



Guyana Refinery Study

Presentation to the Ministry of Natural Resources of Guyana

May 2017



- Strategic question
- Domestic and international market conditions
- Guyana refinery economics
- Alternative commercial options
- Discussion



- Given Guyana's demand for fuels, and its oil and gas production prospects, what are the economics of investing in domestic refining assets?



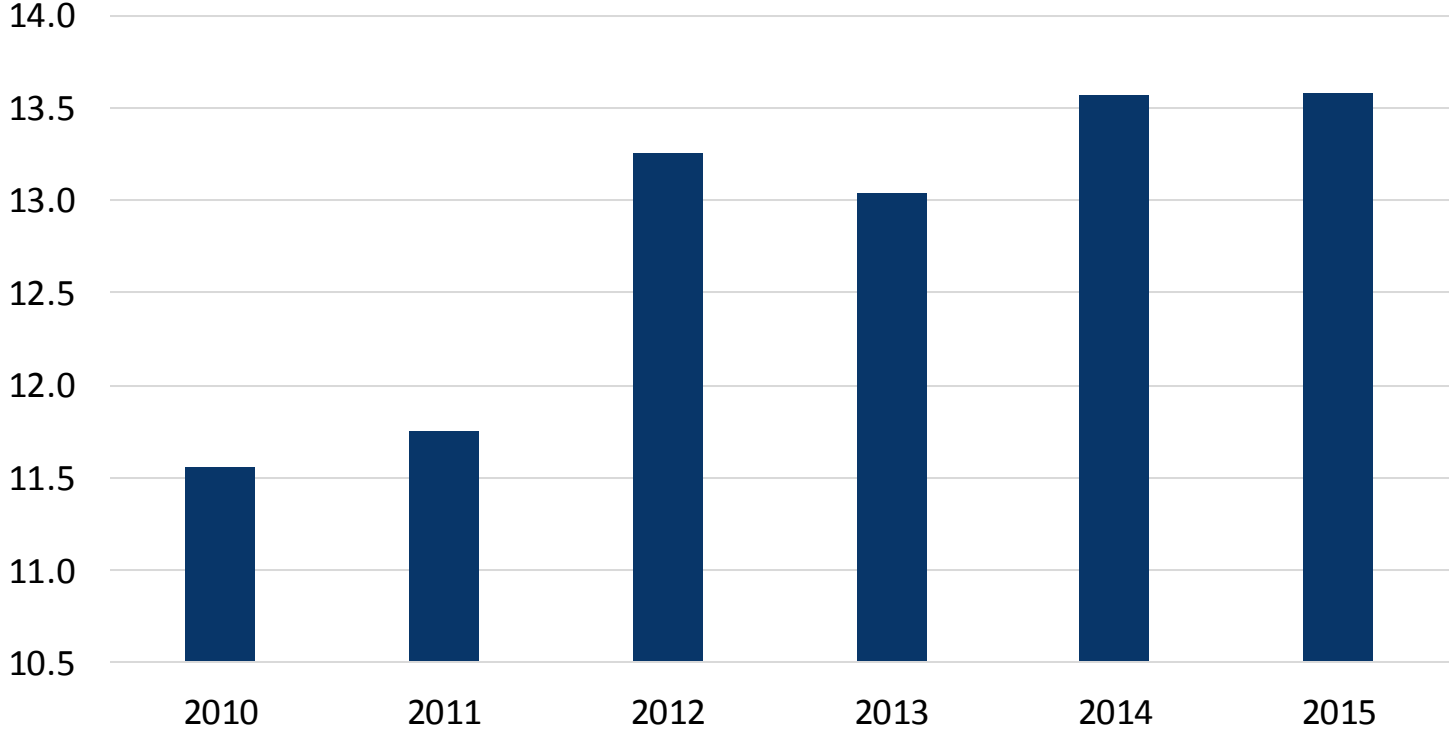
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Guyana's Petroleum Products¹ Demand



- Guyana's petroleum products demand increased more than 17% between 2010 and 2015, but the growth appears to have slowed

Guyana Petroleum Products Demand (MBD)



¹Petroleum products include: mogas, gasoil, kerosene, jet fuel, fuel oil, LPG and aviation gasoline
Source: Guyana Energy Agency



Guyanese Petroleum Product Imports

- Given Guyana's lack of domestic crude oil refining, the country depends entirely on petroleum product imports
- Historically PDVSA has supplied over 50% of Guyana's imports through the PetroCaribe agreement, but now Petrotrin accounts for about half of the import volume

Guyana Petroleum Products Imports

	PDVSA		Petrotrin		Other	
	B/D	%	B/D	%	B/D	%
2012	6,915	52%	2,212	17%	4,131	31%
2013	4,376	34%	4,221	32%	4,445	34%
2014	4,794	35%	4,563	34%	4,215	31%
2015	2,285	17%	6,420	47%	4,870	36%

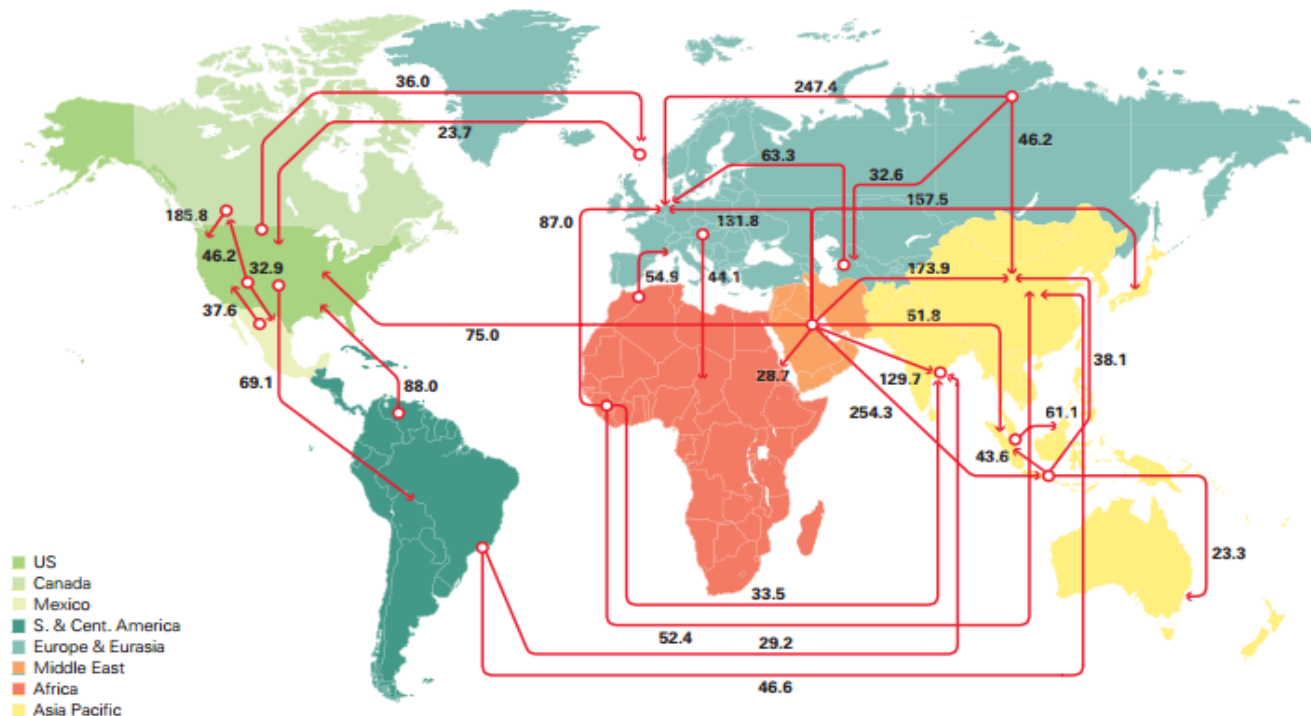
Source: Guyana Energy Agency, Hartree analysis



Trends in the Atlantic Basin

- The Atlantic Basin has undergone a structural shift from a net importing to a net exporting region
- US Gulf Coast (USGC) refineries have become major exporters of refined products to the Caribbean and Latin America, in addition to their traditional middle distillate export role to Europe

Major Trade Movements of Crude Oil and Products 2015 (MMT)



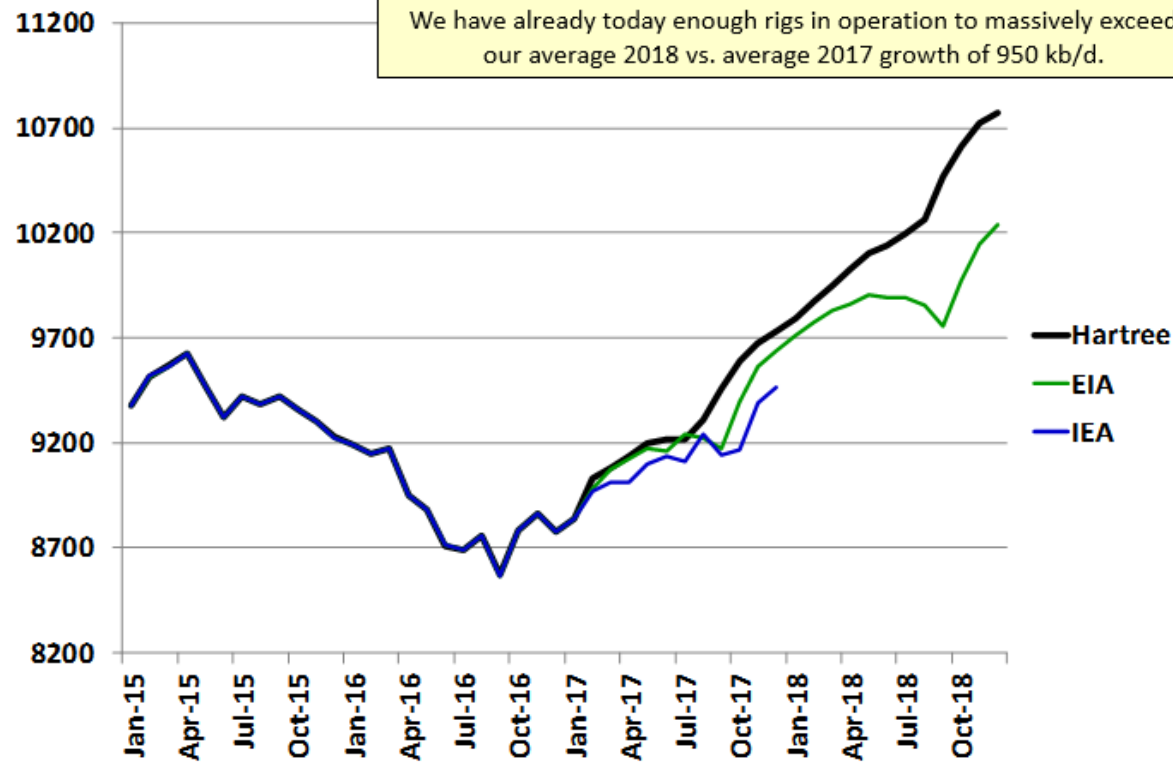
Source: BP Statistical Review of World Energy 2016



Short-Term International Market Context (1/2)

US Crude Supply Projections (MBD)

We have already today enough rigs in operation to massively exceed our average 2018 vs. average 2017 growth of 950 kb/d.



- “OPEC and 11 other leading producers including Russia agreed in December to cut their combined output by almost 1.8 million barrels per day” - CNBC
- The purpose was to reduce crude inventories which are currently at record highs
- However, US E&P companies have managed to continue producing by lowering their costs
- The rise in US production and inventories has cancelled the impact of the OPEC/non-OPEC production cut

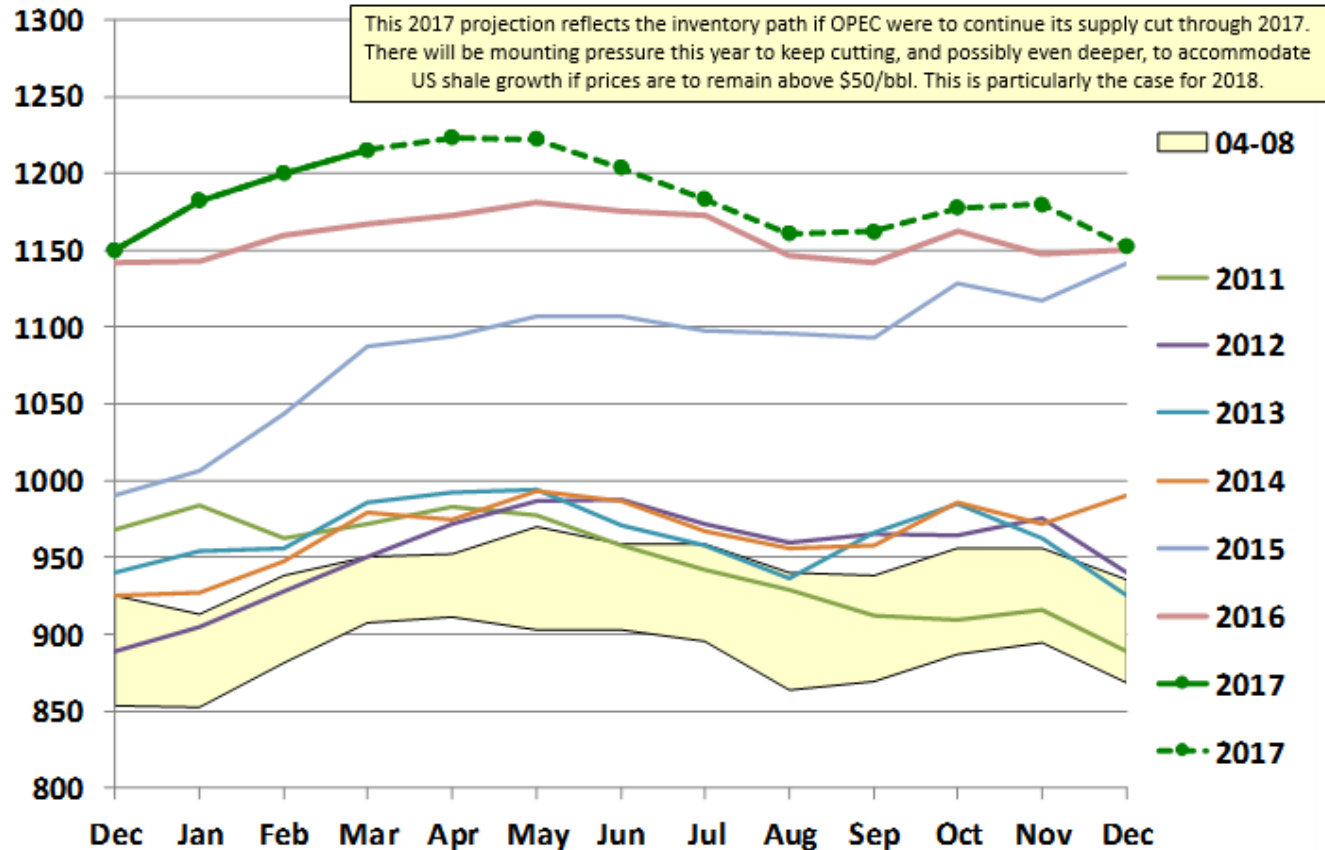
Source: Hartree Research, EIA, IEA



Short-Term International Market Context (2/2)

- Even if OPEC cuts were to be extended another 6 months, we expect only a modest effect on crude inventories

Commercial OECD Crude Inventories (MMB)



Source: Hartree Research, EIA, IEA



Oil Market Prospects

Short Term

- Oil Price levels over the next 12 to 18 months depend on OPEC's ability to live with and manage the effect of sharply accelerating US shale production and surprisingly resilient Non-OPEC/non-US oil production in the \$50-\$55 oil price range
- Challenges arise from a lack of global visible oil inventory draws even if OPEC were to extend their cuts through the full year of 2018
- Sensitivity to oil prices is hence skewed to the downside

Longer-Term Questions / Concerns

- For how long does the resource base allow US shale oil grow at potential of around 1 MMBD per year if prices were to allow for such rates?
- What are the prospects for shale plays outside the US, such as Argentina and Russia?
- To what extent is the drop of upstream investment in 2015/2016 offset by continuing decline in offshore F&D costs and are related concerns overblown?
- Will oil product demand growth return to the long term average of around 1 MMBD or remain elevated in line with continuing urbanization and migration into the middle class
- Is OPEC going to be able to maintain the necessary production discipline for prolonged periods of time if need be?
- How will Aramco's IPO affect Saudi Arabia's role in OPEC?

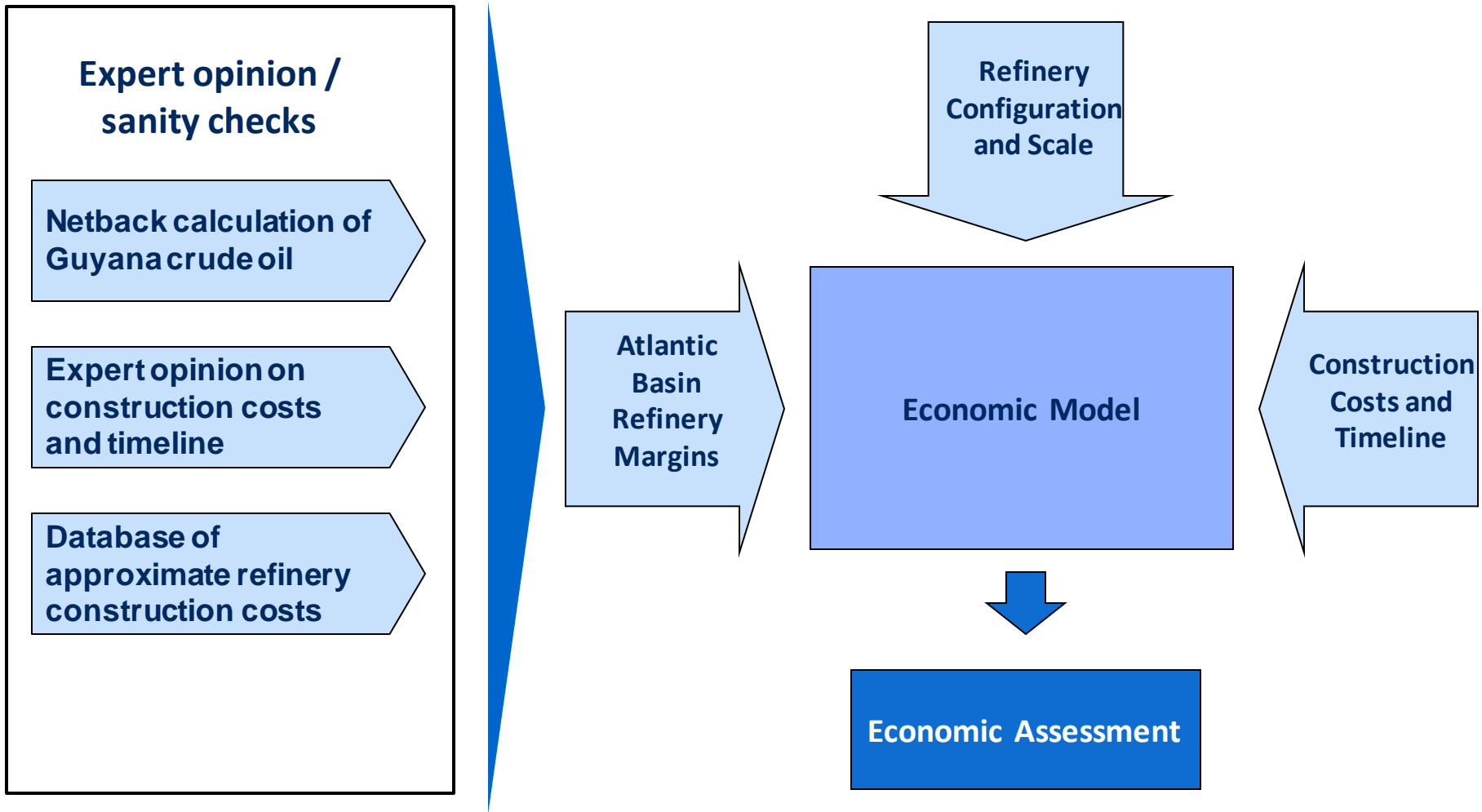
Source: Hartree Research



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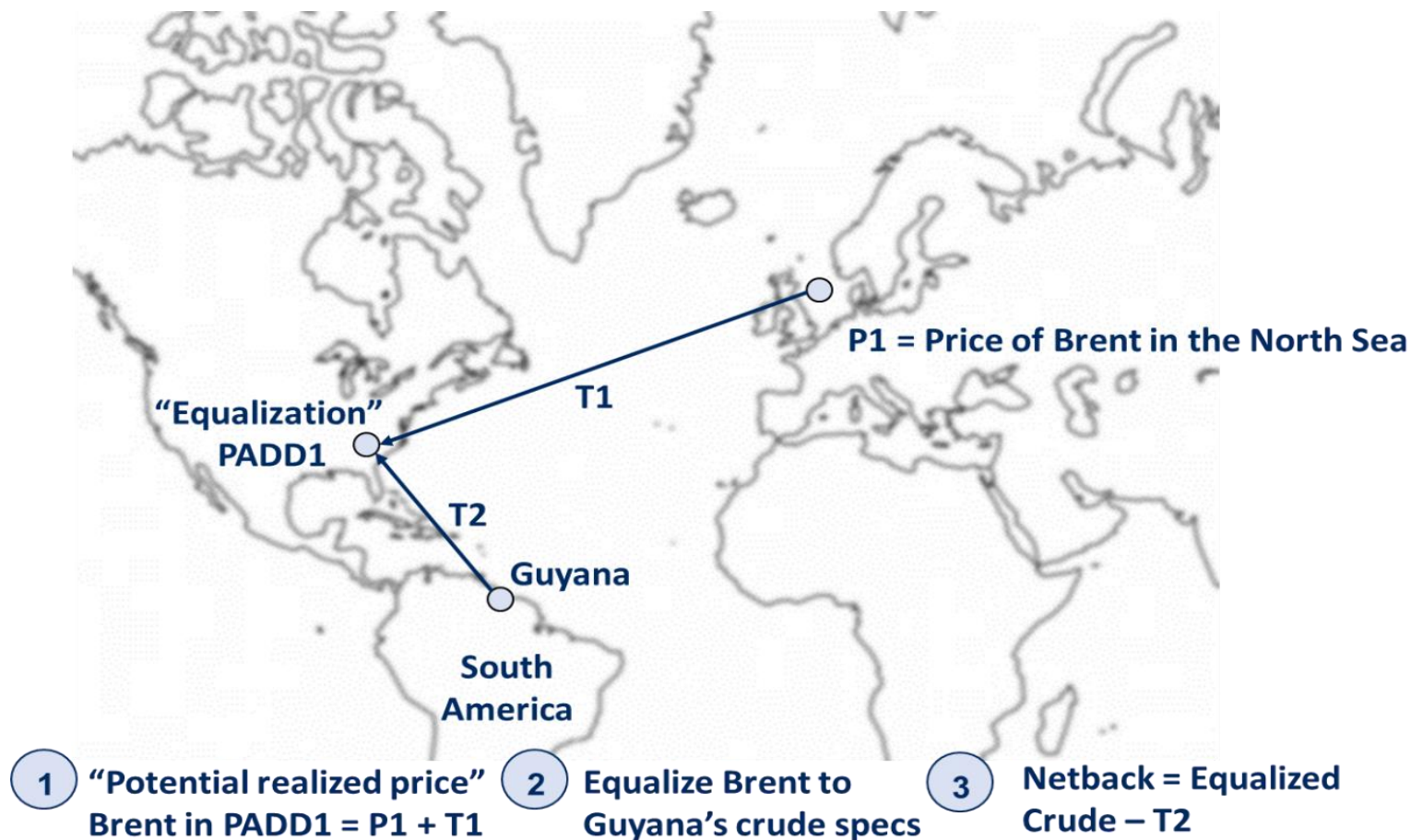
Methodology





Guyana Crude Oil Valuation (1/2)

Graphical Representation of Netback Methodology



Source: Hartree Analysis



Guyana Crude Oil Valuation (2/2)

Benchmark Crude Specifications

Crude	Origin	API (°)	Sulphur (%)
Guyana Crude	Guyana	32.1	0.51
Cabinda	Angola	32.2	0.15
Bonny Light	Nigeria	35.1	0.15
Light Louisiana Sweet (LLS)	Louisiana	35.6	0.40
Brent	United Kingdom	37.5	0.40

Guyana Crude Netbacks

Region	2016 Netback (USD/B)
PADD_1	\$46.53
PADD_3	\$46.62
NWE	\$46.47
Average	\$46.54

Note: Using routes to Venezuela as proxy to those to Guyana
Source: Hartree Analysis, S&P Global Platts "Methodology and Specifications Guide Crude Oil". 2016



Petroleum Products Valuation

Graphical Representation of Netforward Methodology



1 Netforward = P1 + T1

Guyana Products Netforward

Product	Origin	2016 Netforward (USD/B)
Regular Gasoline	USGC	\$59.73
Premium Gasoline	USGC	\$65.30
Ultra Low Sulphur Diesel	USGC	\$59.88

Note: Using routes to Santos (Brazil) as proxy to those to Guyana
Source: Hartree Analysis



Guyana Refinery Modeling Assumptions

Refinery Configuration and Scale

Comments

- USGC marginal refinery configuration is FCC
- Given Guyana demand of 15 MBD, **100 MBD FCC** refinery was assumed

Atlantic Basin Refinery Margins

- 10 year average margin of a 50/50 HLS/LLS crude mix in a USGC FCC refinery is **\$5.84 USD/B¹**

Construction Costs and Timeline

- Parametric estimate of refinery construction costs considering size, location and inflation
- Base cost of **\$5.2 BN USD**

Economic Model

- Capital project model calculating NPV, IRR and maximum debt leverage

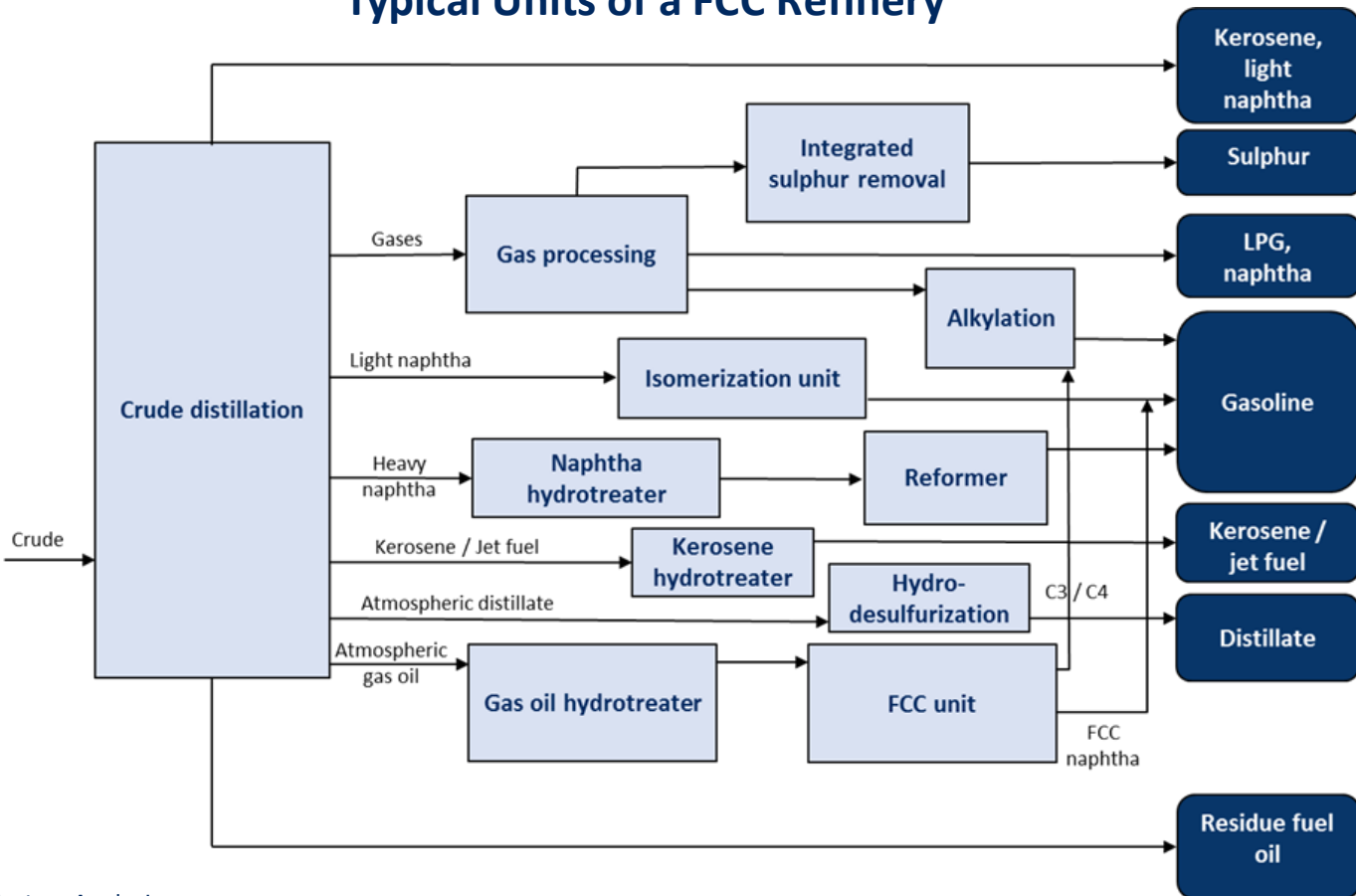
1: Using the IEA's Refining Margins



Marginal Refinery Configuration in the USGC

- The marginal refinery configuration of the USGC is an FCC (fluid catalytic cracking) refinery. A refinery in Guyana would need to compete with those refineries

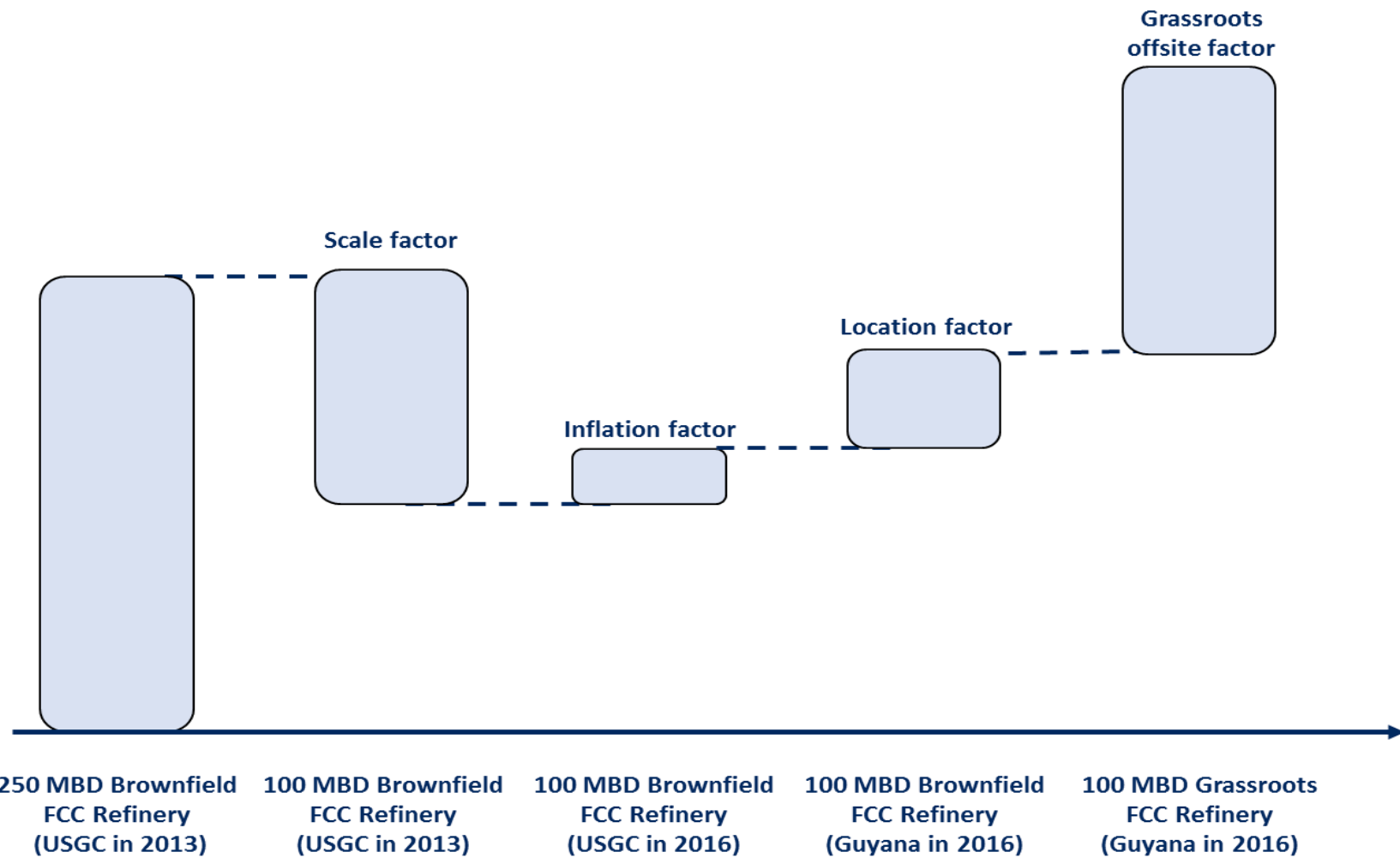
Typical Units of a FCC Refinery



Source: EIA, Hartree Analysis



Refinery Construction Costs Estimation Methodology



Source: Hartree Analysis



Parametric Cost Estimates for a FCC Refinery

Brownfield	Ultra-Light Crude		UL Crude 100MBD capacity	
	Built Capacity MMB/D	Overnight Cost 2013 MM USD	Built Capacity MMB/D	Overnight Cost 2013 MM USD
Atmospheric crude distillation	250	\$ 370.00	100	\$ 207.73
Vacuum crude distillation	N/A	--	--	--
Naphtha hydrotreater unit	100	\$ 170.00	40	\$ 95.44
Kerosene hydrotreater unit	100	\$ 240.00	40	\$ 134.74
Hydro-desulfurization	40	\$ 140.00	16	\$ 78.60
Fluid catalytic cracking unit	40	\$ 110.00	16	\$ 61.76
Hydrocracking unit	N/A	--	--	--
Delayed coker unit	N/A	--	--	--
Continuous Catalytic Reformer unit	50	\$ 140.00	20	\$ 78.60
Alkylation unit	20	\$ 290.00	8	\$ 162.82
C5/C6 isomerization unit	20	\$ 100.00	8	\$ 56.14
Aromatic extraction unit	20	\$ 610.00	8	\$ 342.47
Integrated sulfur removal (capacity LT/SD)	100	\$ 30.00	40	\$ 16.84
Naphtha stabilizer and stripper	50	\$ 100.00	20	\$ 56.14
Gas plant and hydrogen unit	20	\$ 110.00	8	\$ 61.76
Auxiliary equipment	250	\$ 610.00	100	\$ 342.47
Production area setup	250	\$ 290.00	100	\$ 162.82
Initial feed and catalyst loading	250	\$ 70.00	100	\$ 39.30
	Total USGC (2013)	\$ 3,390.00	Total USGC (2013)	\$ 1,897.64
			Total USGC (2016)	
			+4.9% \$	1,990.87
			Total Guyana (2016)	
			+30.0% \$	2,588.13
			Total Grassroots	
			+100% \$	5,176.25

Source: EIA, Hartree Analysis

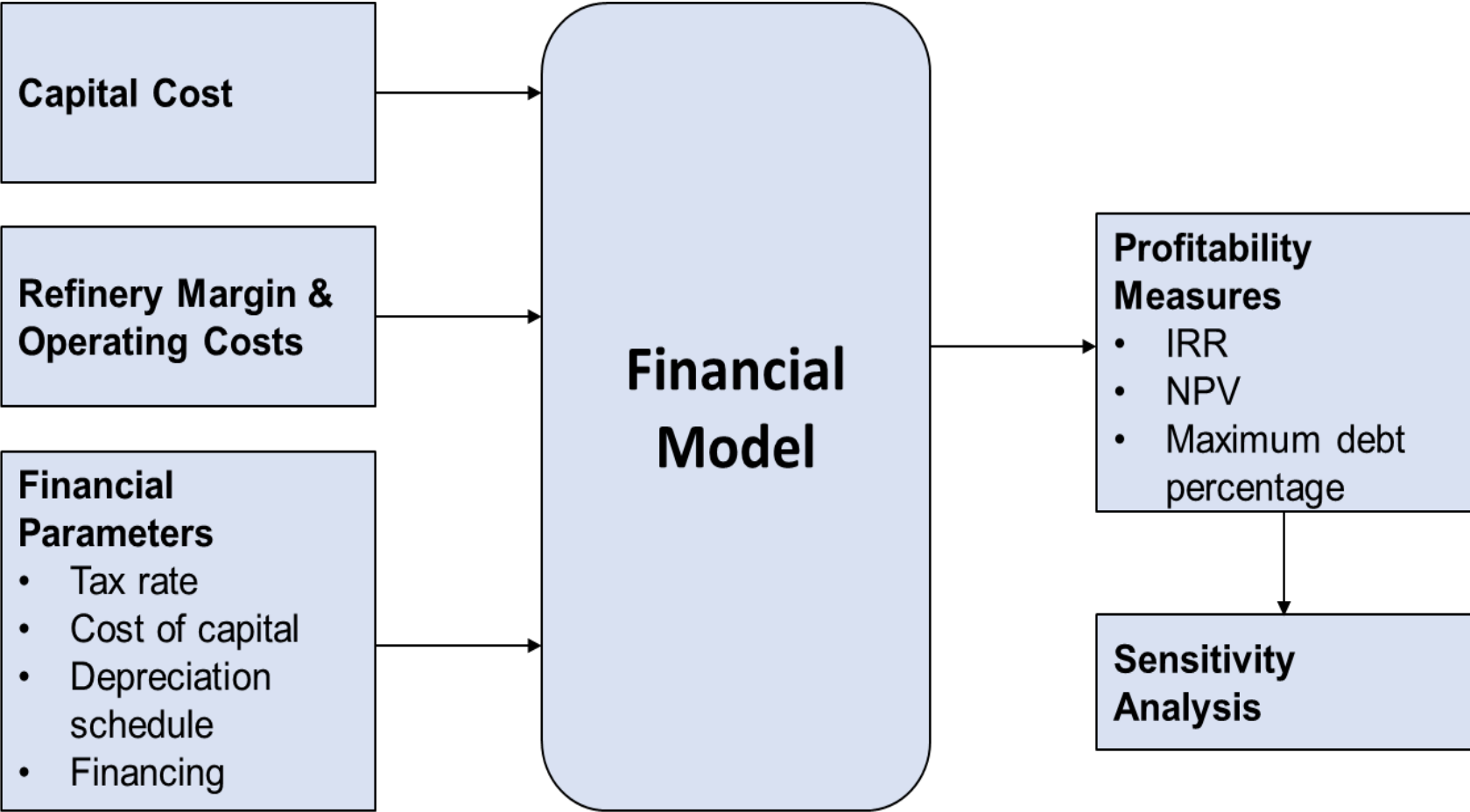


Model Assumptions

Input	Values Considered	Source and Comments
Construction Cost: Guyana Location Factor	30%	Most likely factor according to experts
Construction Cost: Grassroots Offsite Factor	100%	Most likely factor according to experts
Refining Margin	\$5.84 USD/B	IEA refining margins with the methodology previously explained
Tax Rate	Income Tax – 27.5% Carried loss basis: 10 years	Guyana Energy Agency and PWC Worldwide Tax Summary
Cost of Debt	2.88%	Bank of Guyana, 364 day treasuries plus a 0.50% premium
Cost of Equity	10%	Median total shareholder return in the chemical industry from 2011-2015
Depreciation Schedule	20-year straight line	Standard assumption
Debt / Equity Ratio	100% equity	Provides the unlevered economics of the project and allows to analyze the maximum debt possible
Refining Capacity	90%	First/second quartile efficiency (Solomon survey)
Exchange Rate	206.5 GYD/USD	Bank of Guyana, most common exchange rate in the past years
Operating Costs	\$3.30 USD/B	IEA Refinery Margins Methodology Notes
Time Period Considered	30 years	Standard assumption
Construction Time	60 months	Consistent with the database and expert opinions



Economic Model





Results

Summary of Scenario Results

	Base Case	Low Guyana's Location Factor: 20% Low Grassroots Offsite Factor: 80%	High Guyana's Location Factor: 40% High Grassroots Offsite Factor: 120%
IRR	Negative	Negative	Negative
NPV (USD @10%)	-\$3.04 billion	-\$2.44 billion	-\$3.69 billion
Maximum Debt Leverage	15%	18%	13%

- Even in the most optimistic scenario the IRR and the NPV of the project are negative



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Alternative Commercial Options

International trade of crude and products

- Ensuring Guyana Government is maximizing their income from commercializing crude oil
- Securing an efficient and secure supply of products delivered into Guyana

Converting Guyanese crude oil to products in the international market

- Selling crude and purchasing products
- Swapping crude oil for products
- Tolling crude for products

Acquiring exposure to refining economics

- Joint venturing an offshore refinery (and tolling)
- Acquiring stock in refining companies

Managing financial exposure to hydrocarbon downside

- Manage crude length
- Manage product short



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