

High Oil Prices & Alternative Fuels Impacts on the US & Global Downstream

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EnSys: Refining Economics Technology Modeling

Abstract

"High Oil Prices & Alternative Fuels Impacts on the US & Global Downstream "

In 2005, the world is facing the potential for sustained high oil prices and for relative tightness in the downstream industry. High prices will spur growth in alternative and non-conventional fuels. A report by Oak Ridge National Laboratory has identified potential for an additional 1 billion tons per year of biomass production in the US, sufficient to displace oil from one third of US transport fuels. The EU is mulling regulations to mandate 5% or more biofuels in its transport fuels and other regions are considering similar biofuels incentives. Qatar and other nations are committing to multi-billion dollar GTL projects; Canada and Venezuela are expanding their production of non-conventional oil – and China is entering into coal to liquids projects on a significant scale.

This paper examines the potential impacts of these developments on the US and global downstream – versus a “business as usual” reference. Quantitative projections to 2020 are presented from application of EnSys’ integrated WORLD model of the global petroleum supply, refining and transportation system. The focus is on how the “1 billion ton” US biofuel and other developments will alter refining operations, capacity, investments, crude and product trade and price differentials in the US and other world regions.



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Summary of Presentation

- 2 perspectives on 2020 global oil downstream
 - “business as usual”
 - high price / alternative outlook
- Focus on:
 - non-conventional & alternative fuels supply
 - demand reduction
- WORLD model assessments of 2020 outlook:
 - refining capacity / investments
 - market prices / differentials
 - trade
- Implications



2020 Outlook

emerging alternative scenarios

- Both IEA and EIA forecasts made in 2004/2005 reflect potential wide range in global outlook by 2020
- “business as usual” (**BASE**)
 - Current high oil prices are a temporary phenomenon
 - Peak oil doomsayers wrong, optimists right
 - OPEC re-establishes & maintains capacity surplus – even with strong demand growth, re-establishes control over oil price
 - Oil prices revert to at or below \$30/bbl
- Alternative (**ALT**)
 - OPEC strain to maintain supply growth, signs of “peak oil”
 - High oil prices (\$35 - \$40+ /bbl) are set more by the marginal high-cost technologies
 - The potential / prospect for continued high prices creates strategic shifts away from dependence on conventional oil
 - Expressed through:
 - Growth in non-conventional & renewable supplies
 - Reduction in oil product demand through shifts from oil and conservation



2020 Outlook

potential exists for large increases in non-conventional /
alternative fuels

Potential Non-conventional / Alternative Fuels Supply 2020

	base	alternative	difference
Oil Price	moderate	high	
	\$28.50	\$44.33	
EIA AEO 2005 Case	Reference	High Oil B	
Extra Heavy Oil / Syncrude / Shale Oil	4.1	5.9	1.8
Canada - Western Oil Sands	3.4	4.4	1.0
Venezuela - Orinoco upgraded	0.7	1.5	0.8
NGL's	10.3	10.6	0.3
Petchem Streams	1.0	1.0	0.0
GTL's	1.25	2.25	1.0



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2020 Outlook

potential exists for large increases in non-conventional /
alternative fuels

- **Canada oil sands**
 - Vast reserves, proven technology, economics
 - Current projections by Canadian industry & government are for 2.5 - >3 mmbpd by 2015, hence Base 3.4 by 2020 and stretch 4.4
- **Venezuela Orinoco**
 - Political uncertainties could flatten growth but plants in place, production & upgrading technologies proven



2020 Outlook

potential exists for large increases in non-conventional / alternative fuels

- NGLs
 - Offsetting effects in Alt Case:
 - Lowered oil production will cut NGL output but
 - Higher gas production will offset
 - Net small increase projected in Alt case
- Petchem Naphtha demand and returns assumed little impacted
- GTL production substantially higher in Alt case as high oil prices relative to gas raise incentives (EIA High B case has only small increase in gas prices)



2020 Outlook

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CTL's	0.55	2.5	1.95
South Africa	0.25	0.5	0.3
USA	0	0.75	0.8
China	0.25	1.0	0.8
India/Other	0.05	0.25	0.2
Biomass - Ethanol/Biodiesel	1.35	2.55	1.2
USA	0.6	1.2	0.6
Brazil	0.5	0.5	0.0
Europe (EU)	0.15	0.65	0.5
Other	0.1	0.2	0.1



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2020 Outlook

potential exists for large increases in non-conventional /
alternative fuels

- CTL's

- Recent EIA outlook indicated potential for substantial CTL production from large US coal base – and Energy Policy Act contains incentives
- China has large coal reserves, is moving ahead with project (part of strategic diversification) and has announced plans to go to 1 mmbpd plus
- India has large coal reserves and has announced projects
- South Africa potential to expand
- Other players already have production



2020 Outlook

potential exists for large increases in non-conventional /
alternative fuels

- Biomass

- USA

- Energy Policy Act RFS mandates 7.5 bn gal/yr by 2012 and maintaining ratio to gasoline thereafter
 - Oak Ridge study has shown potential to produce ethanol from “cellulosic” wastes equivalent to 10% of US transport fuels by 2020, 20% by 2030
 - EnSys 2020 Alt projection equates to around 7% including ethanol from corn, i.e. around 3.5% each from corn based and cellulosic ethanol

- Europe

- EU has announced tentative target of 20% alternative fuels in transport fuels by 2020
 - Production already exists in several EU countries and is growing rapidly, emphasis on bio-diesel
 - EnSys Base case assumes 2% level by 2020, Alt case 8% level



2020 Outlook

potential exists for large increases in non-conventional / alternative fuels

- Biomass

- Brazil is a major ethanol producer with growing share of ethanol/flex fuel vehicles
- Several other countries are developing plans

Flex fuel vehicles Brazil
% share of market



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Biomass - Ethanol/Biodiesel	1.35	2.55	1.2
Total	18.6	24.8	6.2
Demand	110.1	102.2	(7.9)
Total Impact Alternative vs. Base			14.1
			13%



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2020 Outlook

potential exists for large increases in non-conventional / alternative fuels

- Total non-conventional/alternative supply
 - Potential is for increase of 6+ mmbpd supply by 2020 driven by strategic concerns, policy mandates/incentives versus Base
- Demand Reduction
 - Per EIA and IEA projections, substantial potential exists to reduce demand through technology / conservation incentives/application and as result of higher oil prices
 - WORLD cases were based on EIA AEO cases at Base 110.1 and Alt 102.2 mmbpd 2020, difference -7.9 mmbpd
- Combined impact of supply increase plus demand reduction is 14+ mmbpd
- A major effect is to reduce OPEC conventional supply



2020 Outlook

Demand impact detail

- Projected demand impact spread across all fuels
- Largest reductions in gasoline and distillate
- WORLD results differ slightly from EIA as internal consumptions and coke and sulfur by-products are developed directly in the model

SUMMARY OF DEMAND - 2020 - FROM WORLD MODEL ACTUAL CASES			
	BASE	ALT	Change
mmbpd			
LPG's & Ethane	10.7	10.1	(0.6)
Naphtha	10.4	9.7	(0.7)
Gasoline	26.1	23.4	(2.7)
Jet/Kero	9.5	8.9	(0.6)
Distillate	32.9	30.7	(2.2)
Residual Fuel	10.7	9.8	(0.9)
Other	10.4	8.6	(1.8)
Total	110.7	101.1	(9.5)



EnSys: Refining Economics Technology Modeling

WORLD Model

- Integrated LP model of the global downstream:
 - Crudes & non-crudes supply
 - Refining and “non-refinery” processing & investments
 - Product demand & quality
 - Transportation of crudes, non-crudes, intermediate and finished products
- Not a price/supply/demand forecasting tool
- Captures the activities and economics of the downstream under user-defined short/medium/long term scenarios
- Valuable for analysis of the combined impacts of sector developments on refining activities, investments, crude and product trade, associated economics
- Used by and for: DOE, EIA, EPA, API, OPEC, major oil companies



WORLD Model

- Study undertaken using 18 region global version

US East Coast

US Gulf Coast, Interior & Canada
East

US West Coast & Canada West

Greater Caribbean

Rest of South America

West Africa

North Africa/Eastern Mediterranean

East/South Africa

North Europe

South Europe

Eastern Europe

Caspian Region

Russia & Other FSU

Middle East

Pacific High Growth – OECD

Pacific High Growth – non OECD
Industrialising

China

Rest of Asia



2020 WORLD Results

- US and global:
 - refinery throughputs, capacity additions & investments
 - crudes & products market pricing / differentials
 - crude & product trade flows



2020 WORLD Results

- Substantial reduction in refining investments
- (Analysis does not include capital costs of alternative fuels)

Refining Investments \$bn	BASE		ALT		Change
REVAMP	\$	7.5	\$	6.6	\$ (0.9)
DEBOTTLENECKING	\$	4.6	\$	1.5	\$ (3.2)
MAJOR NEW UNITS	\$	172.4	\$	141.0	\$ (31.4)
TOTAL REFINING	\$	184.5	\$	149.1	\$ (35.4)



2020 WORLD Results

- Capacity additions and utilizations drop

CRUDE DISTILLATION BASE CAPACITY & ADDITIONS

mmbpcd	BASE	ALT	Change
BASE CAPACITY	83.13	83.13	0.00
FIRM CONSTRUCTION	1.07	1.07	0.00
DEBOTTLENECKING ADDITIONS	3.29	2.77	(0.52)
MAJOR NEW UNIT ADDITIONS	16.38	6.73	(9.65)
TOTAL ADDITIONS OVER BASE	20.74	10.56	(10.18)
TOTAL BASE + ADDITIONS 2020	103.87	93.69	(10.18)
TOTAL CRUDE CAP USED 2020	90.53	77.06	(13.47)
Refinery Utilization	87.2%	82.2%	(0.05)



2020 WORLD Results

- Widespread impacts but especially
 - US, Europe – reduced utilizations
 - Middle East / Asia – reduced capacity additions

Refinery Capacity Impacts (crude distillation)

	Global	USA & Canada	Latin America	Africa	Europe	FSU	Middle East	Asia / Pacific
mmbpcd								
Installed 2004	83.13	18.90	8.38	3.83	16.60	8.62	5.87	20.94
Additions to 2020 - Base case	20.74	2.20	2.42	1.91	0.08	1.95	3.35	8.84
Additions to 2020 - Alt case	10.56	1.58	1.50	1.54	0.00	1.20	1.01	3.74
Change	(10.18)	(0.62)	(0.92)	(0.37)	(0.08)	(0.75)	(2.34)	(5.10)
Total Crude Cap Used 2020	(13.47)	(2.89)	(0.83)	(0.32)	(2.21)	(0.75)	(2.09)	(4.39)
Refinery Utilizations - Base case	87.2%	94.5%	89.5%	84.9%	83.8%	74.1%	89.5%	87.3%
Refinery Utilizations - Alt case	82.2%	83.2%	89.5%	84.8%	70.9%	72.2%	89.5%	87.6%
Change	-4.9%	-11.3%	0.0%	-0.1%	-12.9%	-1.9%	0.0%	0.3%



2020 WORLD Results

- Reduced transport fuel demand cuts ULS desulfurization requirements

SECONDARY PROCESSING ADDITIONS - DESULFURIZATION			
mmbpcd	22.22	16.38	(5.84)
- GASOLINE - ULS	5.54	3.61	(1.92)
- DISTILLATE ULS - INCL REVAMP	12.47	8.48	(4.00)
- DISTILLATE ULS - REVAMP ONLY	7.06	6.96	(0.10)
- DISTILLATE CONV/LS	1.20	0.32	(0.88)



2020 WORLD Results

- Upgrading investments are less and shift from FCC and coking (carbon rejection) to hydro-cracking / treating (hydrogen addition)

SECONDARY PROCESSING ADDITIONS - MAJOR UNITS

mmbpcd	BASE	ALT	Change
VACUUM DISTILLATION	6.81	2.39	(4.42)
COKING	1.58	0.03	(1.55)
CATALYTIC CRACKING	2.14	0.19	(1.95)
HYDRO-CRACKING	5.05	5.66	0.61
HDS VGO/RESID	3.01	3.97	0.96
CATALYTIC REFORMING - New	0.87	0.64	(0.23)



2020 WORLD Results

- Implication is higher absolute oil price leads refiners to shift away from carbon rejection:
 - Raw material is worth more so use less
 - Approx 35 wt% of coker yield is coke worth only ~ \$1/bbl
 - (natural gas at \$6-8/MMBTU in ALT case)
 - However, projection may not take account of high “monolithic” cost of HCR/HCV units
 - (or investment figures used in WORLD may understate HCR costs)

CAPITAL COST		
USGC ISBL JAN 2000 BASIS		
	\$ million	capacity bpsd
COKING	\$140	40,000
HCR - GASOIL	\$195	40,000
HCR - RESID	\$265	40,000



2020 WORLD Results

- US Impacts
 - Demand and refinery throughputs decline
 - Some increase in product imports
 - US crude imports decline significantly

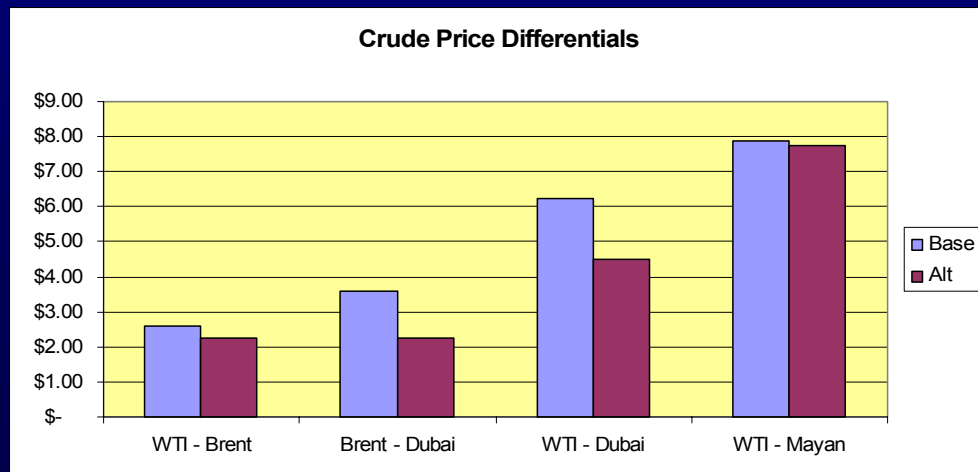
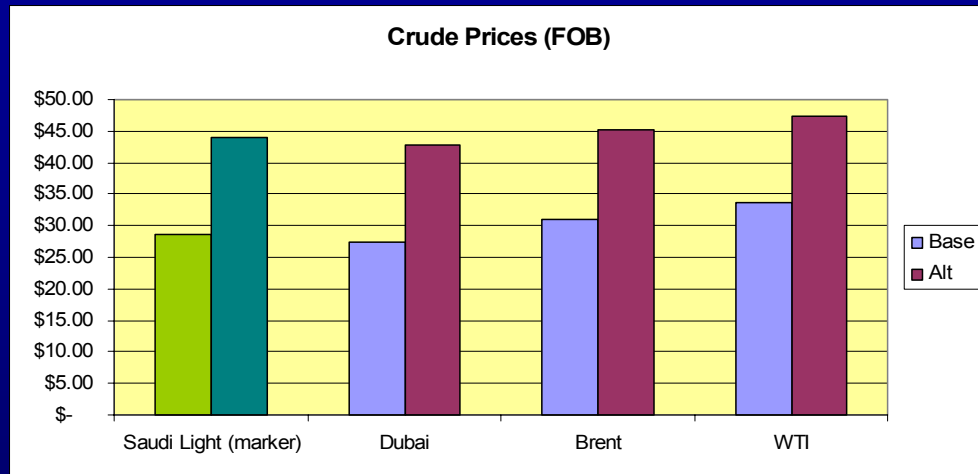
US+Canada Trade Changes Alt - Base

mmbpd	crude	products	total
imports (net)	(4.35)	0.86	(3.49)
production	1.46		
crude processed	(2.89)		



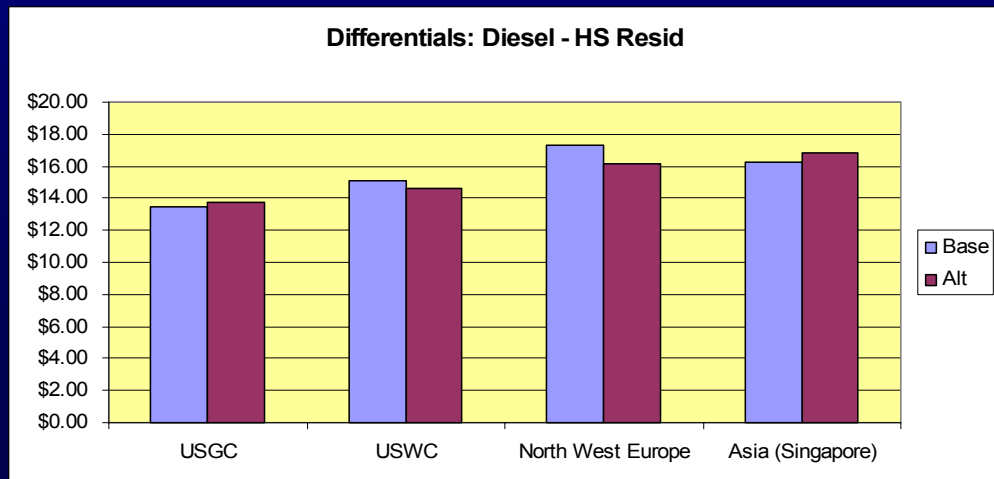
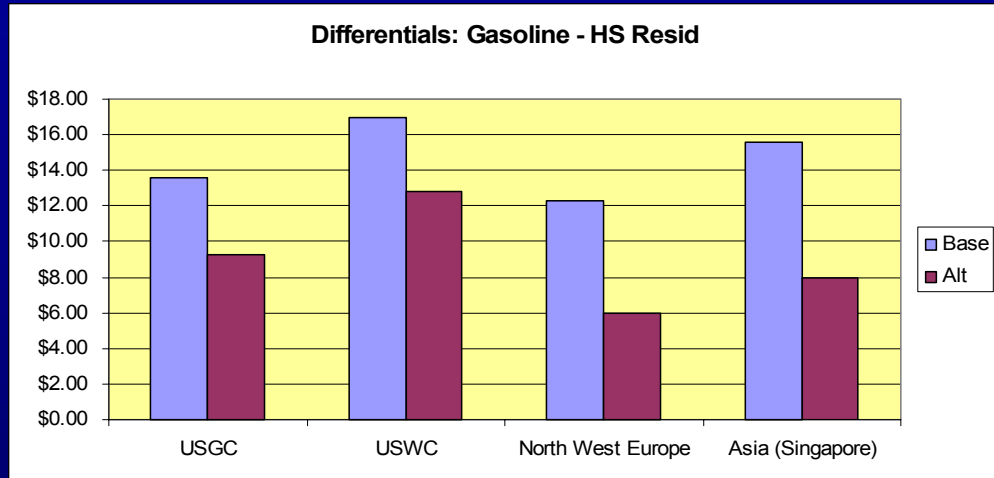
2020 WORLD Results

- Absolute oil prices are higher under ALT case but differentials narrow



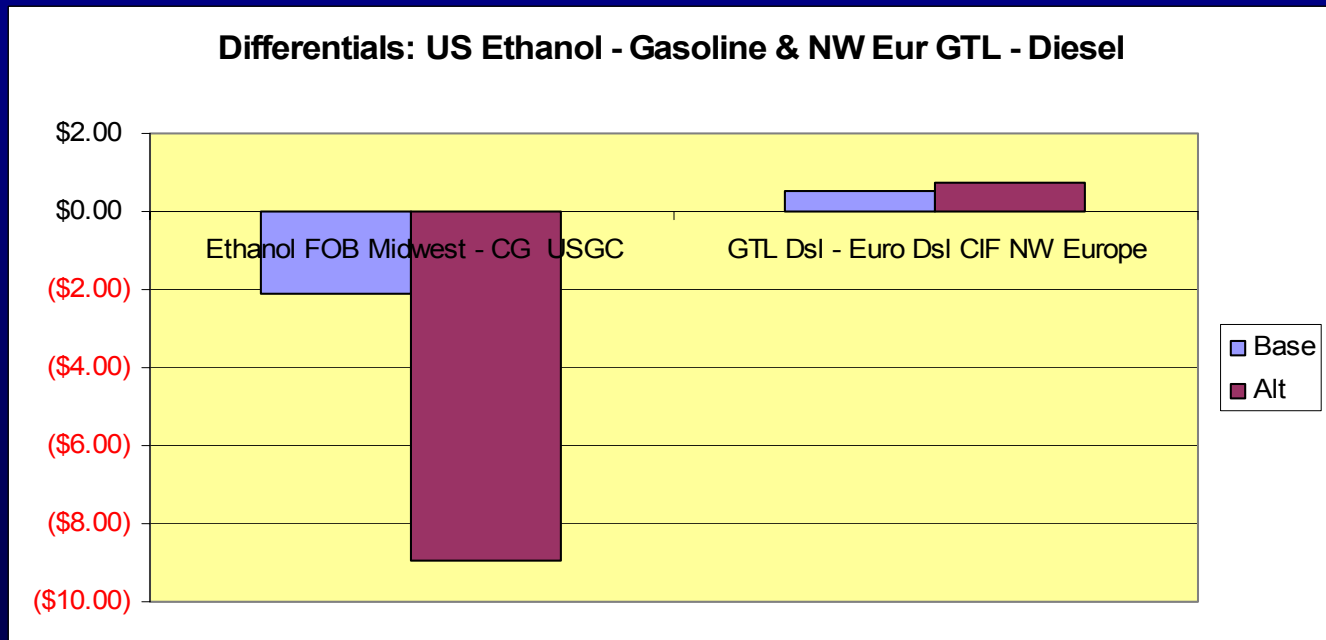
2020 WORLD Results

- In this scenario:
 - US/Can -1.0 mmbpd gasoline dmd &
 - US biomass & CTL supplies emphasize gasoline
- Gasoline differentials narrow more than distillate



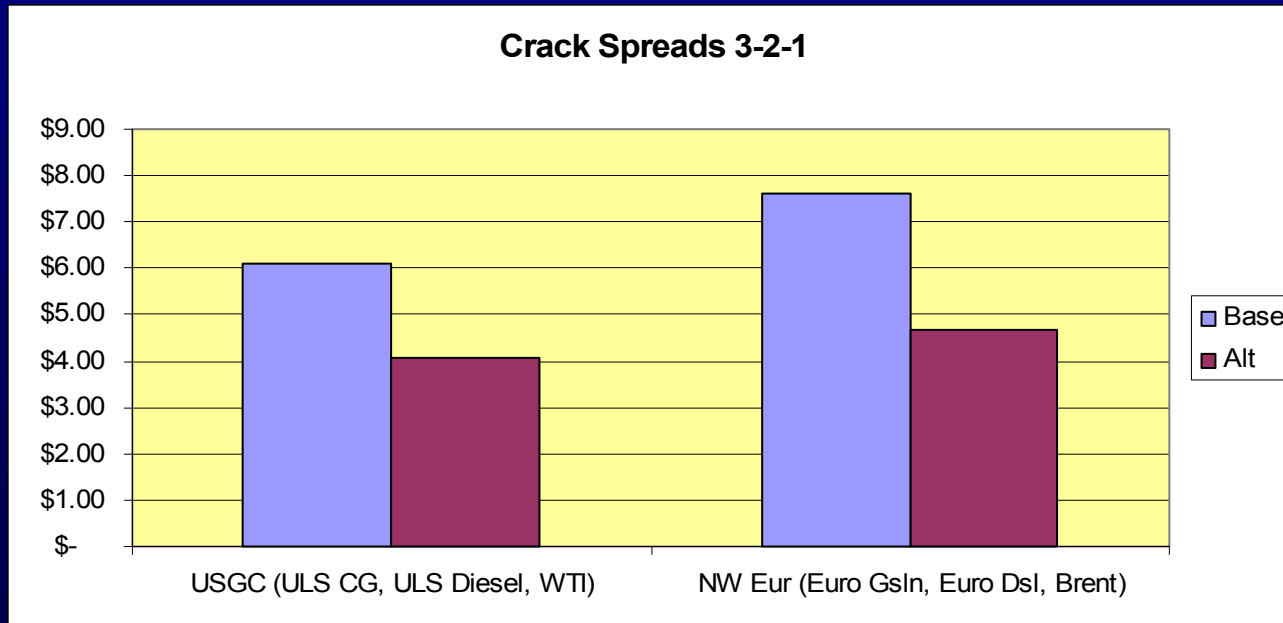
2020 WORLD Results

- Consequently ethanol price impacted more than GTL diesel



2020 WORLD Results

- Crack spreads narrow
 - Especially refineries focused on gasoline
 - n.b. scenario premises



Implications

- **Market Impacts**

- Alternative plus non-conventional fuels impacts (plus conservation) may be “at the margin”
- But bulk of alternative streams are light, clean, take pressure off upgrading plus quality improvement
- Combined impact on US and global downstream is far reaching



Implications

- **Supply/Demand Policy**
 - Fuel shifts need to be monitored
 - Careful thought given to gasoline / diesel supply / demand balance when considering alternative / non-conventional fuels supply options:
 - Biomass: ethanol vs biodiesel
 - CTL: high temp process for gasoline products vs low temp for diesel
 - Continuing shift to diesel demand (Europe, Asia, US??)



Implications

- **Technology**

- This study assumed improving economics of alternative fuels (ethanol, CTL etc.)
- But fairly static refinery processing technologies
 - Established and commercializing technologies
 - Graded declines in costs
- No radical shifts??

