						5	3

Key Considerations for Contractor Rankings

- Size of project - $100MM to $200MM or $500M to $1B+
- Refining & biofuel expertise
- Locations
- Greenfield (New) or Brownfield (Conversion)
- Lump Sum vs. Reimbursable Contract Capabilities
- EPC contractor's team & depth (biofuel subject matter experts)
- Ability to work with Haldor Topsoe (or Licensors in general) – Leading Technology

EPC Contractor Selection Will Enable Owners To Achieve Speed To Market.

Source: Company & Regulatory Filings, W|EPC Analysis

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