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REFCOMM
ROTTERDAM
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KNPC FCC Revamp Project
Opportunities, Challenges and Lessons Learnt

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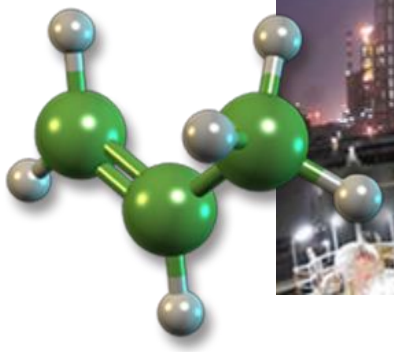
Agenda

- Overview
- Objectives and Opportunities
- Challenges and Lessons Learnt
- Results and Conclusion



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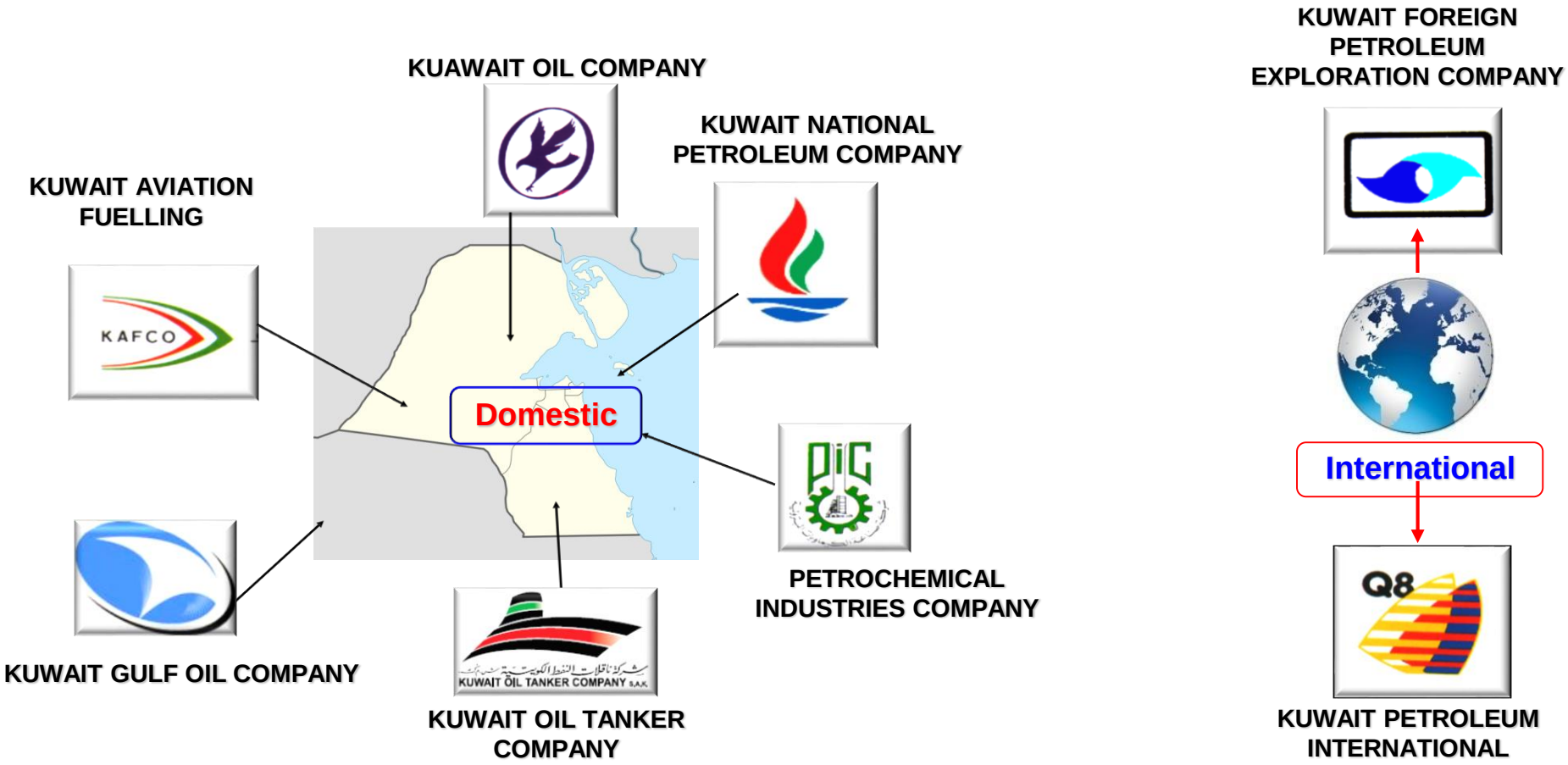
Subsidiaries of Kuwait Petroleum Co.



- KPC was established in 1980, fully owned by the State of Kuwait
- 8 specialized Subsidiaries operate in Kuwait and across the world

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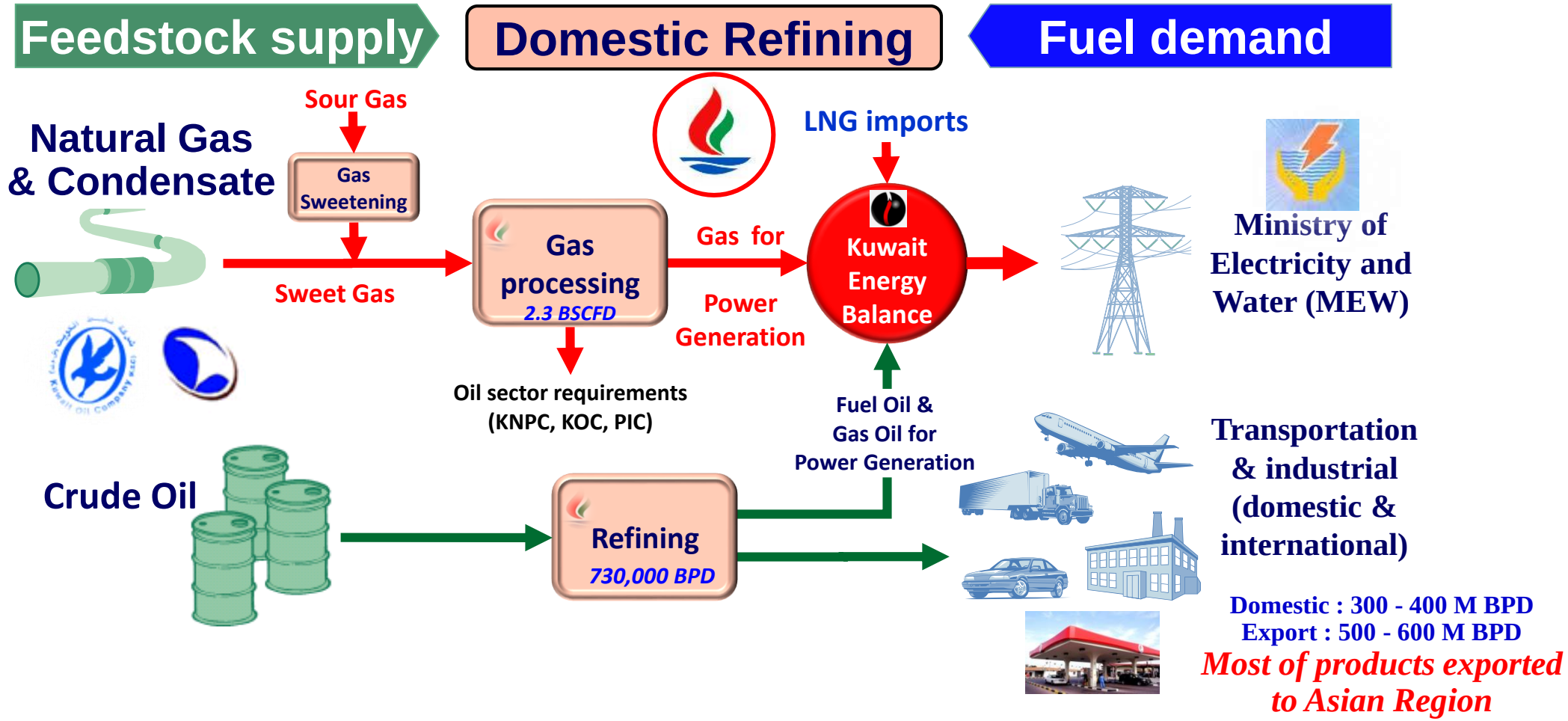
Position of KNPC in Value Chain of Kuwait



KNPC is responsible for Domestic Refining & Gas Processing to satisfy the local fuel demands for Power Generation, Transportation, Industries & supply products for International market

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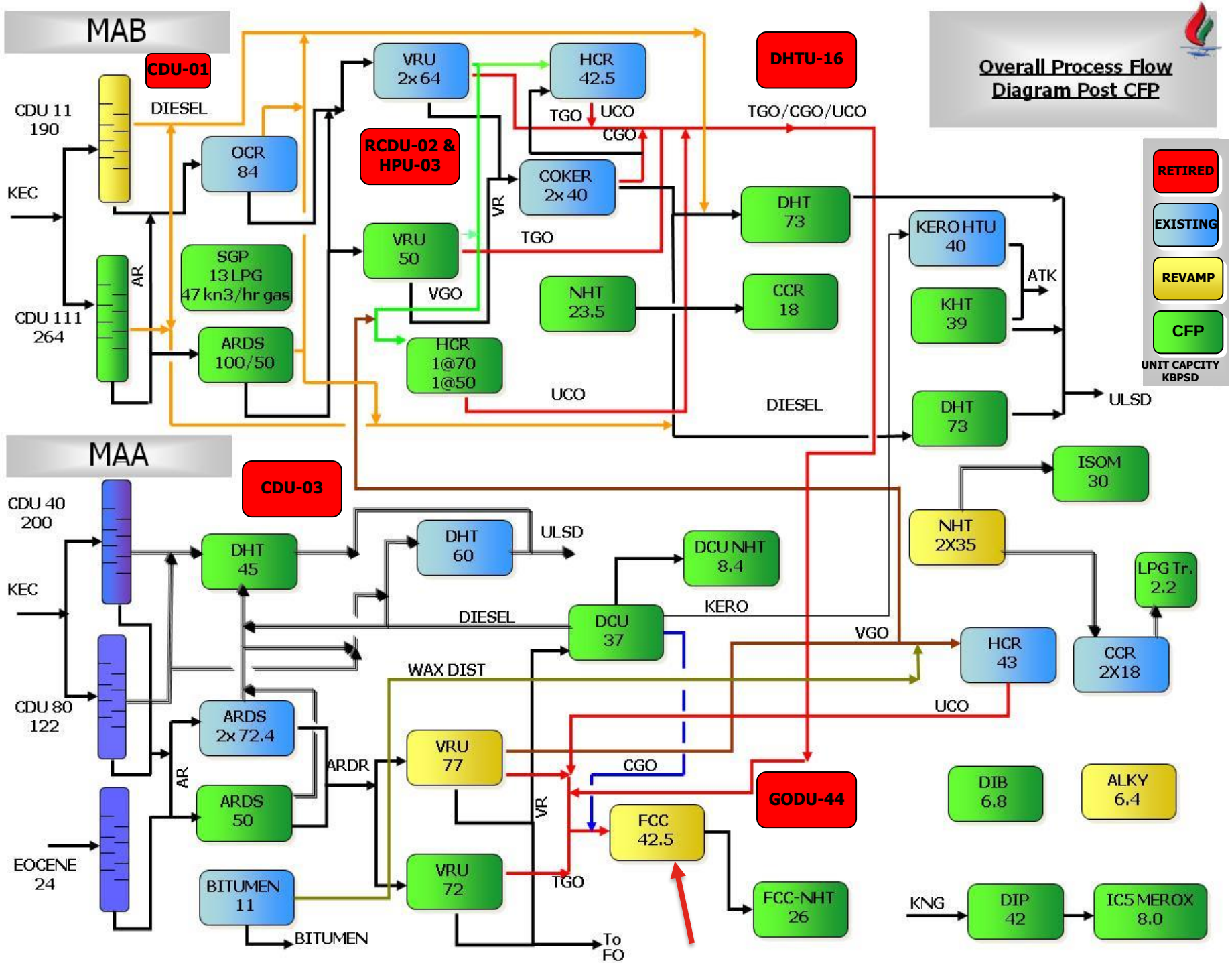

Retired SHU refinery of 200 KBPD

New Refinery of 615 KBPD under construction

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Overview

FCC Revamp - Part of CFP Strategy and Objectives

- Develop KNPC refineries into integrated merchant refining complexes to meet diversified market needs.
- Meet future market demand and specifications for local & international markets.
- Enhance the environmental & safety performance of KNPC refineries.
- Major upgrade of MAA and MAB refineries to convert high sulfur fuel oil to higher value products.
- Respond effectively to KPC / KNPC strategic directives for expanding the refining capacity in Kuwait.
- Provide new employment opportunities for Kuwaitis in the refining sector.

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Overview

FCC Revamp - Part of CFP Strategy and Objectives

- KNPC Mina Al Ahmadi processes about 460000 BPD of crude oil
- First designed by UOP in 1984 and commissioned in 1986 as a 30000 BPSD High efficiency regenerator and riser with down turn arms.
- Revamped by UOP in 1997, increasing from its original nameplate capacity to 40000 BPSD (30000 BPSD VGO+10000 BPSD CGO).
- Current revamp (November 2015) feed capacity at 42500 BPSD processing a mix of CGO/UCO/TGO

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KNPC Objectives for FCC Revamp

- Improve unit Reliability & On Stream Factor
- Processing difficult feed stocks & optimize conversion
  - Key to meet local Mogas and Propylene commitments
- Extended operation run length
- Sustained operation at higher capacity
- Improved Environmental Performance (Flare less during start up, SOx & control of Particulate emissions)

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FCC is strategic for KNPC business

KNPC FCC Project Scope

- New Reactor incorporating the following:
  - VSS ™ G2
  - Optimix ™ feed distributors
  - AF ™ Stripper
- Additional auxiliary air blower & New Orifice chamber
- Main Fractionator changes
  - Top four sections (LCN/HCN fractionation, HCN pump around, HCN/Distillate fractionation, Distillate pump around) replaced trays with random packing to save WGC modifications
- Gas Concentration columns
  - Replaced internals in different sections with high capacity trays

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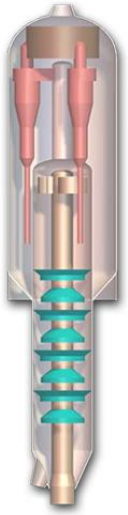
Performance of UOP's Reactor Technologies

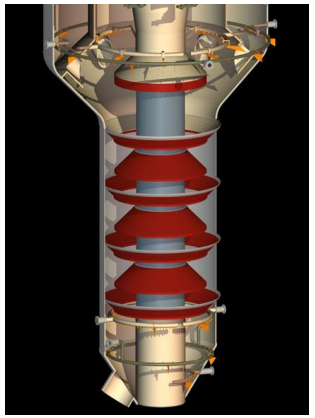
Impact of latest UOP's Reactor Technologies included in KNPC's new reactor design.

VSS™ Riser Termination



- Gasoline Selectivity
- Dry Gas, ΔCoke, Trg
- Improved Reliability

AF™ Stripper



- Conversion
- Dry Gas, ΔCoke, Trg
- Improved Reliability
- Improved Ops Flexibility

Elevated Optimix™ Feed Distributor

- Conversion
- Gasoline Selectivity
- Dry Gas, ΔCoke, Trg
- Improved Reliability

Technology Improved Performance and Operating Flexibility

KNPC FCC Challenges & Solutions

- High Sulfur → from FCC Unit
- High Aromatics → from CCR units
- High Olefins → from FCC
- KNPC Mogas pool currently meets Bz spec as two existing CCR Units at MAA Refinery are designed to meet the Bz spec of < 1 Vol. %

Technology Solutions:

- FCC Light and Heavy Gasoline Selective desulfurization, Cap.: 26 KBPSD to meet future sulfur spec
- Isomerization unit of 30 KBPSD for reducing olefins/aromatics
- DIP unit of 42 KBPSD to produce iso-pentane as Mogas component to reduce Aromatics/Olefins
- Alkylation unit revamp for higher production to reduce Aromatics/Olefin

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KNPC FCC Challenges & Lessons Learnt

- Scope Growth at FEED stage
- Split scope from CFP
- Avoid scope overlap between FCC and CFP contractor
- Raise DCN to include appropriate scope to FCC to avoid additional FCC shutdowns
- Coordination with Licensor to define specific requirements
- MAA alignment on the final scope
- Execution challenge due to interface during shutdown
- Pre-commissioning
- Commissioning and start up

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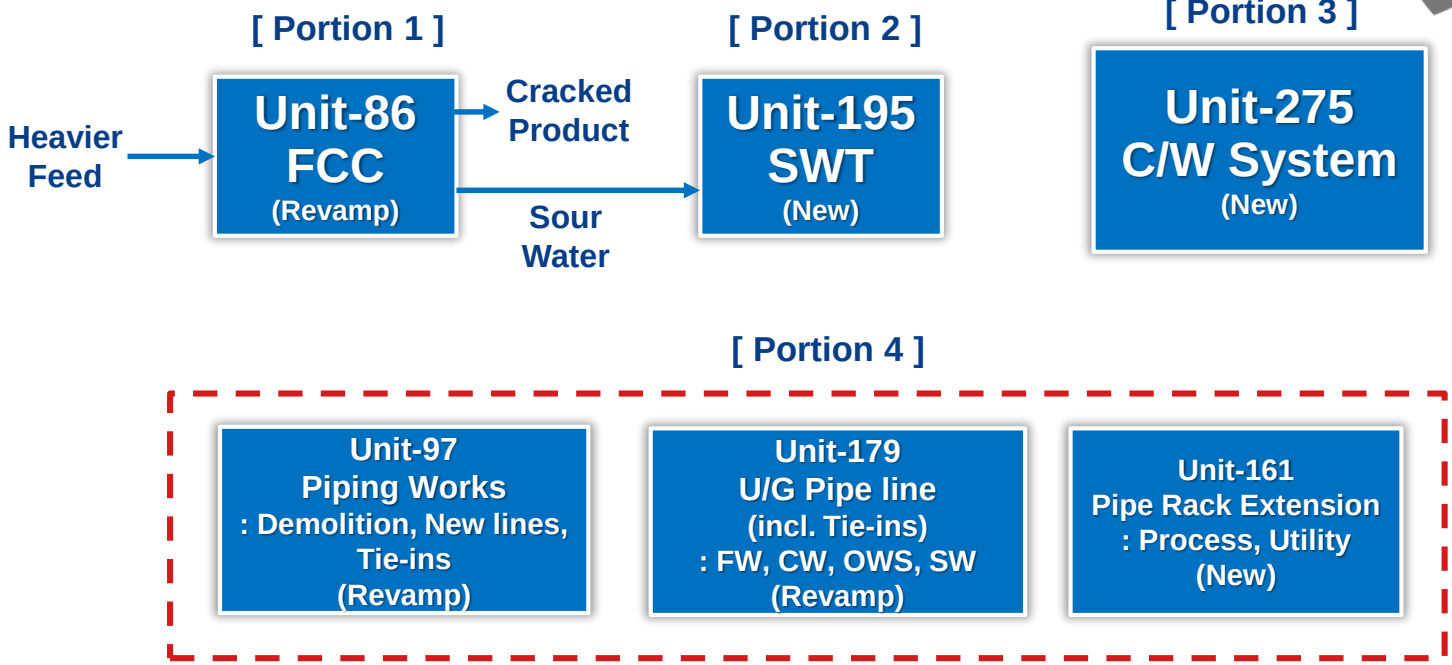
KNPC FCC Challenges & Lessons Learnt

Scope Growth at FEED Stage:

Sour Water Treatment (SWT), Cooling Water System,
Pipe rack and underground piping scope



Sour Water, Cooling Water and Piping Required Capacity Augmentation

KNPC FCC Challenges & Lessons Learnt

Coordination with Licensor:

- FEED completed in year 2008, but EPC awarded in 2013. Technology upgrades incorporated resulted in additional changes.
- FCC FEED was a basic engineering package, not full blown FEED package, required close coordination throughout EPC phase.

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KNPC FCC Challenges & Lessons Learnt

Utility/tie-in Conditions Changes

- Actual utility conditions are different than BEDD.
- Wet slops tie-in conditions (cold tie-in to hot tie-in resulted in scope change.
- HSE changes
  - Move from Chlorine injection to sodium hypochlorite

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KNPC FCC Challenges & Lessons Learnt

Refinery Coordination Challenges:

- Wet Gas compressor modification
- Regenerator cyclones
- Scaffolding and other works inside vessels
- Scope alignment

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KNPC FCC Challenges & Lessons Learnt

Construction Stage:

- Lifting of heavy equipment
- Timely Handover of equipment
- Skilled EPC manpower/subcontractor

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Focused team work only way for safe and timely completion of the project

KNPC FCC Challenges & Lessons Learnt

Pre-commissioning Stage:

- Punch listing and categorization .
- Instrument Loop Checking
- Effective Communication and Full Participation
- Maintain cleanliness at site to avoid accidents
- Plan in advance for utilities
- PSSR: Pre Safety Start up Review

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KNPC FCC Challenges & Lessons Learnt

Post-commissioning Stage:

- Availability of design feed for PGT run of FCC
- EPC/Licensor/Vendor resources, Lab Resources
- Fractionator related issues (Heavy Gasoline EP Vs. Performance Guarantees)
- Hot spot on stand pipes
- Auxiliary Air Blower commissioning

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KNPC Revamp Results Summary

- Rx- Regen Section – Success!
  - Flawless start-up
  - Excellent catalyst containment
  - Ease of operation
  - Selectivity to C_3= and Gasoline better than UOP prediction
  - Regen temp on lower side reflects on improved stripper efficiency
- Main Column and Gas Concentration Unit – Success with some challenges

	Pre Revamp	Post Revamp
Feed density, API	Base	Base -3
Propylene, Wt-%	Base	Base + 8%
Gasoline, vol-%	Base	Base + 1.5%

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Acceptance of Facilities and closing of Project in progress

Economics and Payback

- Processing of poorer feed (Heavier feed like TGO/CGO)
- Improvement in Gasoline yield
- Improvement in Propylene yield
- Improved OSF

Total Estimated Financial Benefits =25-30 MMUS$/Annum

Payback of about … 6 years

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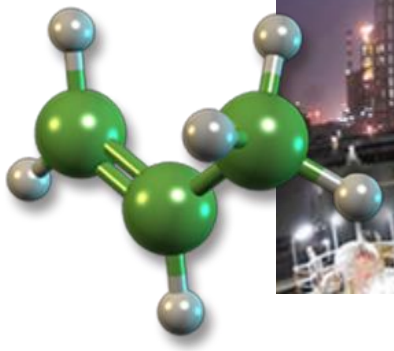
Conclusions

- Reactor replacement met unit processing objectives
- Project maximized use of existing assets
- Improve refinery profitability
  - Improved product slate, especially Gasoline and Propylene yield
- Challenge of improved run length from 3 to 4 years and operational availability under assessment and can be addressed after completion of current operating cycle.



Reactor replacements improve refinery profitability

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