Enhancing Naphtha flexibility and Petrochemical intensity index of Refineries

Session 5

Dynamics of Feedstock: Leveraging Synergies of Value Chains between Petroleum and Petrochemicals

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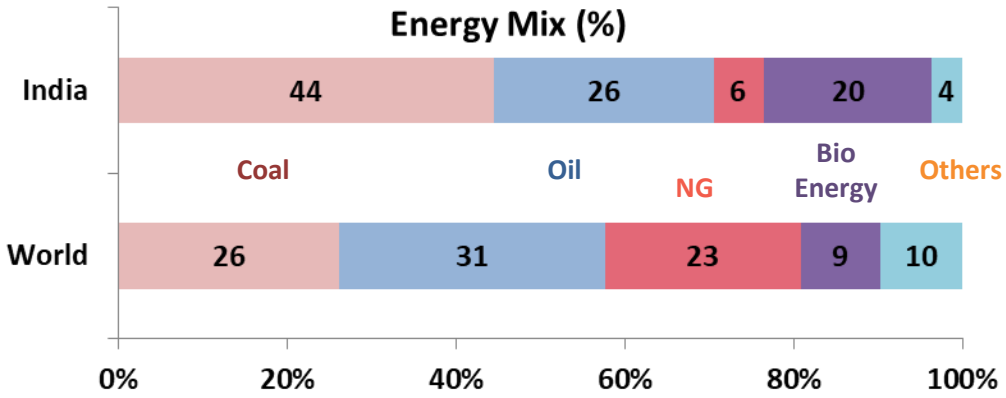
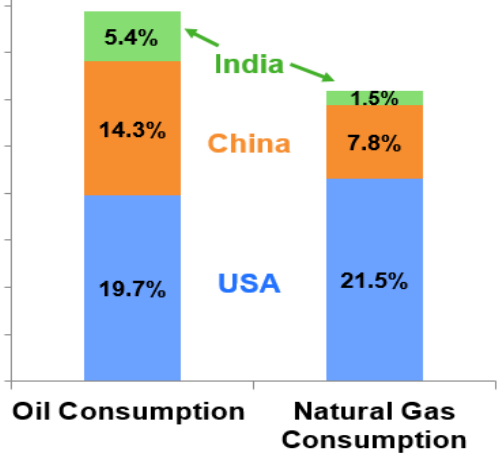
FICCI Summit on "Global Chemicals & Petrochemicals Manufacturing Hubs in India" 25-26th Nov'21

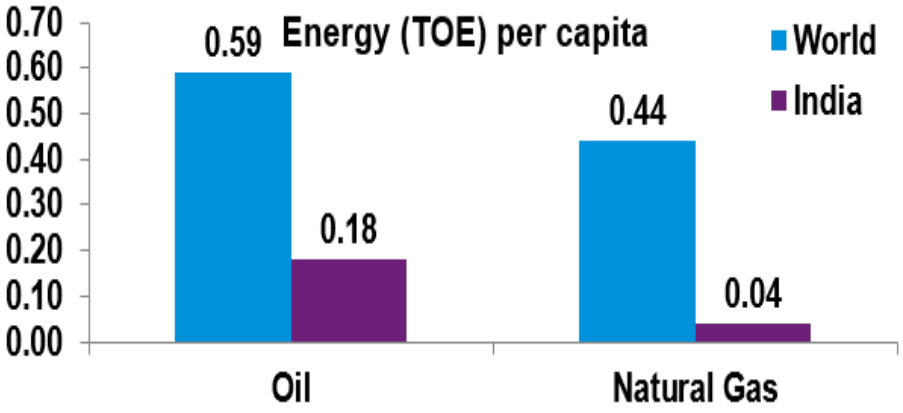
Global & Indian Energy Outlook



India's share in World Oil & Gas Consumption

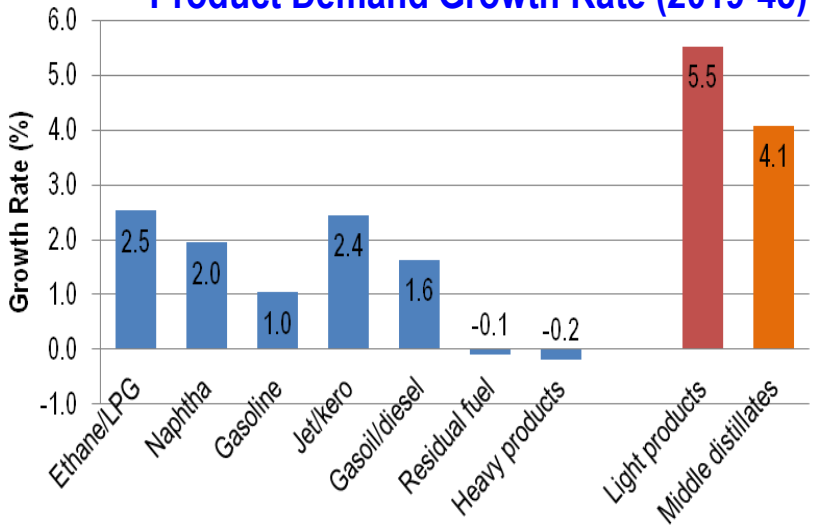


Per Capita Energy Consumption



Source- IEA WEO 2020

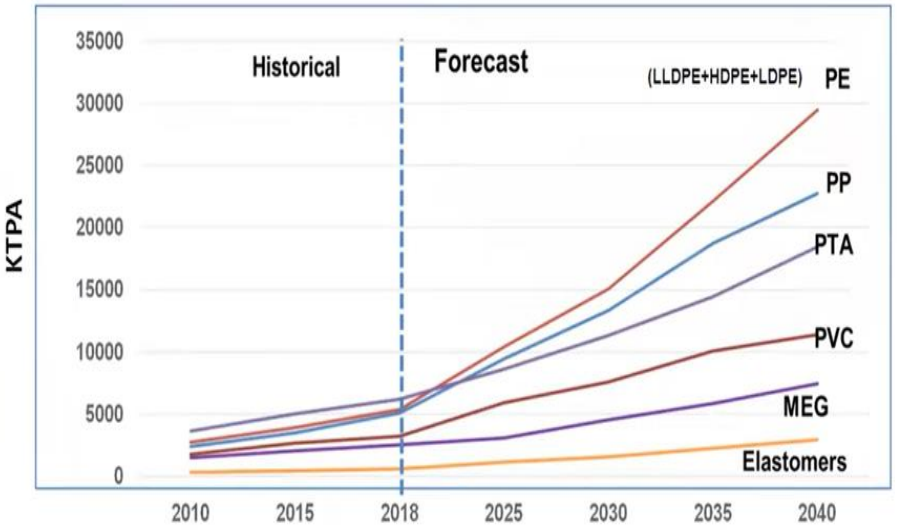
Product Demand Growth Rate (2019-45)



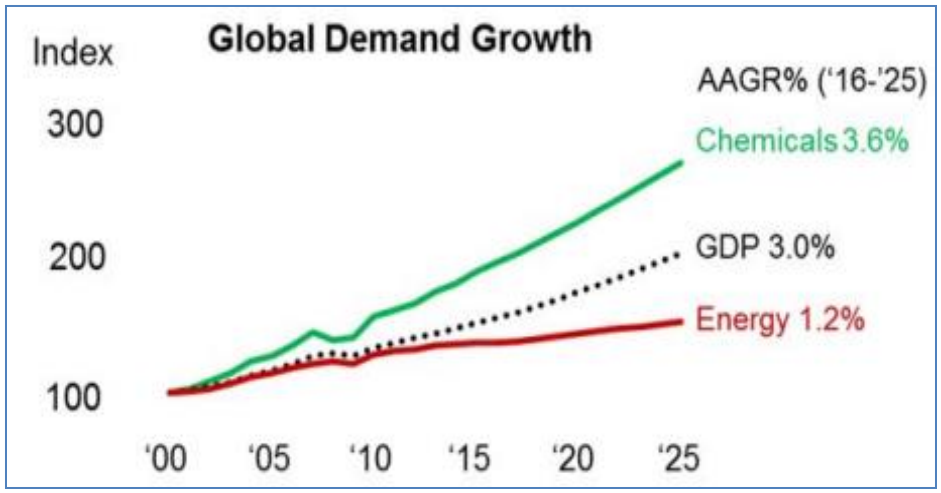
Source: OPEC Report 2020

- Growth rate of Light product (ethane, LPG, naphtha & gasoline) higher than middle
- Growing demand for ethane/ LPG/Naphtha due to petrochemicals

Petrochemical Demand Scenario: Global

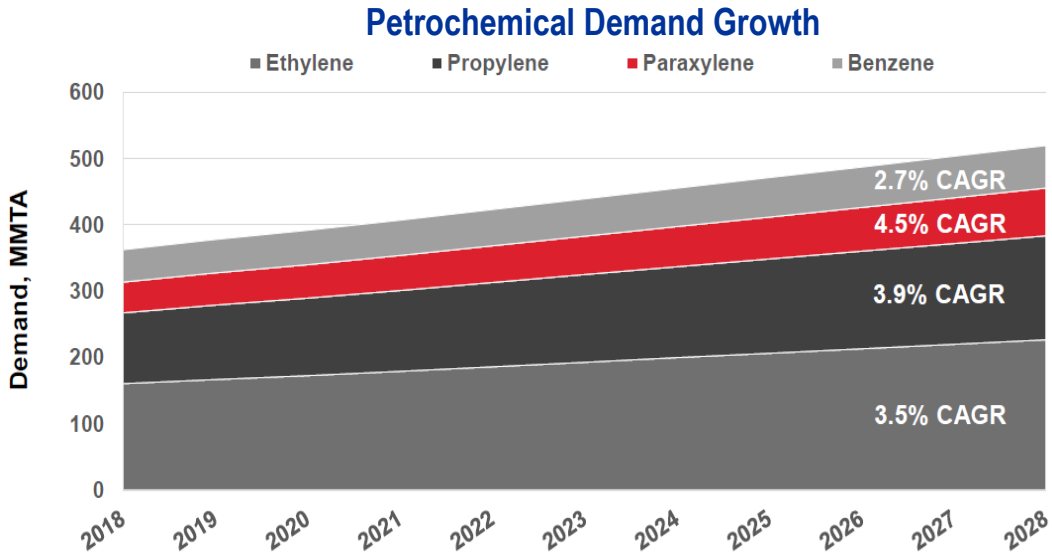


Source: OPEC Report 2020



Source: IHS Markit 2018

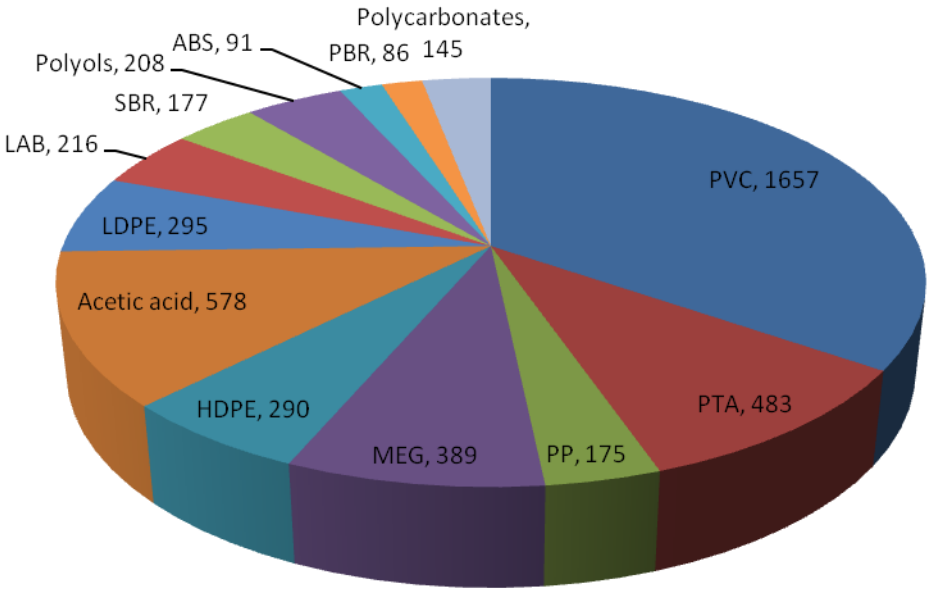
- Petrochemical demand growth driven by GDP growth **(~1.4 times of GDP)**
- **Growth in petrochemicals will contribute about 35-40% of increase in total Crude Oil demand**



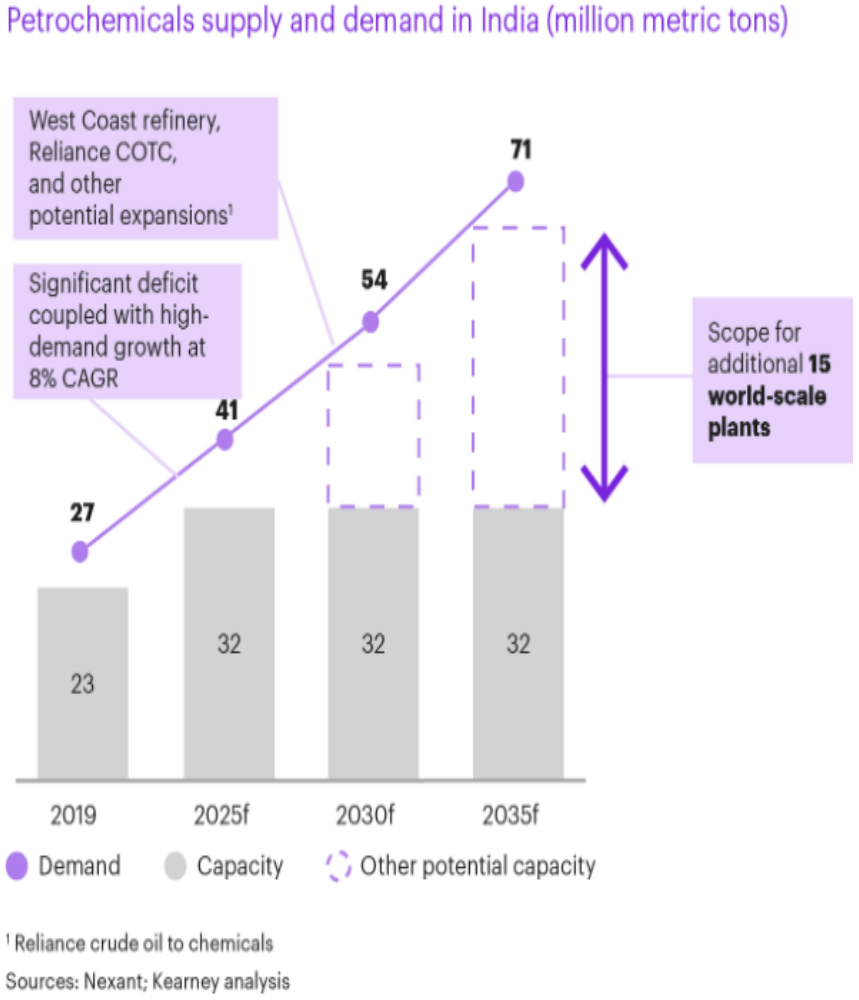
Source: IHS Markit, UOP

Petrochemical Demand Scenario: India

- Several petrochemical products being imported in India
- It is desired to reduce import dependency to bring in '***Atmanirbhar Bharat***'



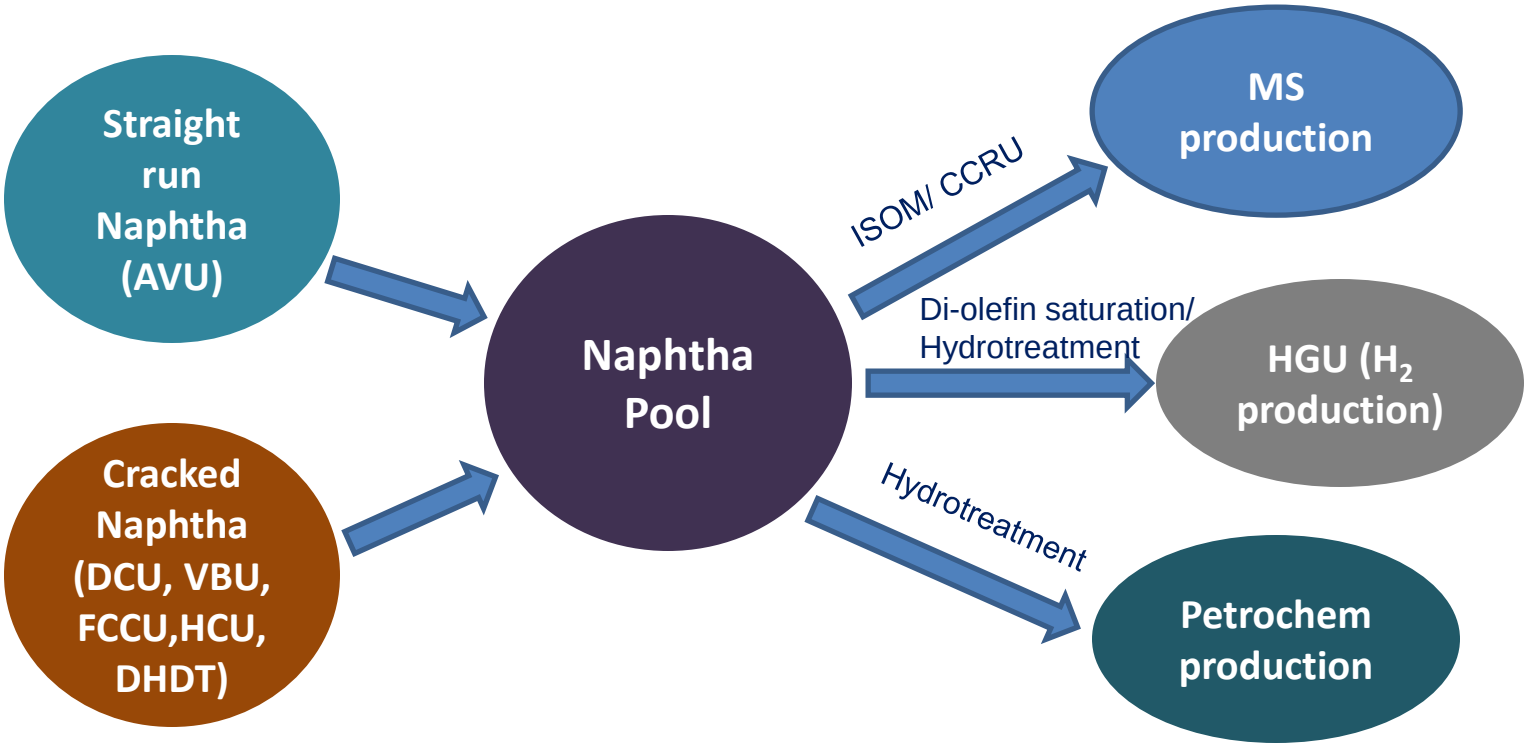
Petrochemical Imports, kTA 2018-19 (India)



Sources: MoCF-2019 (GoI), IHS Markit-2019

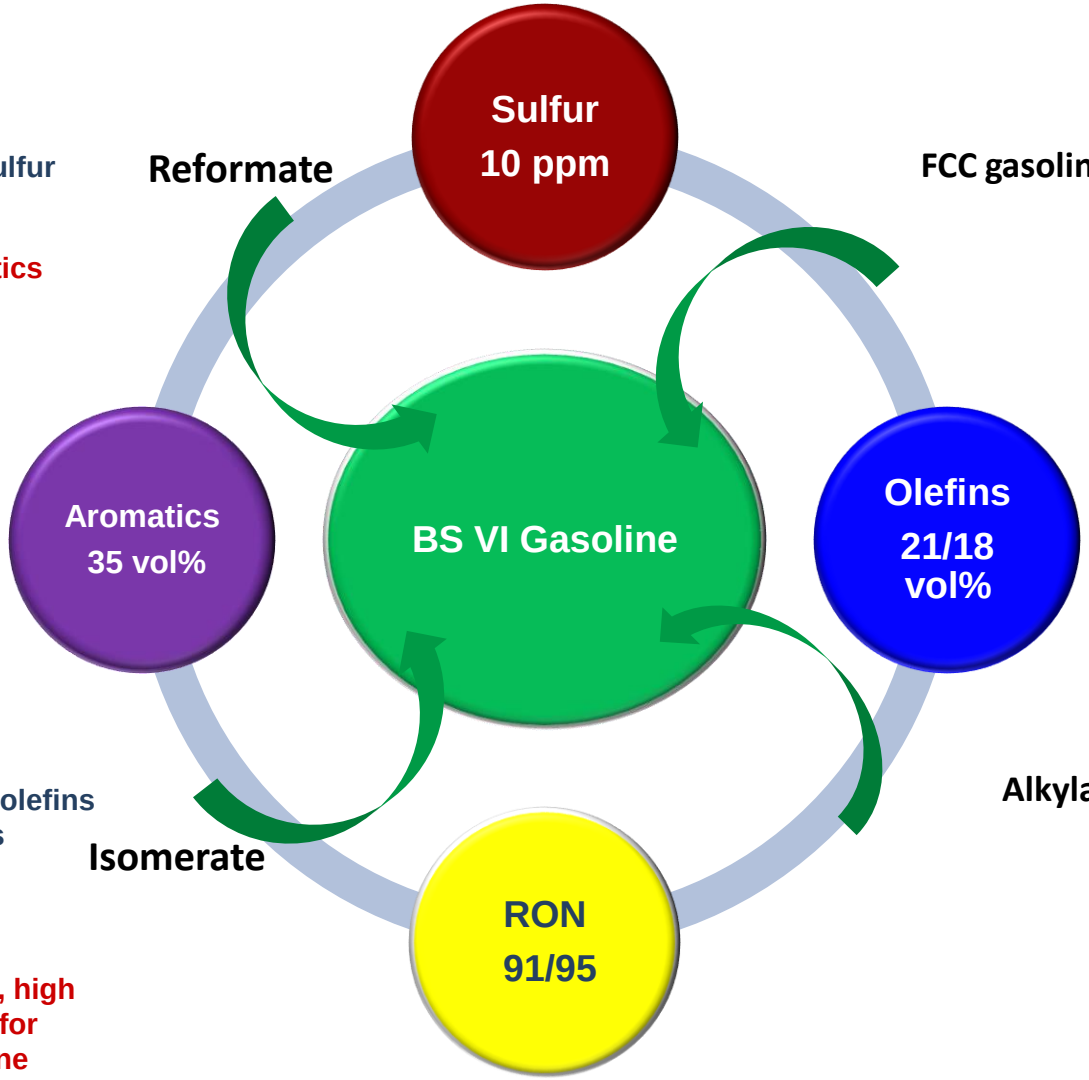
Conventional Refinery Naphtha Management

Current Naphtha Disposition



Largest external Customer: Fertilizer Industry

Role of Naphtha in MS Pool Management



- High octane
- Low RVP, sulfur
- No olefins
- High aromatics

- Moderate octane
- Drop in octane due to desulfurization
- High olefins

- Low sulfur, olefins & aromatics
- No olefins
- High RVP
- Low octane, high investment for higher octane

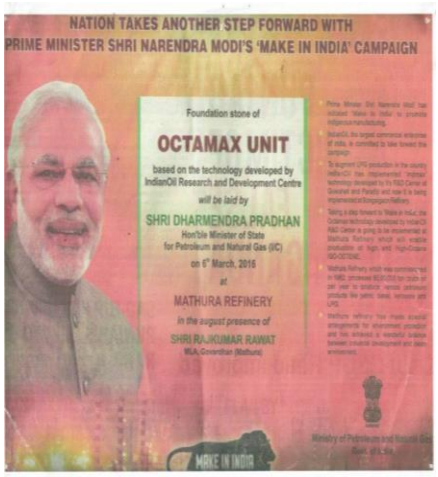
- High octane
- No olefins & aromatics
- High investment
- Environmental issues
- Reduction in LPG

Technologies For Generation Of High RON Streams Adds Flexibility To MS Pool Wrt Naphtha Re-routing For Value Addition

Drop in Fuel Technology (Octamax) : Adds MS pool flexibility

- Octamax®: Production of BS VI gasoline from cracked C4 streams
- Blending RON > 120 achieved

55 kTA unit under operation at IOCL Mathura Refinery
63 TMTPA increase in gasoline → Net benefit INR 27 Cr/Yr



OCTAMAX Unit-Mathura

Pilot Unit-R&D

IndianOil makes green technological breakthrough at Mathura Octomax unit

NEW DELHI: State-owned Indian Oil Corp (IOC) on Wednesday said it has made a technological breakthrough in commissioning a Octomax unit at its Mathura refinery that will help manufacture Euro-VI fuel emission compliant petrol.

"The breakthrough technology developed by IOC's R&D Centre converts C-4 streams from Catalytic Cracker and/or Naphtha Cracker units to high-octane gasoline (petrol) blending stream, thereby enabling compliance with stringent fuel quality norms," a company statement said.

"The Octamax Unit has been completed ahead of the targeted schedule and without any cost overrun, IOC said.

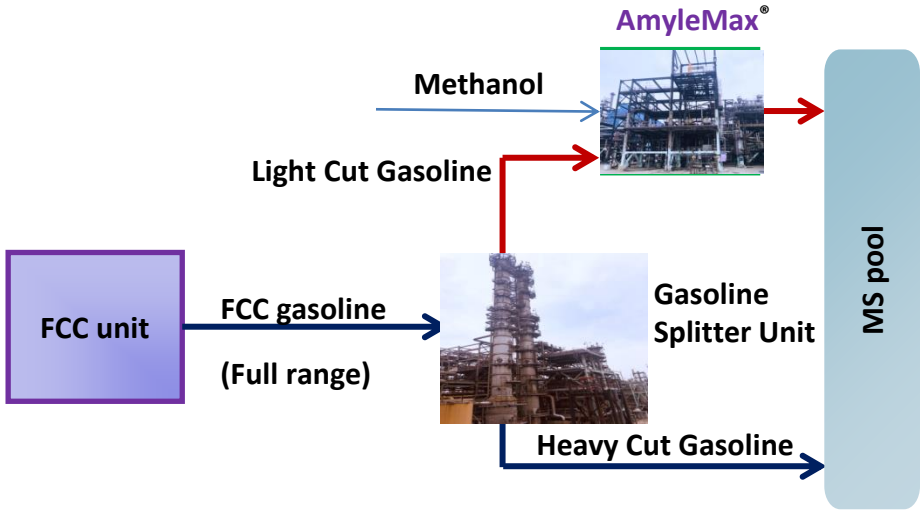
"The blending octane number of the sample drawn from the newly commissioned unit was seen to be 118, higher than the guaranteed 108, while meeting all other defined product properties," it said.

"The technology once again showcases the technical prowess of IndianOil in meeting the BS-VI fuel quality norms through indigenous efforts," it added.

IOC said Octamax truly is a 'Make in India' venture where all activities, from concept to development of the technology, preparation of basic design engineering package, erection and commissioning of the unit, have been accomplished through indigenous efforts. MPOST

AmyleMax Technology for LCN to TAME

- **AmyleMax® Technology** : For conversion of reactive Olefins of entire LCN stream (C5-90°C) to ethers
- High RON, Low RVP and Olefin Reduction Technology



Successfully demonstrated in 42 kTA Demo Unit at Gujarat Refinery - 2019

Refinery Naphtha Management – New Imperatives

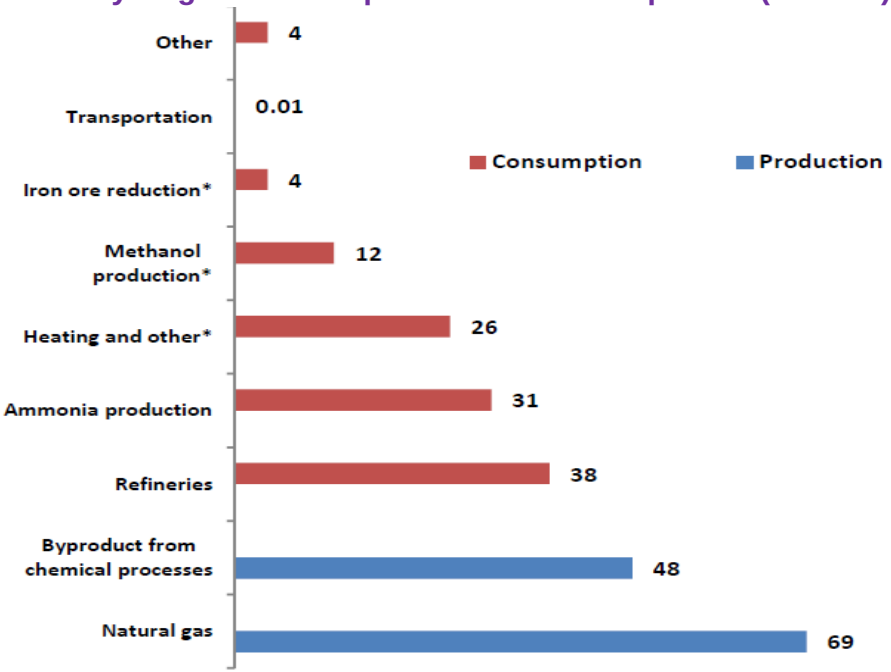
- Emerging Green Hydrogen Scenario
- Lower demand of distillate fuels (MS & Diesel)
- Need for enhancing Petrochemical Intensity

Hydrogen Generation & Consumption

	Global	India
H_2 production (2021), MMTPA	117	6
Projected H2 demand (2050), MMTPA	530	28

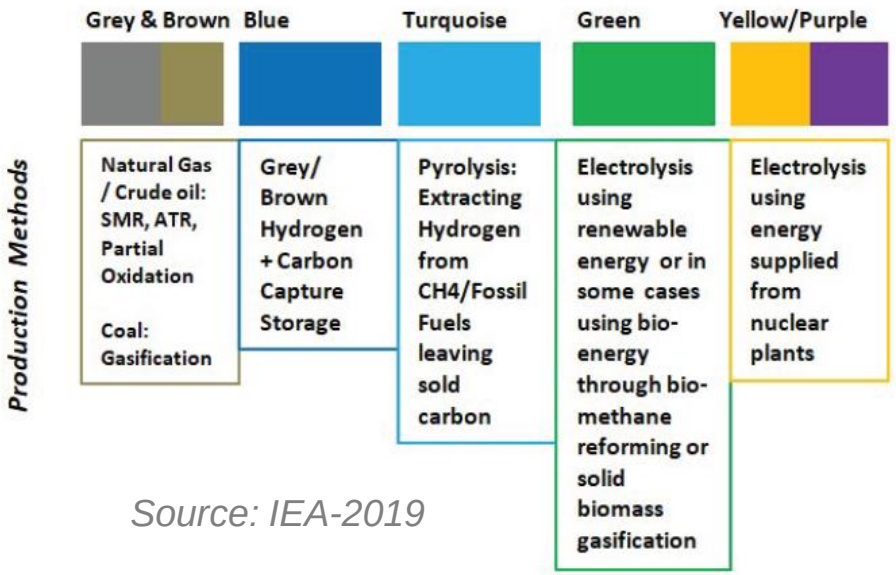
Source: TERI-2020, IEA-2021

Global Hydrogen Consumption & Production pattern (MMTPA)

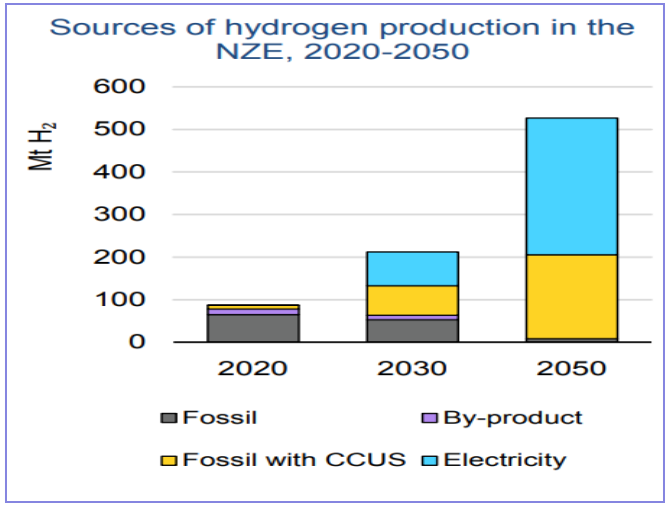


Source: Energy Industry Review, Aug'21

Colour Spectrum of Hydrogen



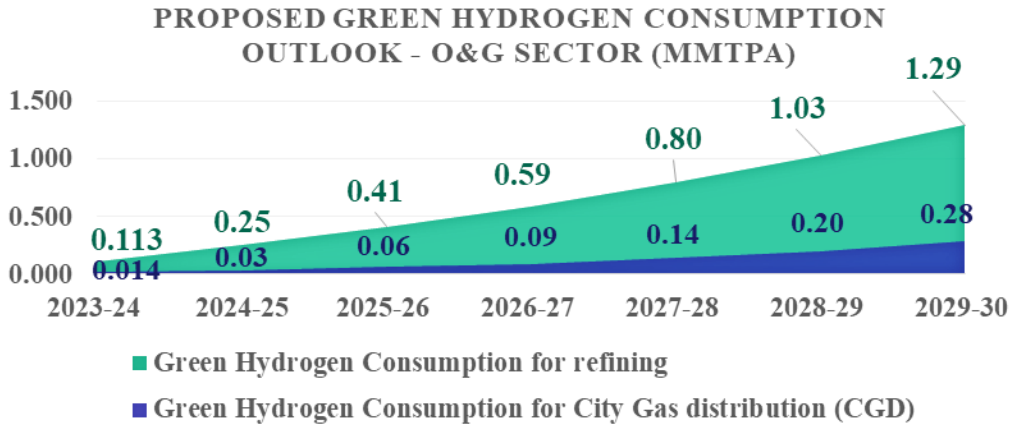
Source: IEA-2019



Source: IEA-2021

Indian Green Hydrogen scenario

- Green hydrogen ➔ a key facet in India's aim to achieve net-zero emissions by 2070
- PLI Scheme: 10,000 MW capacity of integrated solar PV manufacturing plants to be set up by Q4 of 2022-23 with direct investment of ~Rs 14000 Crore
- PLI scheme for indigenous electrolyzer manufacturing under formulation
- Fuel cells included in the PLI scheme for Advanced cell manufacturing



- **Based on Draft proposed by MNRE (50% GHCO by 2030)**
- **Industry has proposed 10% Green Hydrogen in refineries by 2030**

Green H2 initiatives by IOCL:

- *7000 TPA cumulative Green Hydrogen capacities at Mathura and Panipat Refineries on Build Own Operate (BOO) basis" :– **EoI (Nov'21)***
- *Pilots on fuel cell buses in Gujarat, U.P and Kerala*
- *Strengthening R&D in green hydrogen production, storage, fuel cells and electrolyzers*

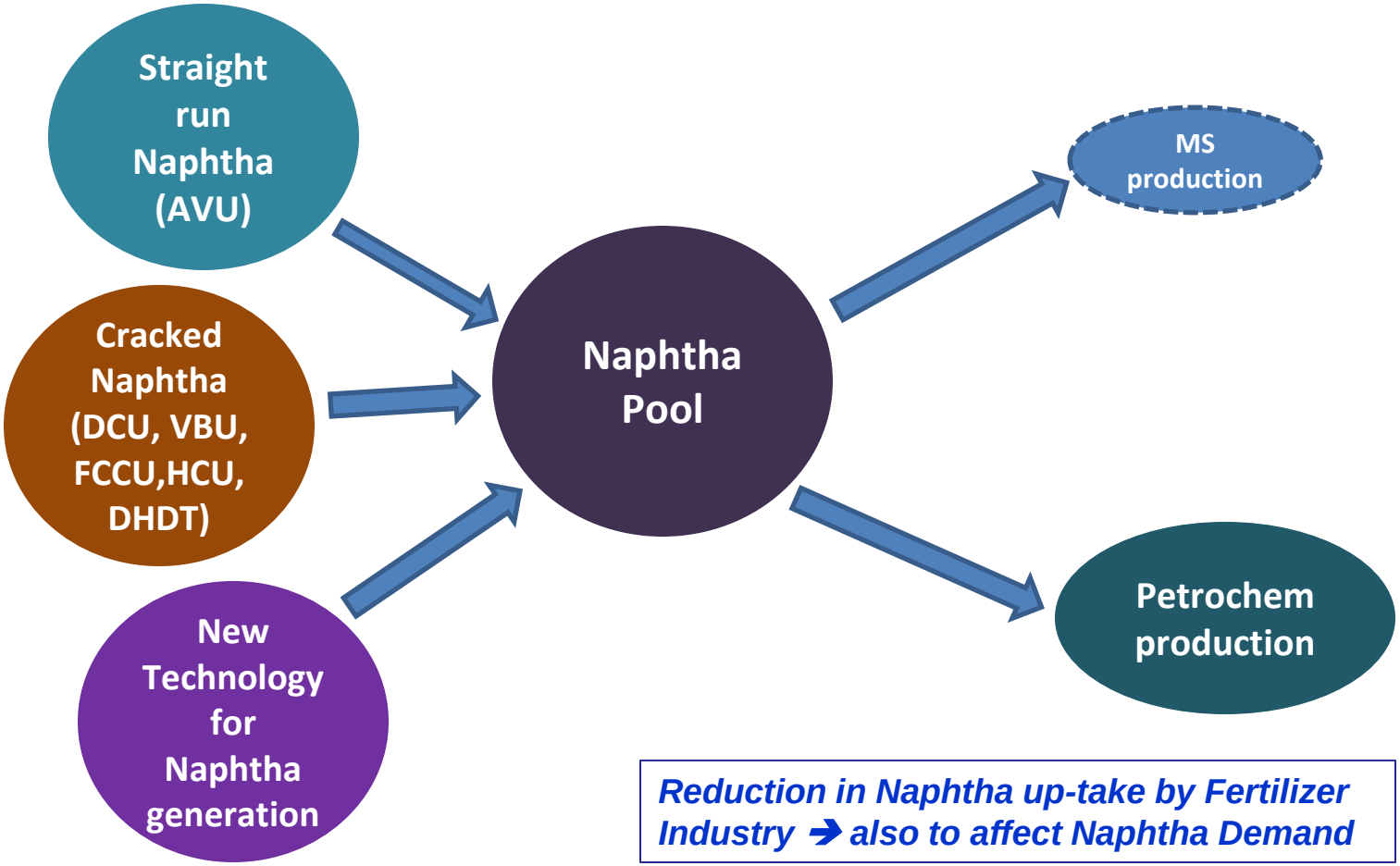
- Ultimate aim of the government ➔ Bring down the **cost of Green Hydrogen to $2 per kg** & **5 MMTPA Green Hydrogen capacity by 2030**

Future Naphtha Management

IndianOil scenario:

- HGU capacity: 1088 TMTPA
- Expected Surplus Naphtha: 182 TMTPA (25% Green H2) or 728 TMTPA (100% Green H2)

** Excluding Refinery capacity expansions*

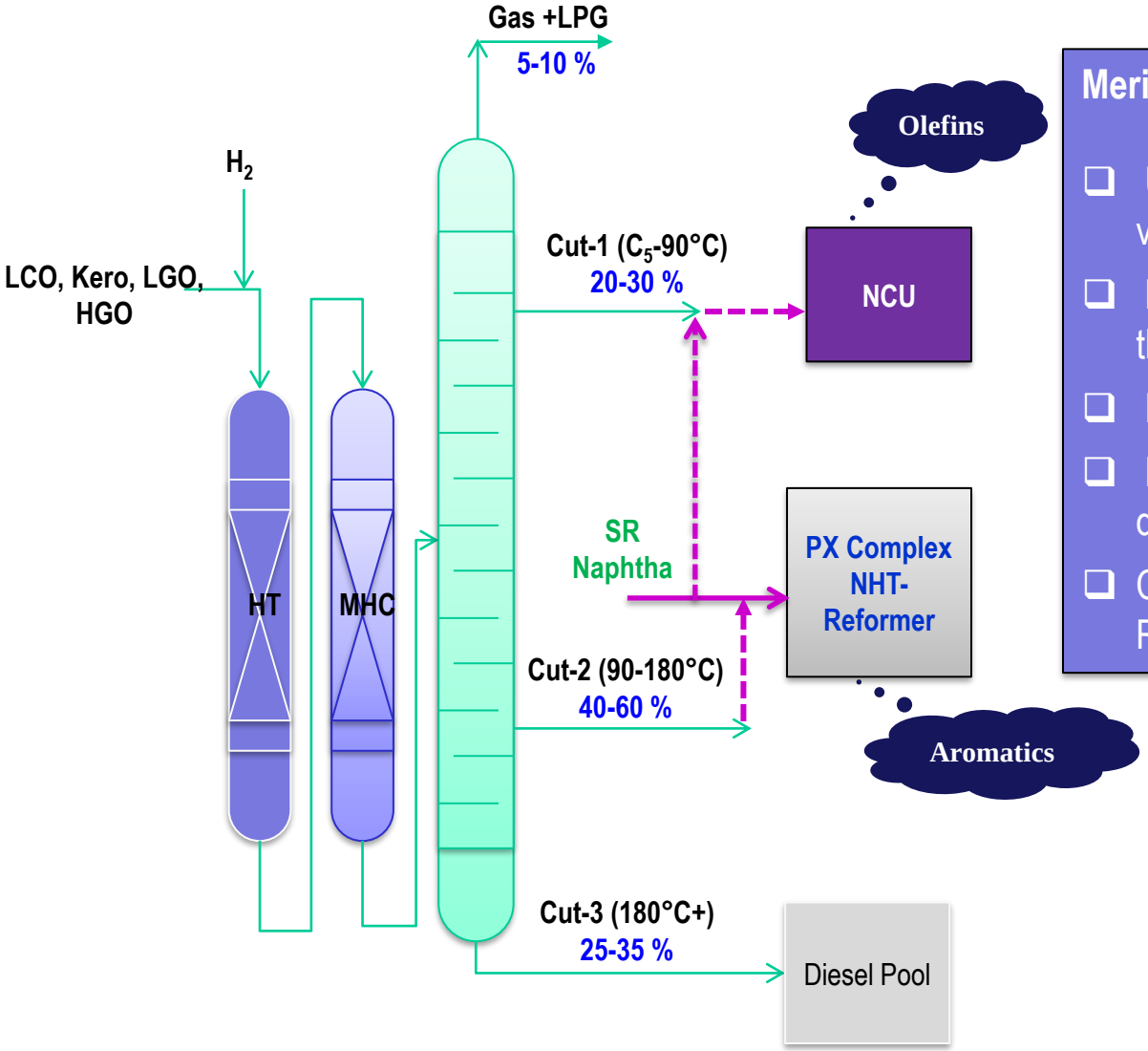


Reduction in Naphtha up-take by Fertilizer Industry ➔ also to affect Naphtha Demand

Green Hydrogen to replace H2 from HGU resulting in Surplus Cracked Naphtha ➔ Need 'Naphtha to Chemicals' Technology tailormade for predominantly 'Cracked Naphtha'

Naphtha Generation from Middle Distillates

Selective Mild Hydrocracking of Middle Distillates to Naphtha

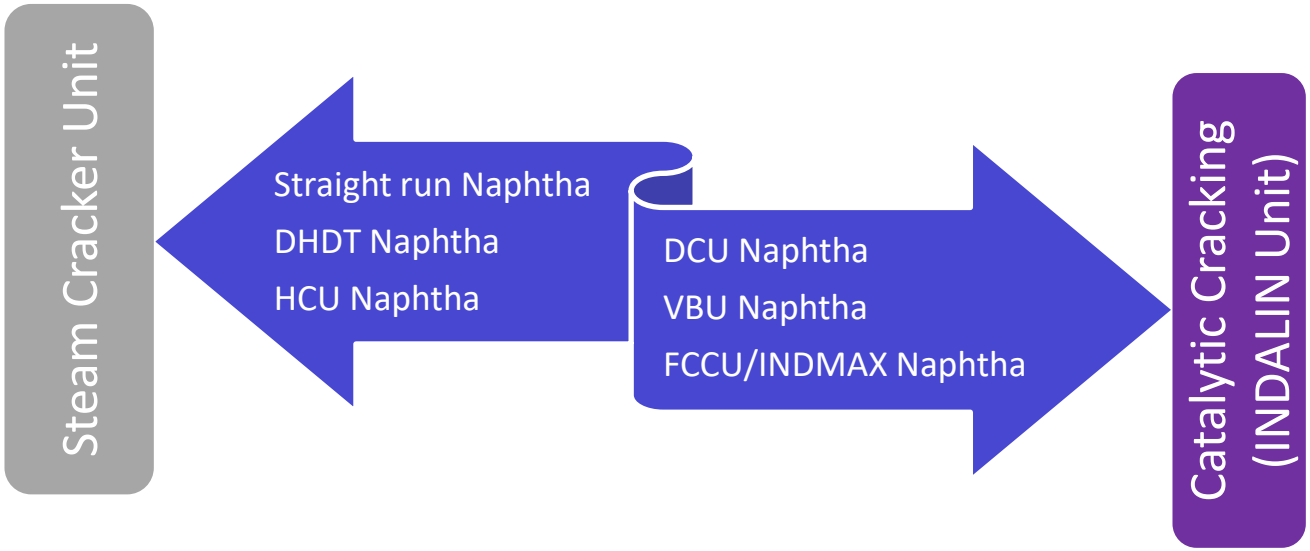


Merits of S-MHC:

- Upgradation of low value LCO to high valued BTX feedstock
- Maximization of petrochemical feedstock through Diesel minimization
- Essential for any future COTC complex
- Proprietary reactor internals- distributor, quench box
- Can be implemented in Grassroot & Revamp of DHDS Units

S-MHC to Emerge as Key Technology for 'Diesel to Naphtha' Conversion

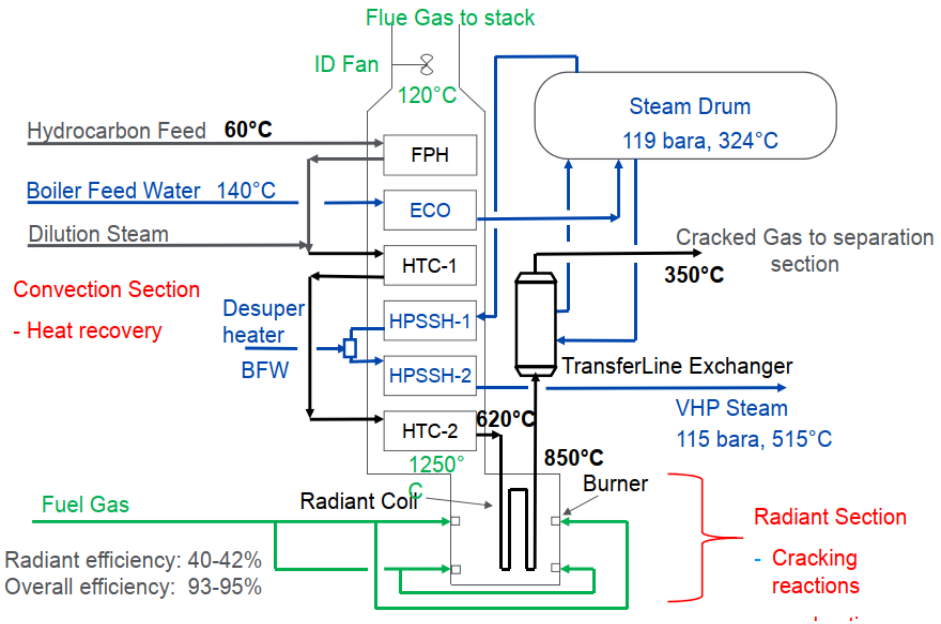
Routing of Naphtha in Crude to Chemical Scenario



Naphtha management is key to optimum 'Crude to Chemical' configurations

Steam Naphtha Cracker

- Current Global Thermal Cracker Capacity: ~195 MMTPA (271 crackers)
- Salient Features:
  - Non catalytic & Highly endothermic Rxn
  - Inlet Temp: 550-700°C
  - Outlet Temp: 750-900°C
  - Residence time: 0.15 – 0.5 sec
  - Low Pressure is better
  - Dilution Steam to Feed ratio: 0.25 – 1.0
  - ***Yields: C_2=: 25-30 wt% & C_3=: 15-20 wt% (Propylene/Ethylene: ~1)***

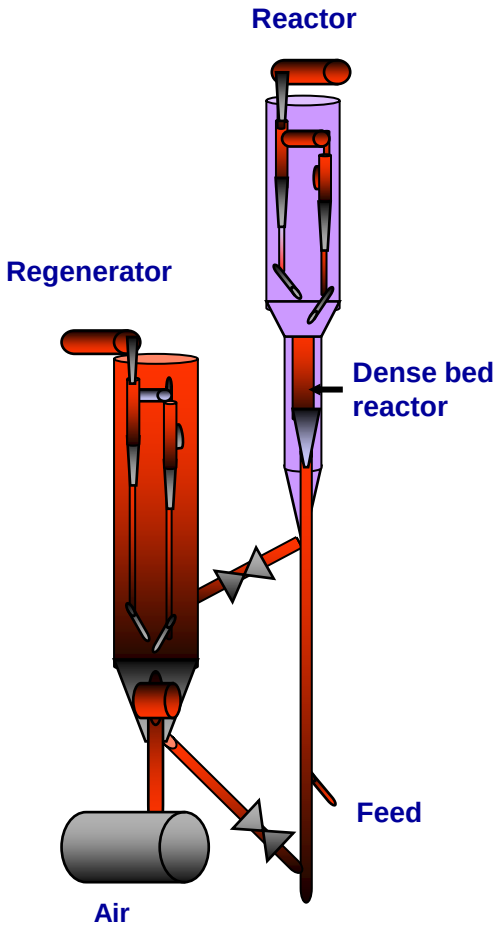


Source: Technip FMC

- Key process technology for conversion of naphtha into light olefins to fulfill the demands
- Crucial role in Crude Oil to Chemicals configurations for achieving maximum chemical conversions

Catalytic Naphtha Cracking –INDALIN Technology

Schematic diagram



Technology features:

- Up-gradation of Naphtha to Light olefins & BTX
- Proprietary catalyst & hardware technology
- Circulating fluidized bed Reactor-Regenerator hardware configuration
- No requirement of feed pre-treatment
- **Can process 'Cracked Naphtha' like FCC naphtha, Coker Naphtha, pyrolysis naphtha & Kero, SRGO, Straight run naphtha, etc. with high conversions**

Typical operating conditions	
ROT, °C	600-625
Cat/Oil	15-20

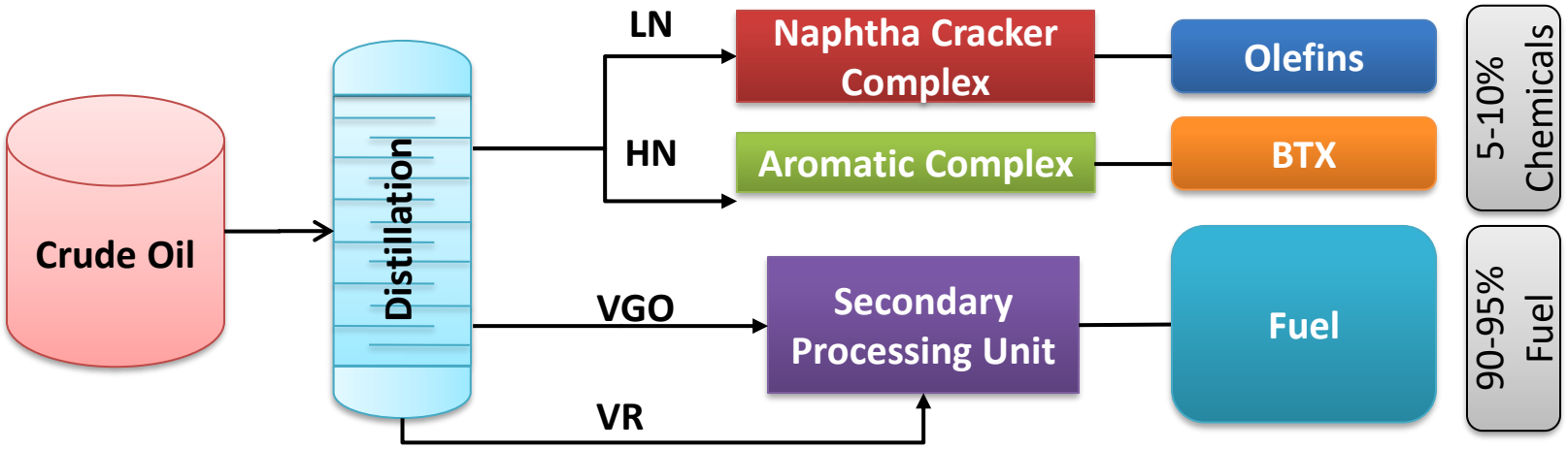
Product yields	wt %
Dry Gas (excluding ethylene)	5-8
Ethylene	**13-15**
LPG (excluding propylene)	20-26
Propylene	**26-30**
Gasoline (C5-180°C)	20-26
BTX in gasoline, wt%	40-45

Steam Cracker vis-à-vis Catalytic Cracking

Process details	Steam Cracker	Catalytic Cracking	
		KBR	IOCL INDALIN
Feedstock	Restriction wrt Olefinic Feedstock	Light Olefinic Naphtha (C4-C8)	**Olefinic Coker/FCC Naphtha & Streams boiling upto 400°C**
Feed pretreatment	Yes (NHT)	No	**No**
Severity	High severity operation (>800 ºC)	Medium Severity operation (>630ºC)	**Low severity operation (600-625ºC)**
Propylene/Ethylene ratio	~ 1	~1.6	**~ 2**
Catalyst	Non-catalytic	Catalytic	**Catalytic**
Flexibility	Lesser flexibility in product selectivity	Lesser feed flexibility	**Can selectively maximize BTX or Light Olefins**
Energy Cost & CAPEX	++++	+++	**+++**

Crude Oil to Chemical Conversion

Traditional Refinery-Petrochemical integrated Process Scheme for Chemical Production

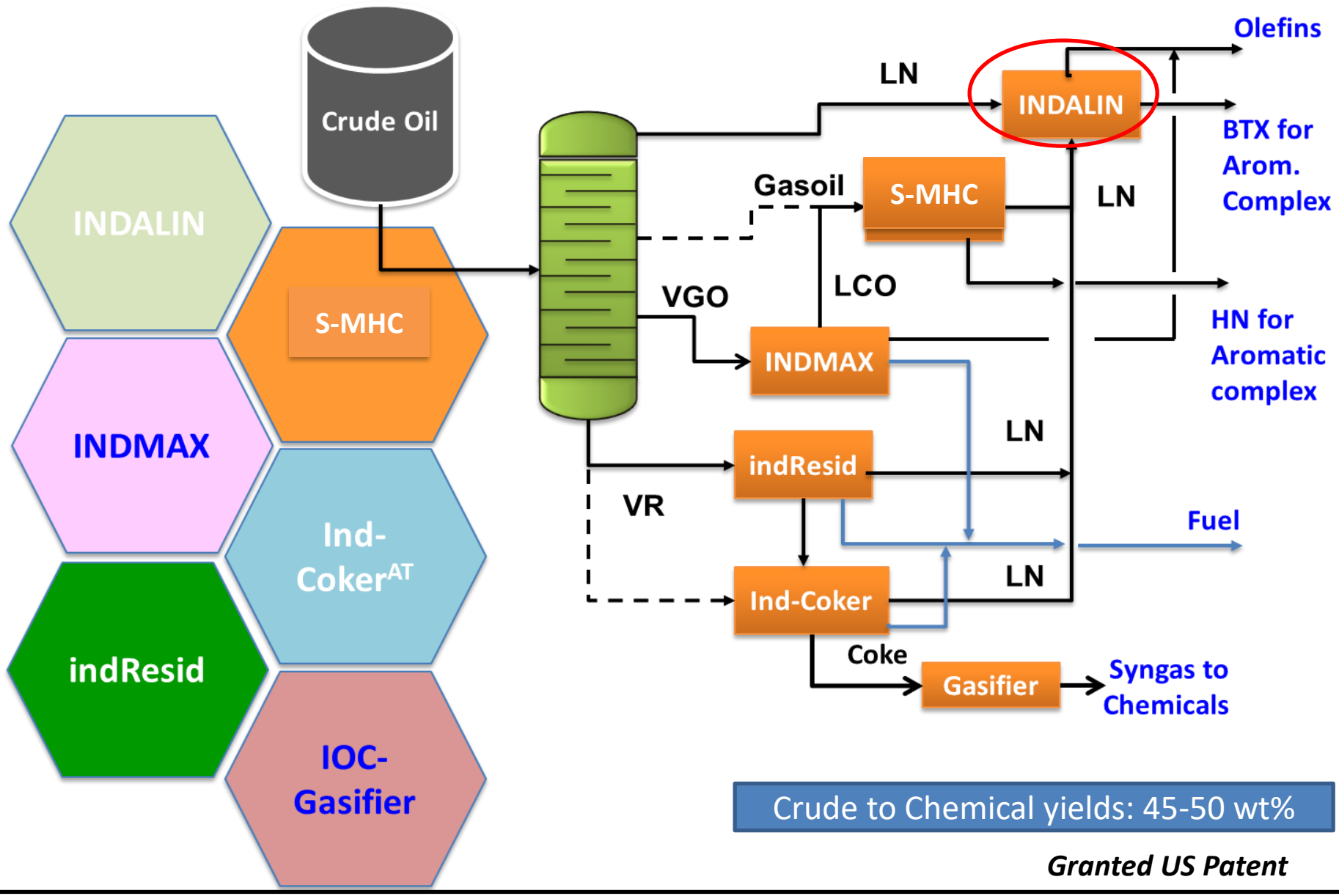


Crude to Chemical Conversions ~5-10% in Conventional Refineries ➔ Needs Increasing Integration with Petrochemicals

Source : IHS Markit

INDALIN – A Perfect Fit for COTC Configuration

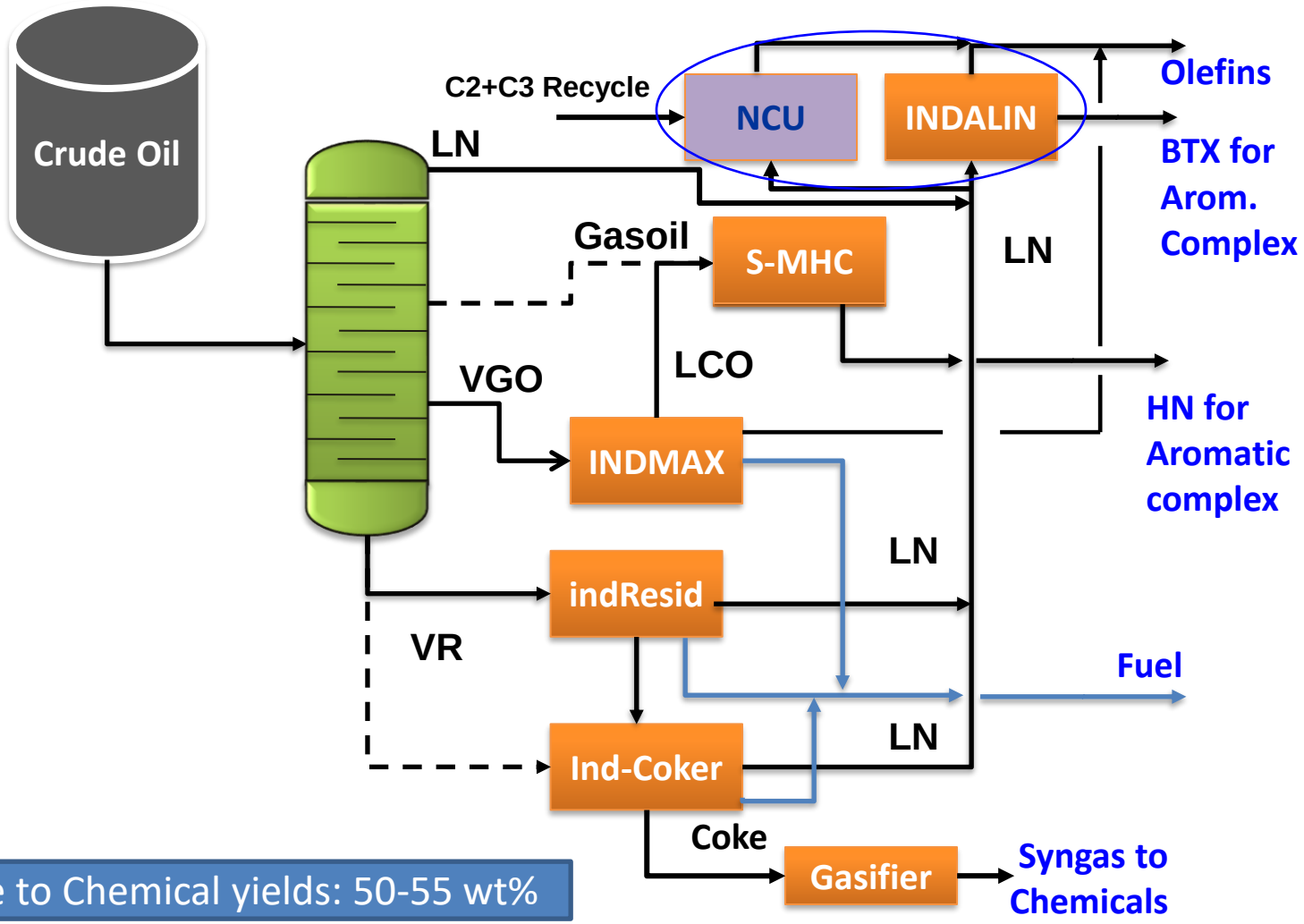
One of the IOCL COTC Configurations



Crude to Chemical yields: 45-50 wt%

Granted US Patent

INDALIN – NCU Combination for COTC



Crude to Chemical yields: 50-55 wt%

INDALIN & NCU could be synergistically integrated for COTC configurations

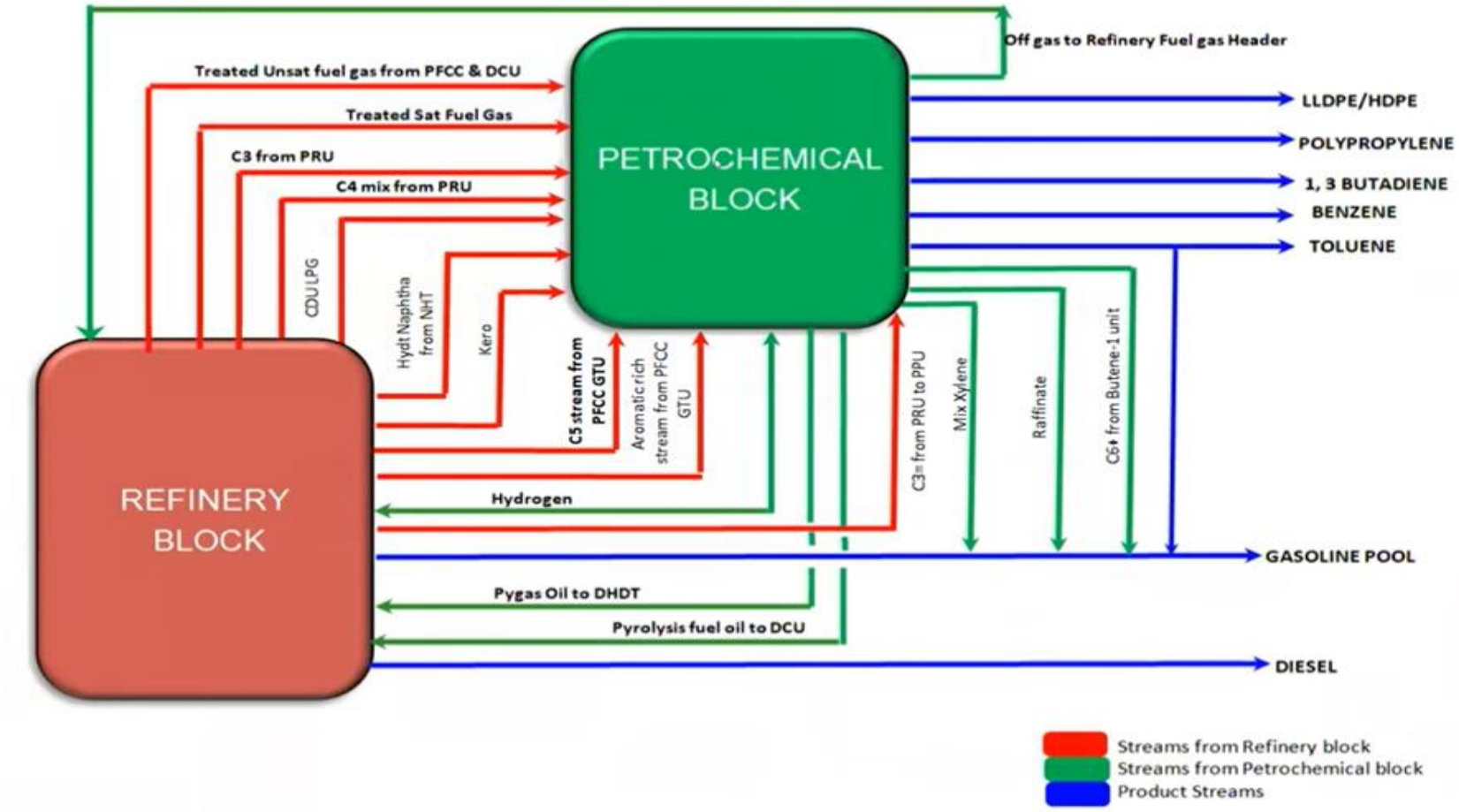
Summary

- New processes to take lead for generation of Naphtha from Middle Distillates – *Technologies similar to Selective MHC*
- Naphtha surplus expected due to possible offloading of 'Cracked Naphtha' from HGUs requiring alternate value addition options
- Steam crackers to play key role in increasing Petrochemical intensity from Saturated Naphtha streams
- IndianOil's 'INDALIN' Technology-probably one of the best solutions for conversion of 'Cracked Naphtha' to 'Chemicals' at much lower energy intensity and flexibility compared to existing technologies
- INDALIN Technology can be optimally fitted into any of the 'Crude to Chemicals' configurations

IndianOil is Poised to Provide Novel Technological Solutions for Enhancing Petrochemical Intensity & Naphtha Management

Thank You

Refinery-Petrochemical Integration: COTC



Source: LKMT-2021