



Ian Clarke

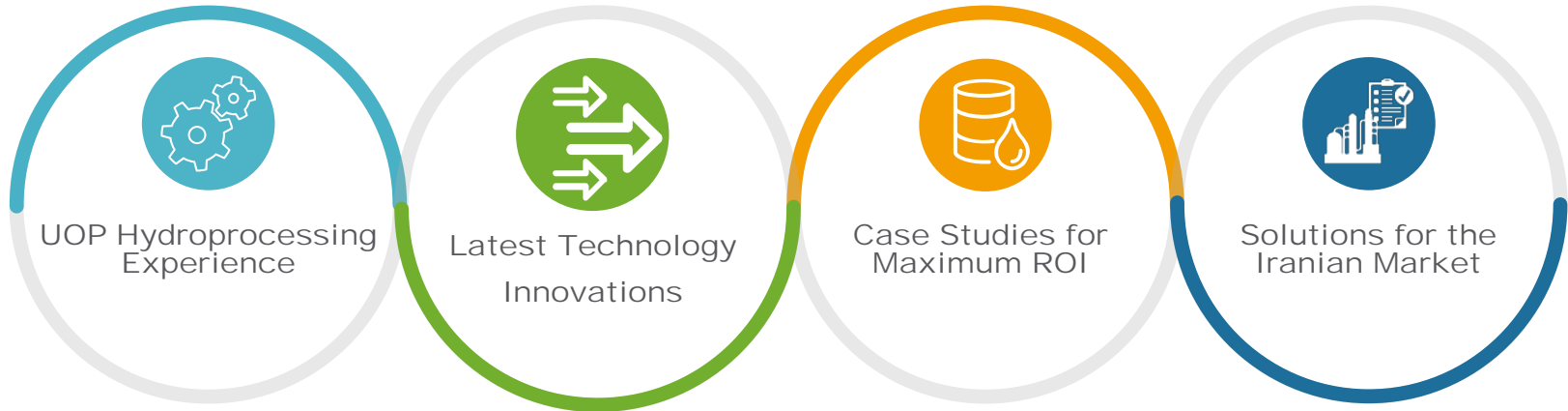
# UOP Hydrocracking Technology

Hydroprocessing and Heavy Oil  
Technology Manager

Upgrading Fuel Oil to Euro V Fuels

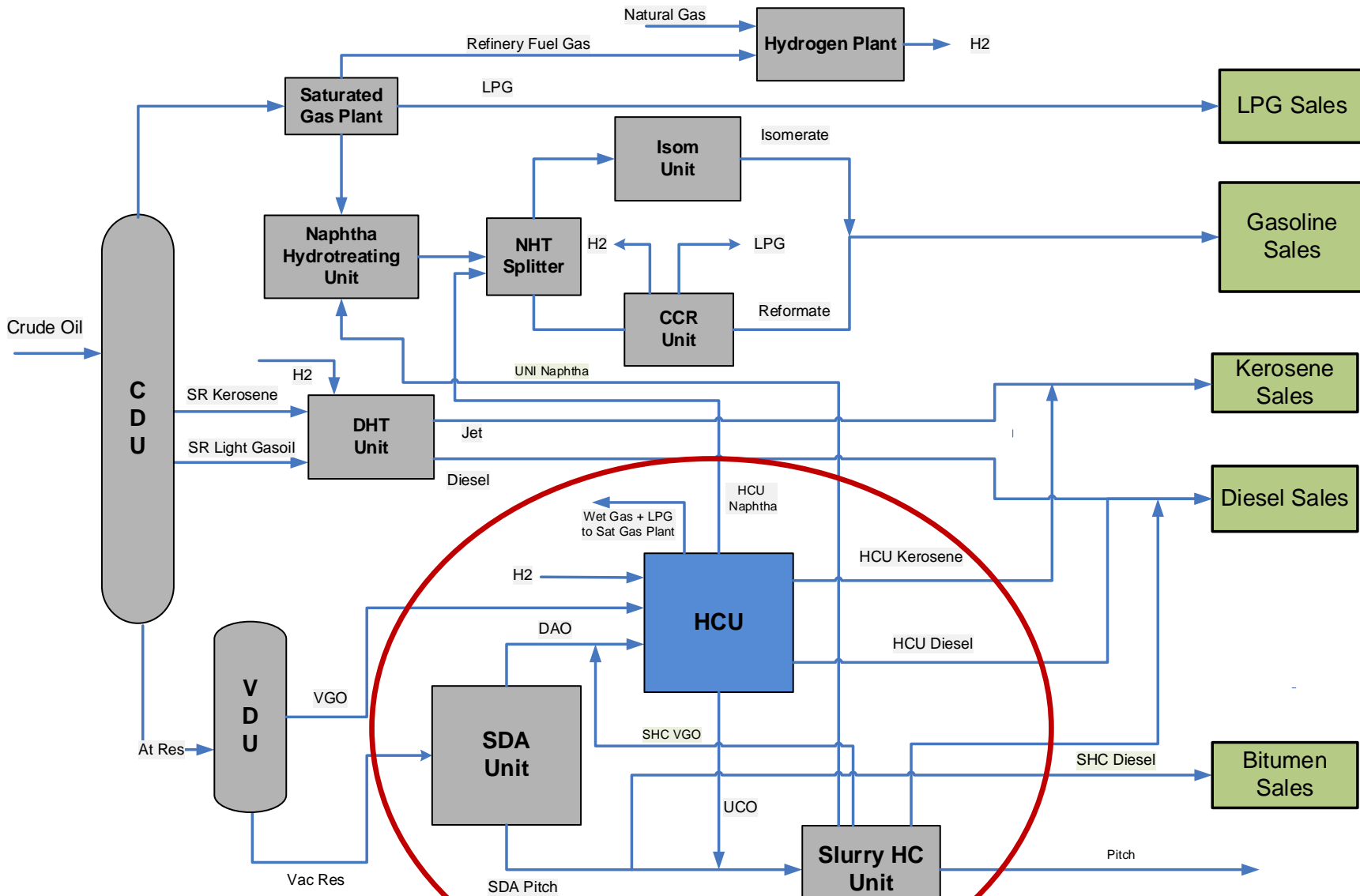
5<sup>th</sup> December 2017 | Bottom of the Barrel Workshop | NIORDC, Tehran

# Agenda



Hydrocracking is a key enabler to maximise transportation fuels and to reduce fuel oil to less than 10% of crude

# Hydrocracking Unit



# UOP Hydrocracking Process – Increasing Conversion and Profitability

- Hydrocracking converts low value feeds to high value transportation fuels and petrochemical feedstock
- Adds hydrogen which increases the volume of the products
- Converts heavy gas oils to clean jet and diesel,

Increasing Conversion to Naphtha and Distillates



VGO Hydrotreating  
(<20%)



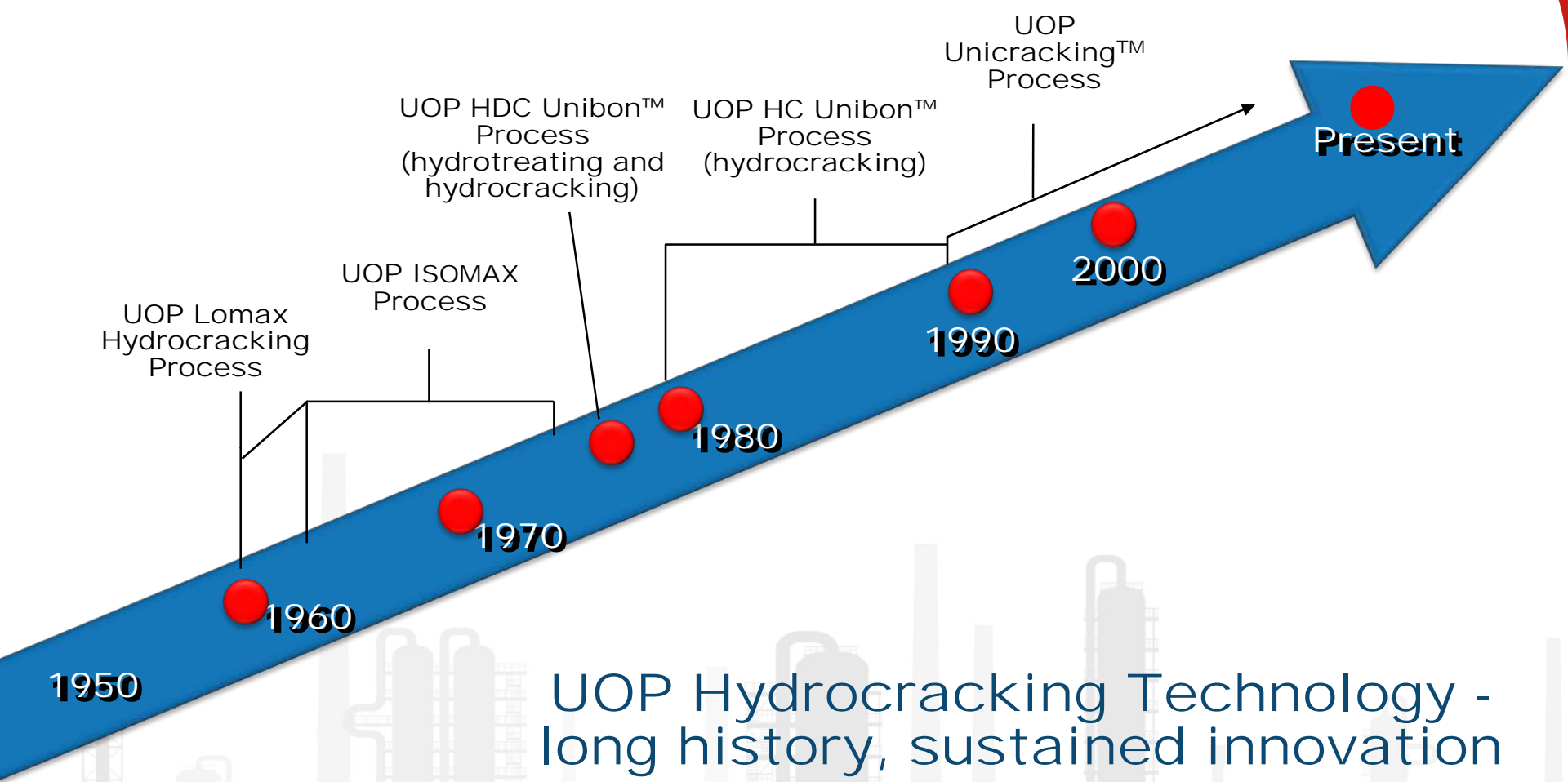
Mild  
Hydrocracking  
(20-50%)

Partial  
Conversion  
(50-90%)

Full  
Conversion  
(90+%)

Flexibility to Meet Refiner Processing Objectives

# UOP's History of Hydrocracking Progress



# Hydrocracking Technology Portfolio

Feedstock

Reactor Section

Fractionation Section

Products

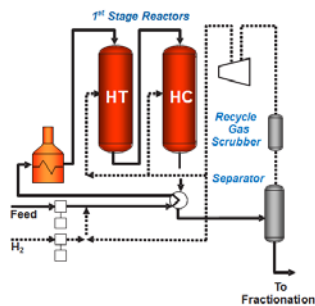
Distillate

LCO

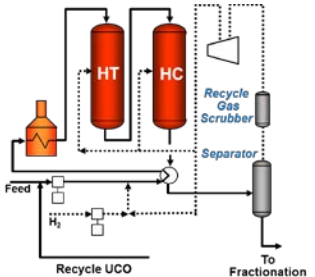
VGO

CGO

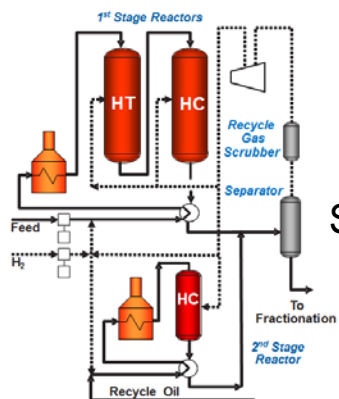
DAO



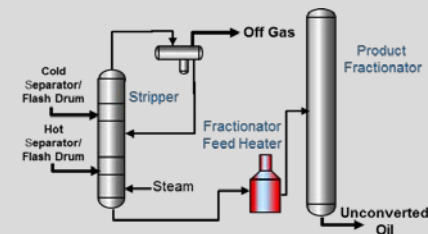
Once Through



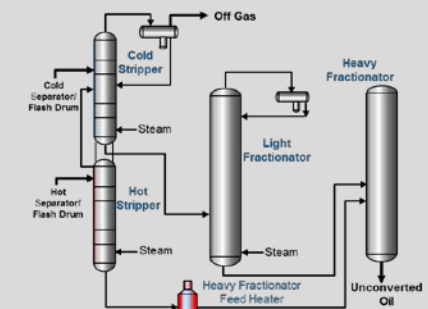
Single Stage  
Recycle



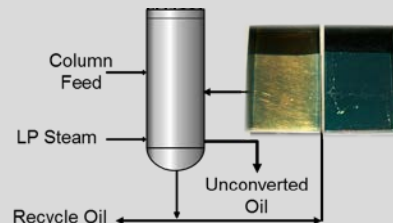
Two  
Stage Recycle



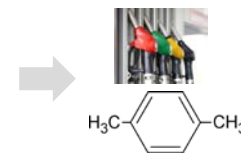
Dual Stripper/Dual Frac



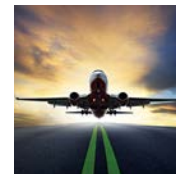
HPNA Management



Naphtha



Kero/  
Jet Fuel



Diesel Fuel



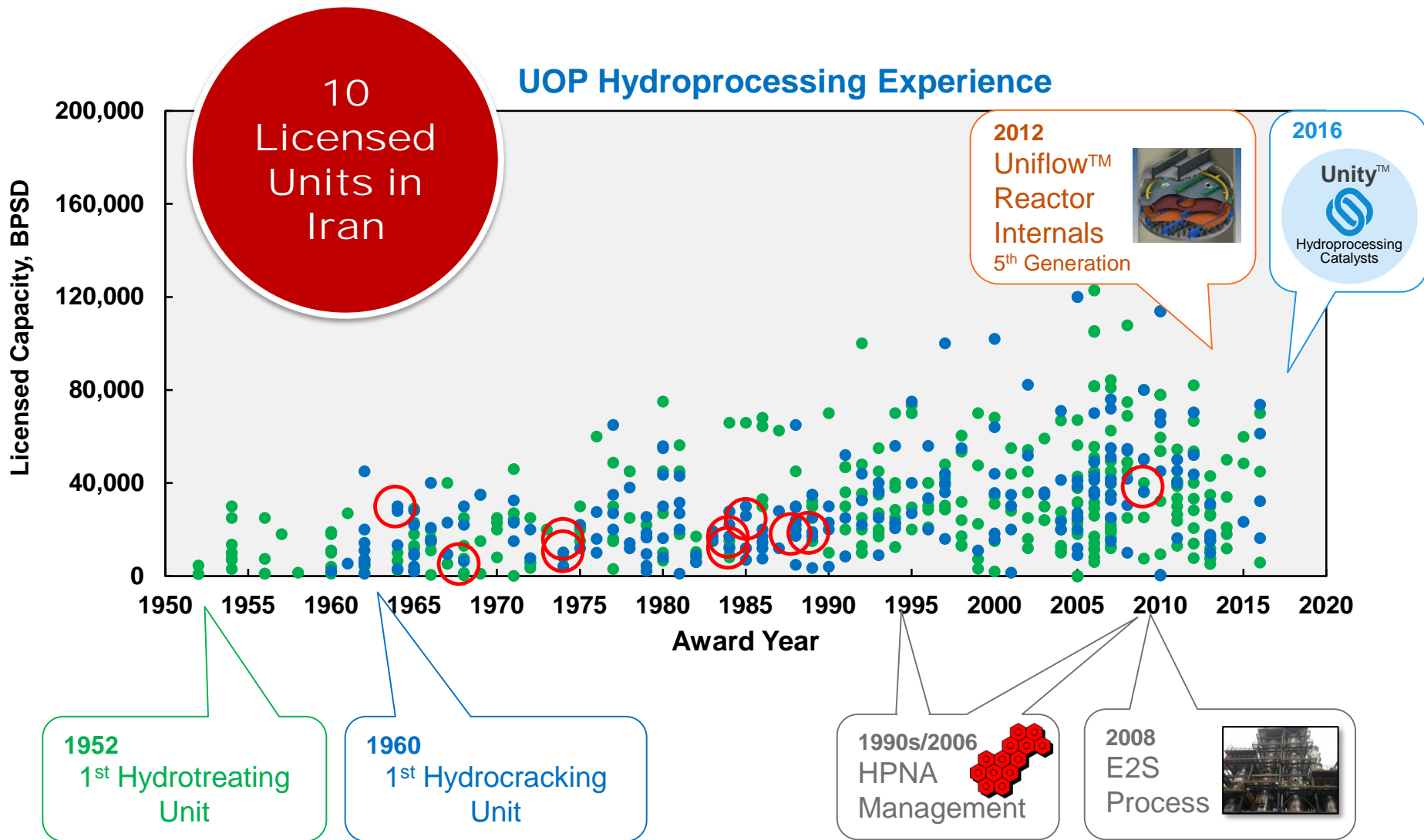
Lubes Base  
Stocks



Customized Solutions to Meet Customer Objectives

Honeywell  
UOP

# 65 years of Hydroprocessing Innovation



**340+ Hydrotreating Units & 220+ Hydrocracking Units Licensed**

# Comprehensive Hydroprocessing Solution

Unity



Hydroprocessing  
Catalysts

## Catalyst Solutions

- Unified portfolio for hydrotreating & hydrocracking
- Crystaphase®



## Equipment Solutions

- Uniflow™ Reactor Internals
- UOP Hydrogen Purification (Polybed™ PSA)
- Callidus Combustion Equipment
- Honeywell Advanced Process Control
- Mitsui smiLLe™ Metallurgy
- Filtrex® ACR Filtration



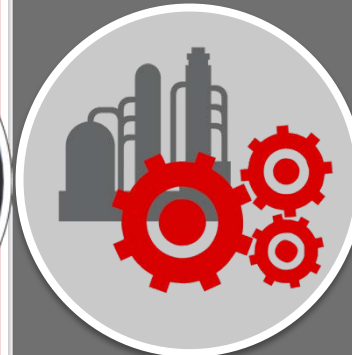
## Process Technology

- Innovative flow schemes
- Unicracking Process
- Unionfining Process
- HPNA Management
- New unit & revamp experience



## Expert Knowledge

- Training simulators
- Experion Solution Suites



## Integrated Solutions

- Bottom of the Barrel (Uniflex™, RCD Unionfining, & SDA Processes)
- Hydrogen recovery & purification



# UOP Hydrocracking Differentiators

- Extensive experience in revamping existing Hydrocracking Units
  - Maximize value from existing assets
- Novel Fractionation
  - Reduced CAPEX and OPEX of fractionation section
- HPNA Management
  - Enabler for higher conversion
- Uniflow reactor internals
  - Maximize catalyst utilization
- Catalyst
  - pre treat and cracking

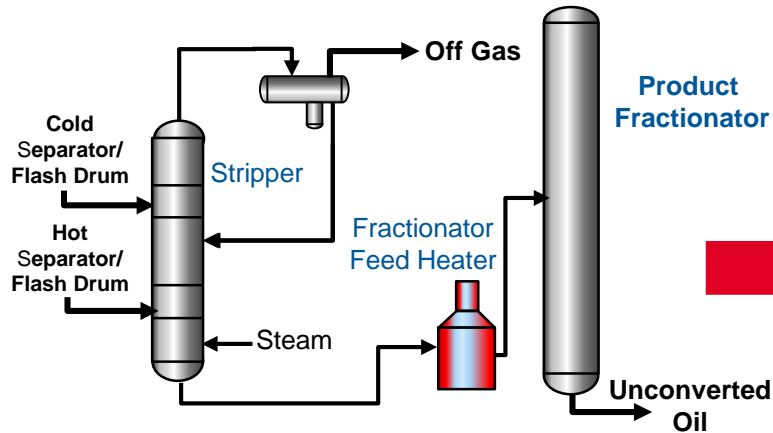
# Improving Profitability from Existing Asset

- A challenging market demands innovative solutions
- UOP can provide a variety of revamp options to meet your objectives
  - Innovative process solutions
  - Experience with different flow schemes
  - Uniflow reactor internals
  - Complete catalyst portfolio
  - Targeted studies to resolve issues, assess future expansion or investigate different processing objectives
- UOP Worldwide Hydroprocessing Revamp experience
  - 74 Revamp Studies and 42 Revamp Schedule A's conducted in the last 10 years

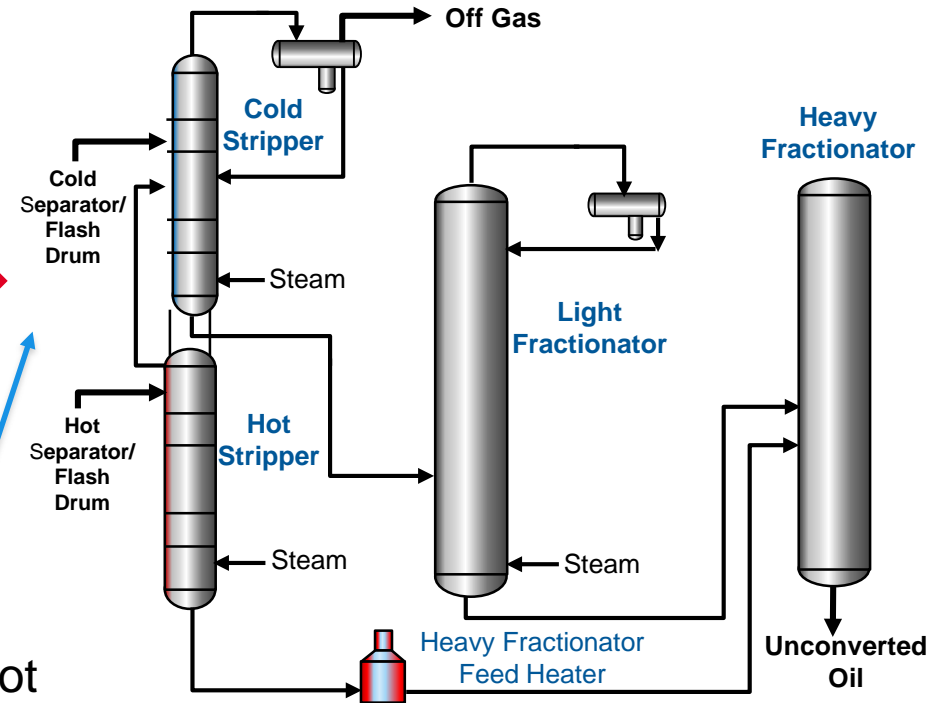


# Energy Savings with Novel Fractionation

## Traditional Single Stripper Design

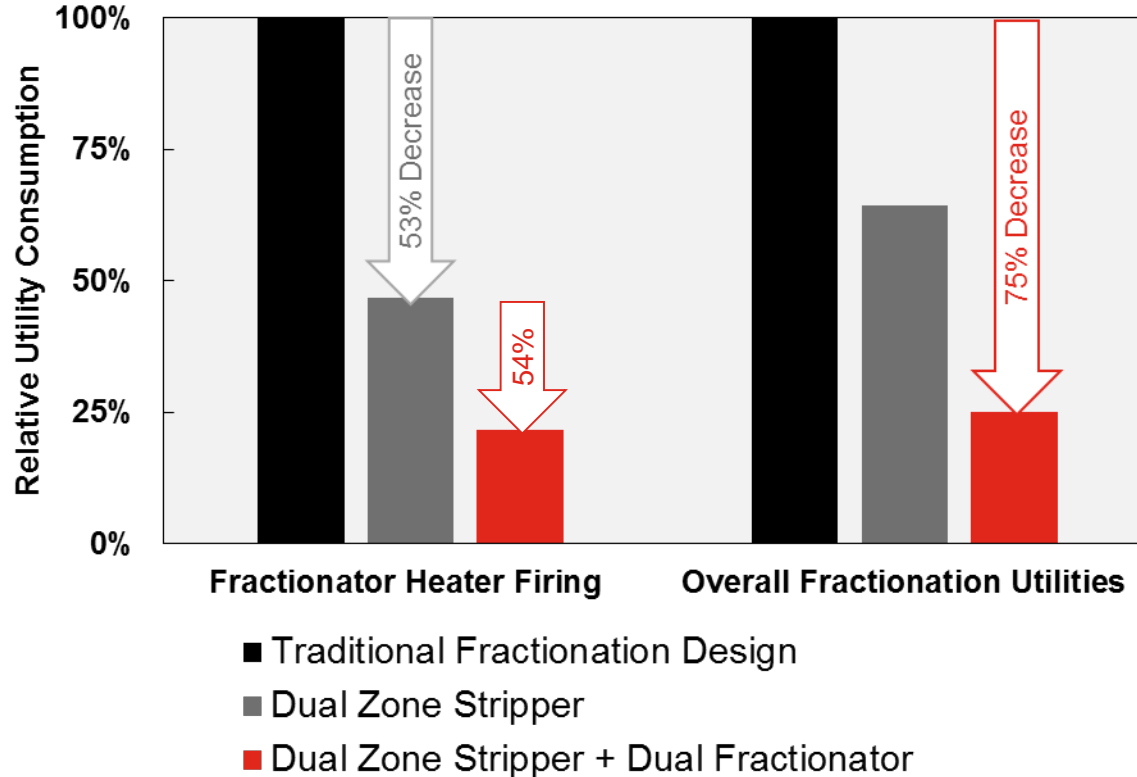


## The Novel Fractionation Flow Scheme



- The separation accomplished in the hot and cold separators is further improved in separate hot and cold strippers
- Improved Diesel/UCO separation with heavy fractionator

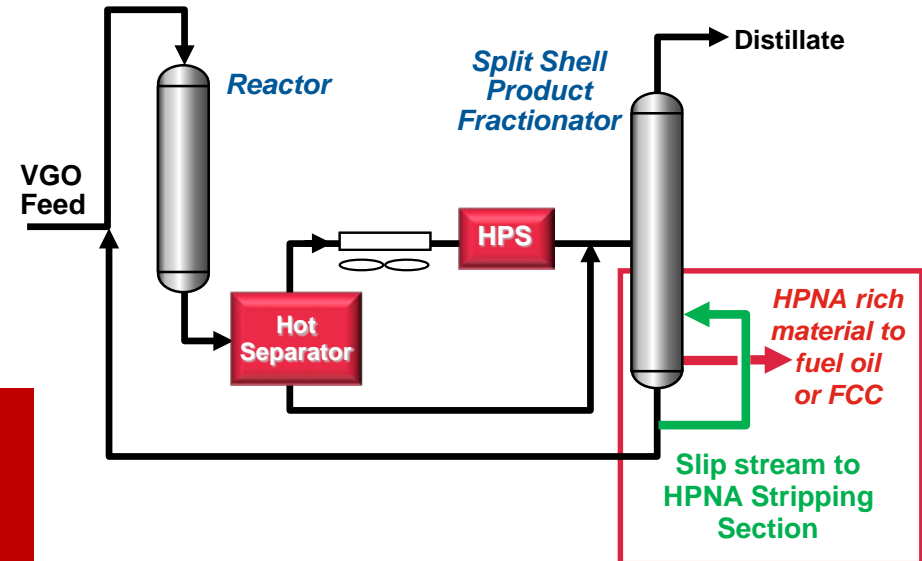
# Novel Fractionation Benefits



- Dual Zone Stripper + Dual Fractionator
  - Improved fractionation efficiency
  - Diesel yields improved by approximately 1%
  - Produces dry diesel directly from fractionator

# UOP HPNA Management Technology Enables Higher Conversion

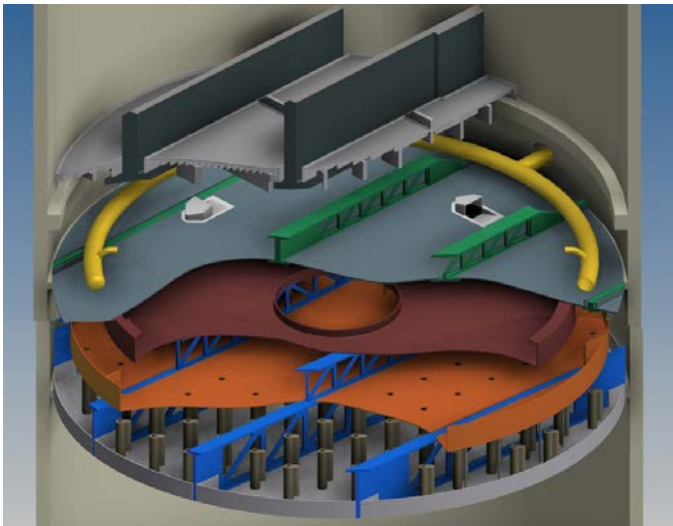
- Heavy Polynuclear Aromatics can build up in recycle oil
- HPNA Management Solutions
  - Split shell fractionator concentrates HPNA's in a small bleed stream
    - 15 units designed with split shell fractionator, 5 operating
  - External HPNA stripper is available as a revamp



Up to 99.5% conversion for entire catalyst cycle

# Improved Distribution with UOP Uniflow Reactor Internals

- New design offering a step change in performance & speed of installation
- First sale in 2013
- Sold into 16 units (new and revamp) with 6 operating successfully



**Example:** Installed in 5-bed HC reactor in Nov, 2014. Unit operating at 32% higher feed rate compared to previous cycle.

Hydrocracking Bed	Radial Spread (°F) New Cycle	Radial Spread (°F) Previous Cycle
Bed 1	Top: 1 Bottom: 1	Top: 3 Bottom: 18
Bed 2	Top: 4 Bottom: 3	Top: 2 Bottom: 6
Bed 3	Top: 4 Bottom: 2	Top: 5 Bottom: 6
Bed 4	Top: 4 Bottom: 3	Top: 12 Bottom: 36
Bed 5	Top: 4 Bottom: 4	Top: 11 Bottom: 45

## Customer Feedback:

*“We would never have been able to operate this unit where it is today without these new internals. This is a step change for UOP”*

# Hydrocracking Catalyst System Components

## Grading System



- Controls pressure drop
- Removes metals

## Hydrotreating Catalyst



- Sulfur removal
- Nitrogen removal
- Aromatic saturation

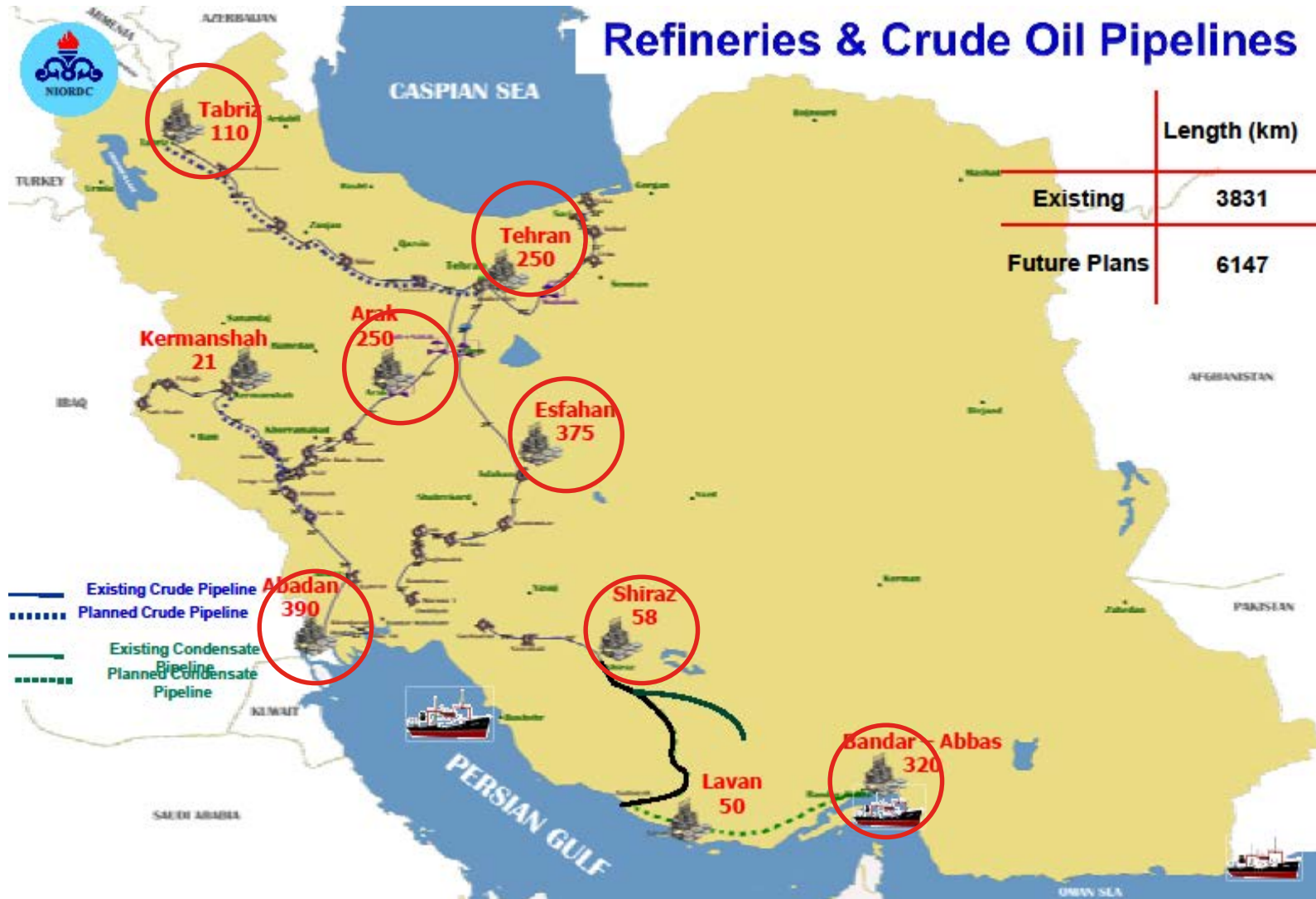
## Hydrocracking Catalyst



- Selective cracking to reduce boiling range
- Aromatic saturation
- Selective isomerisation



# Iranian Hydrocracking Opportunities



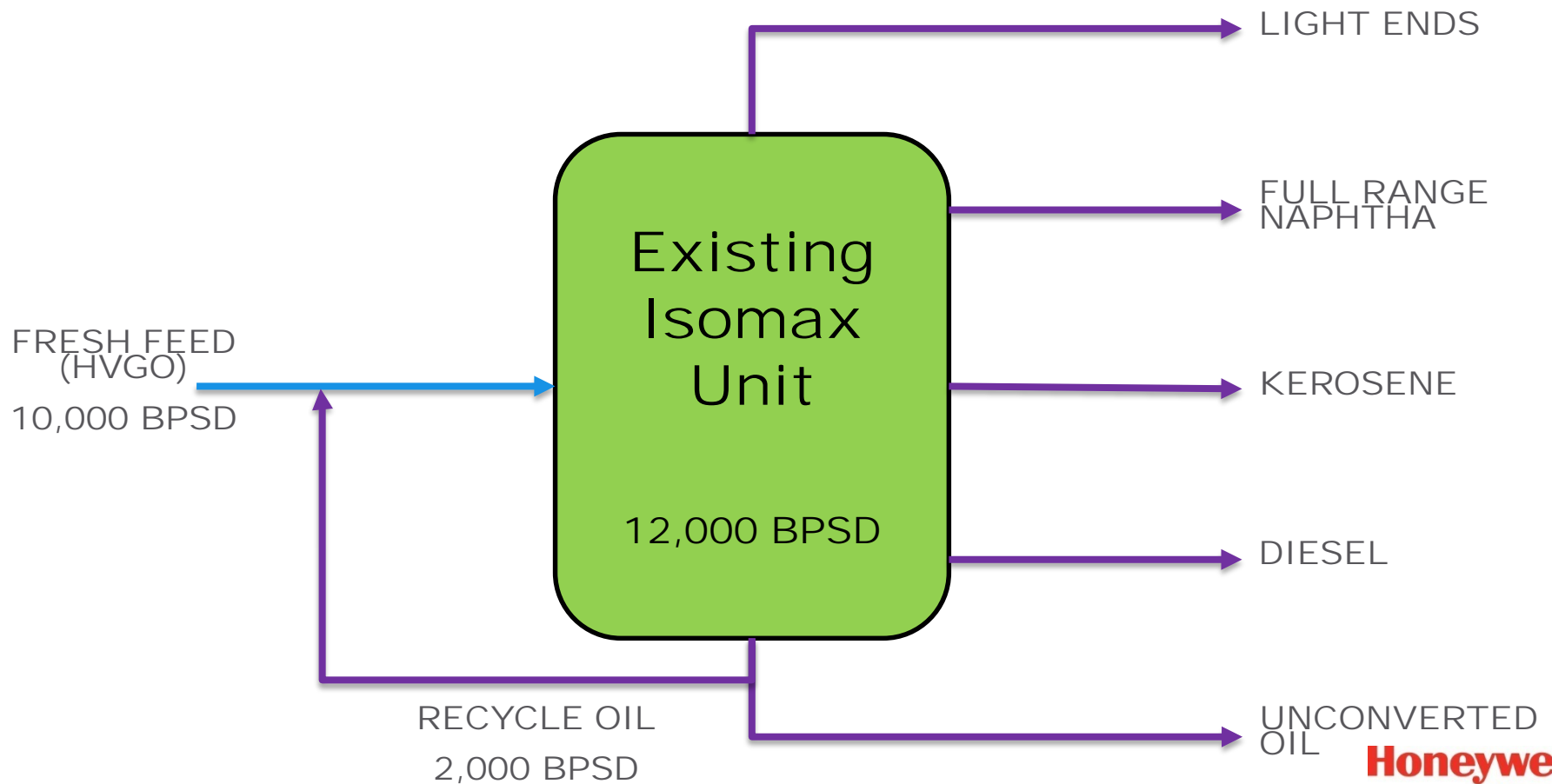


# Revamp of existing Iranian units

- **Key enablers for staged investment and fuel oil reduction**
- **Maximum utilisation of existing refinery assets**
- **Revamp Opportunities for increased throughput**
- **Phased investment for Bottom of the Barrel upgrading**
- **Delayed investment of major unit revamp**

# Existing Unit – Iranian Isomax Unit

19%  
Fuel  
Oil

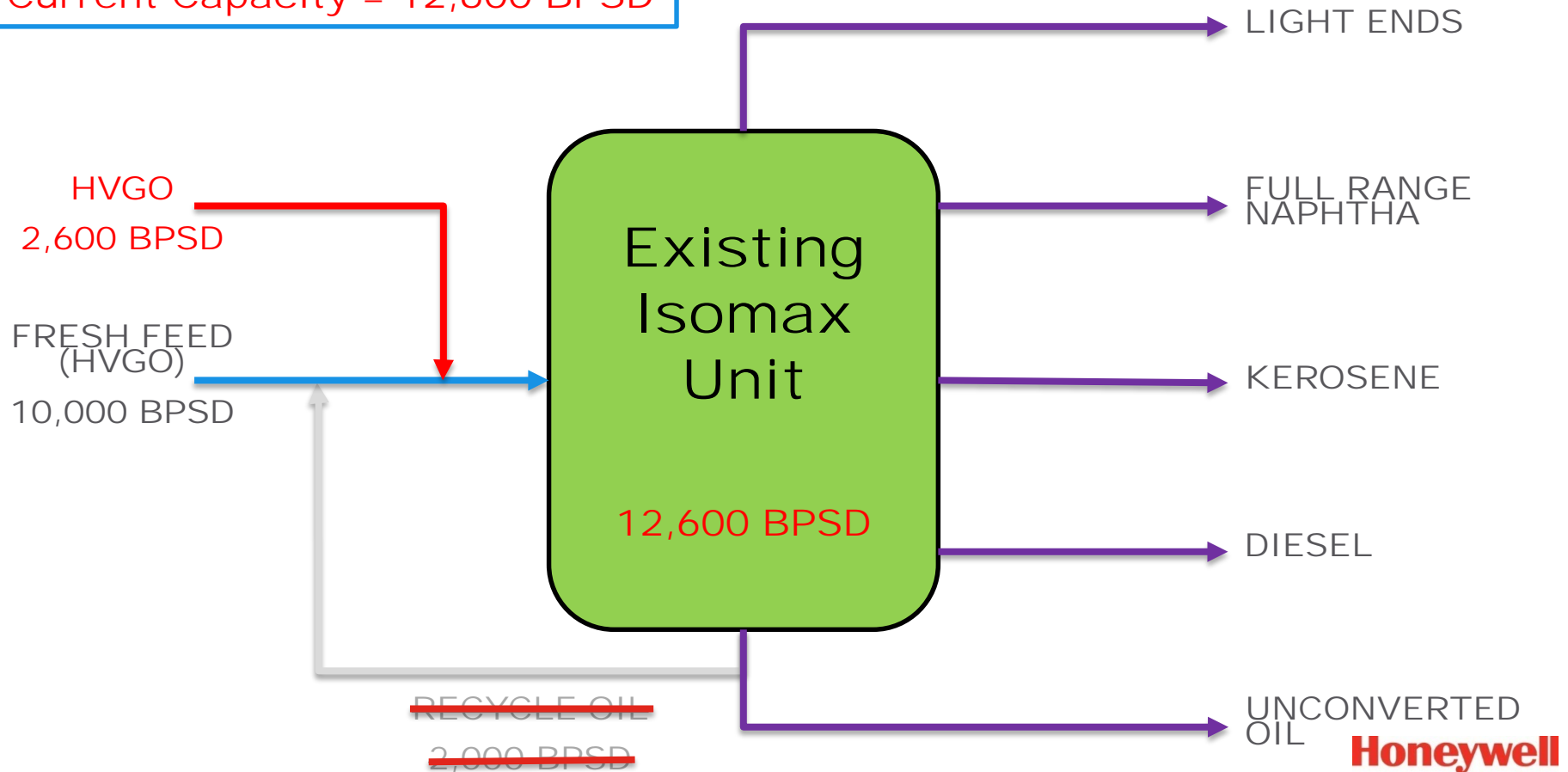


# Existing Unit – Iranian Isomax Unit

## Phase 1 – New VDU

13%  
Fuel  
Oil

Original Capacity = 12,000 BPSD  
Current Capacity = 12,600 BPSD

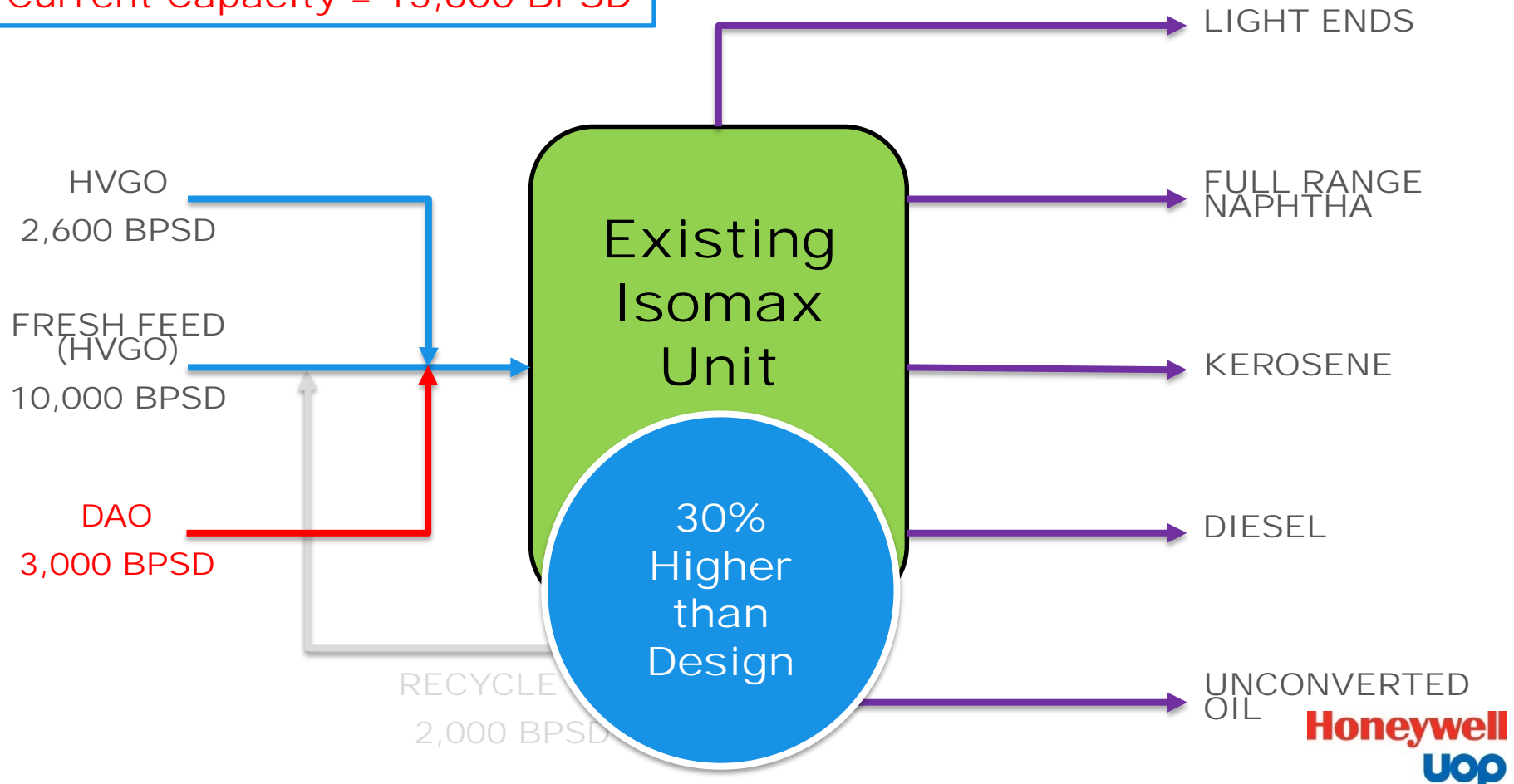


# Existing Unit – Iranian Isomax Unit

## Phase 2 – New SDA

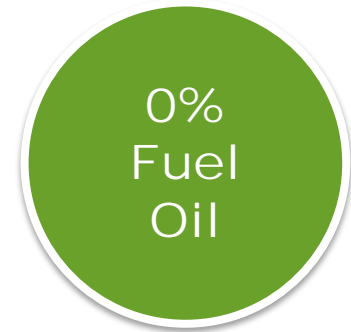
4%  
Fuel  
Oil

Original Capacity = 12,000 BPSD  
Current Capacity = 15,600 BPSD

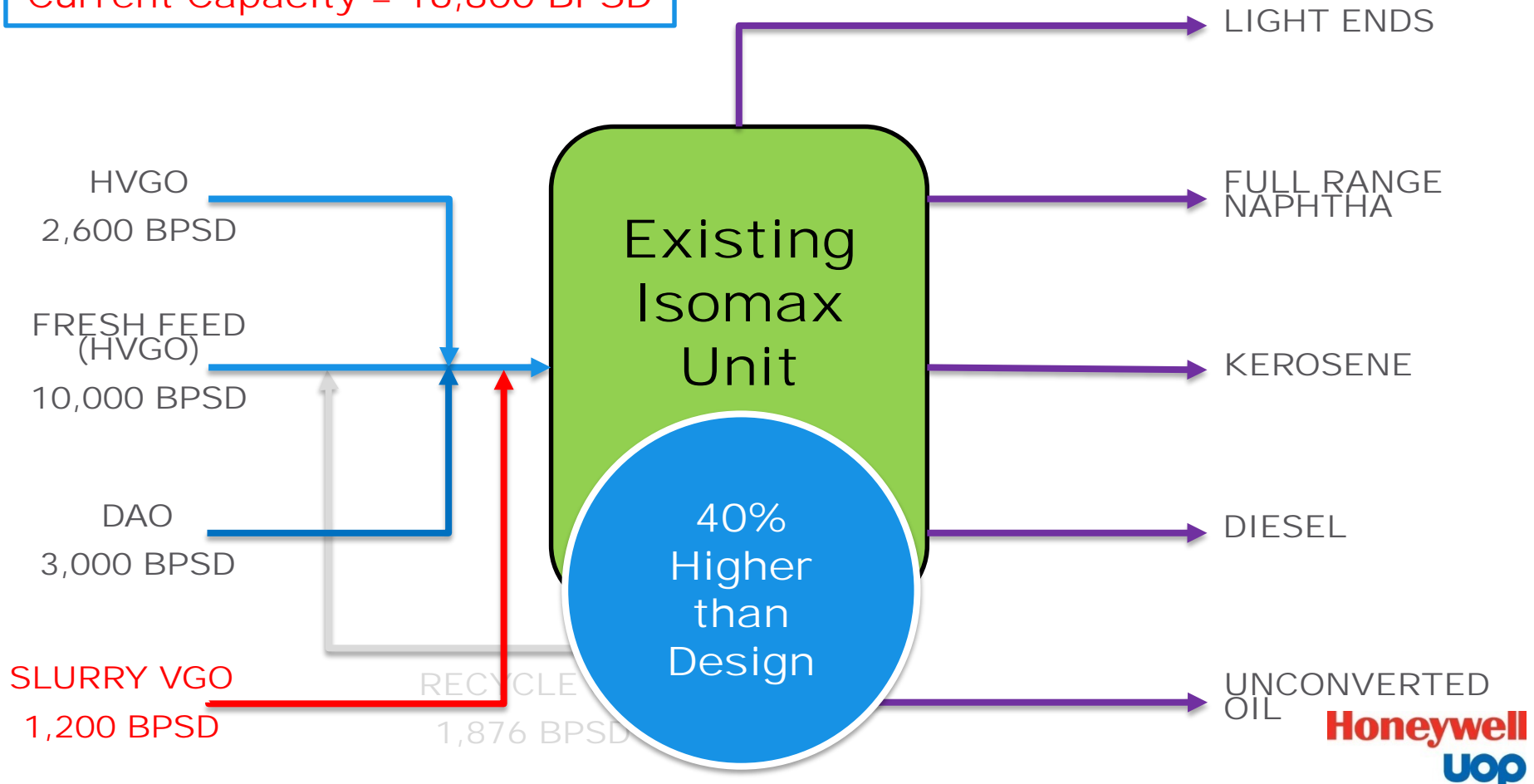


# Existing Unit – Iranian Isomax Unit

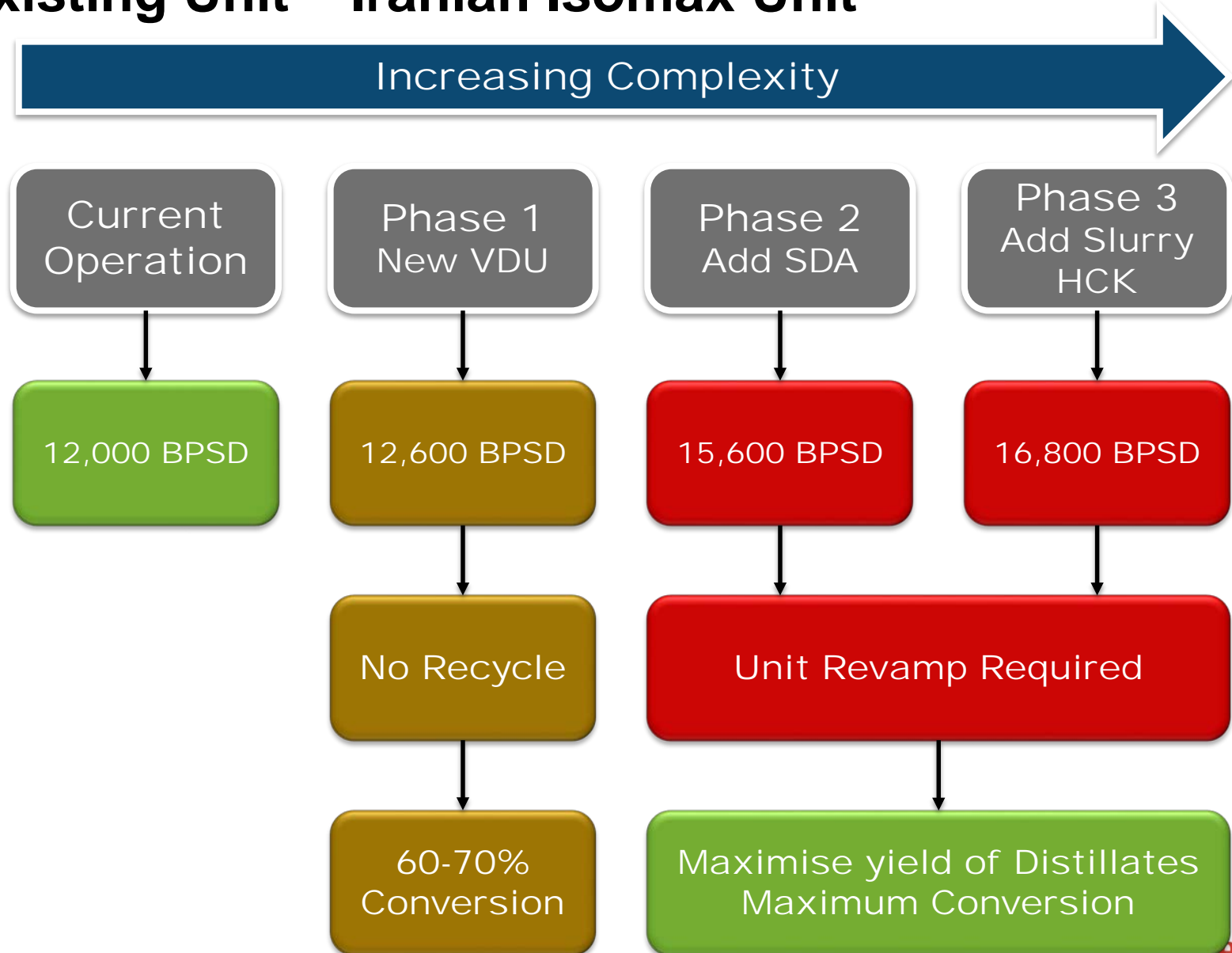
## Phase 3 – New Slurry Hydrocracker



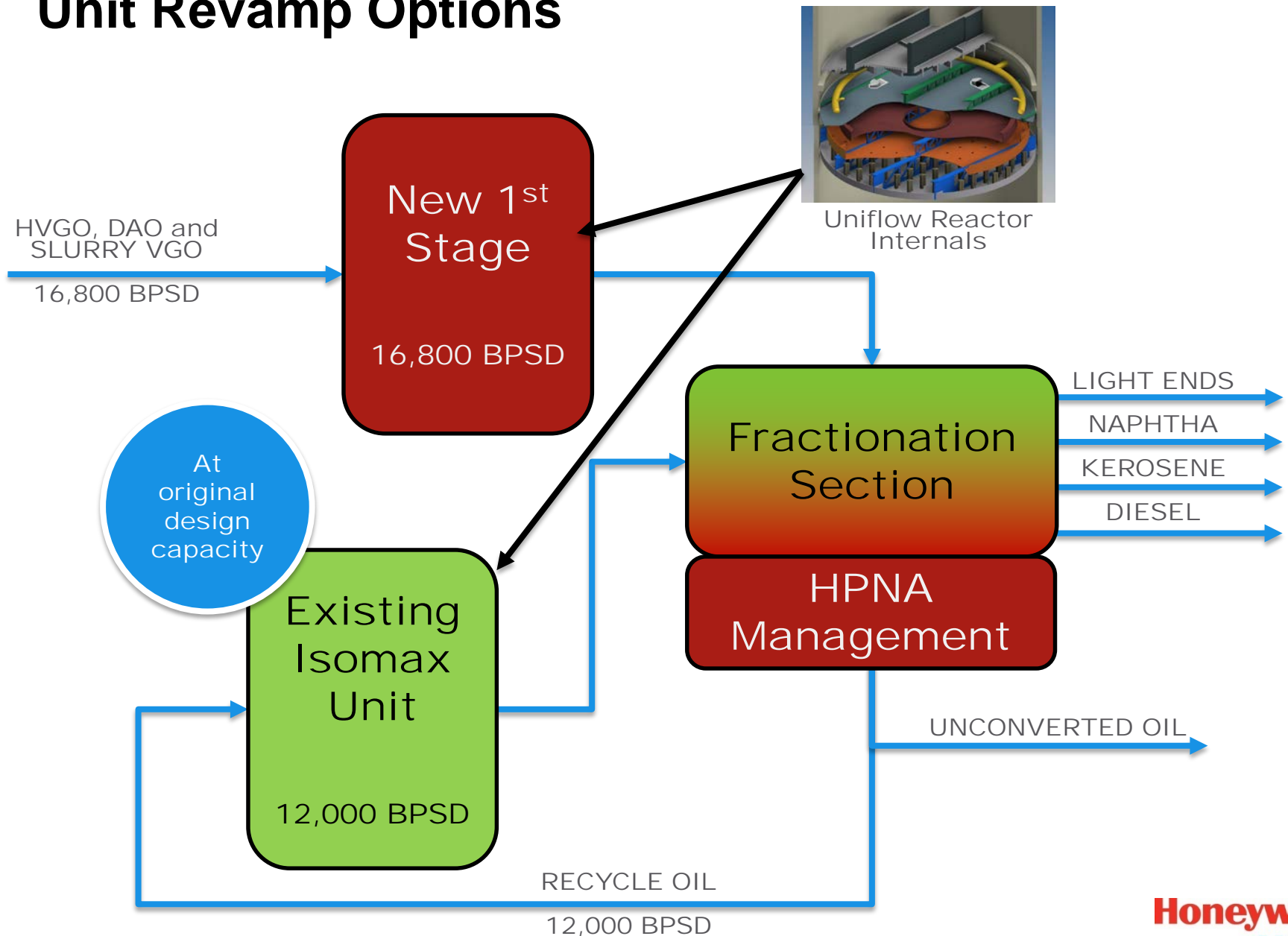
Original Capacity = 12,000 BPSD  
 Current Capacity = 16,800 BPSD



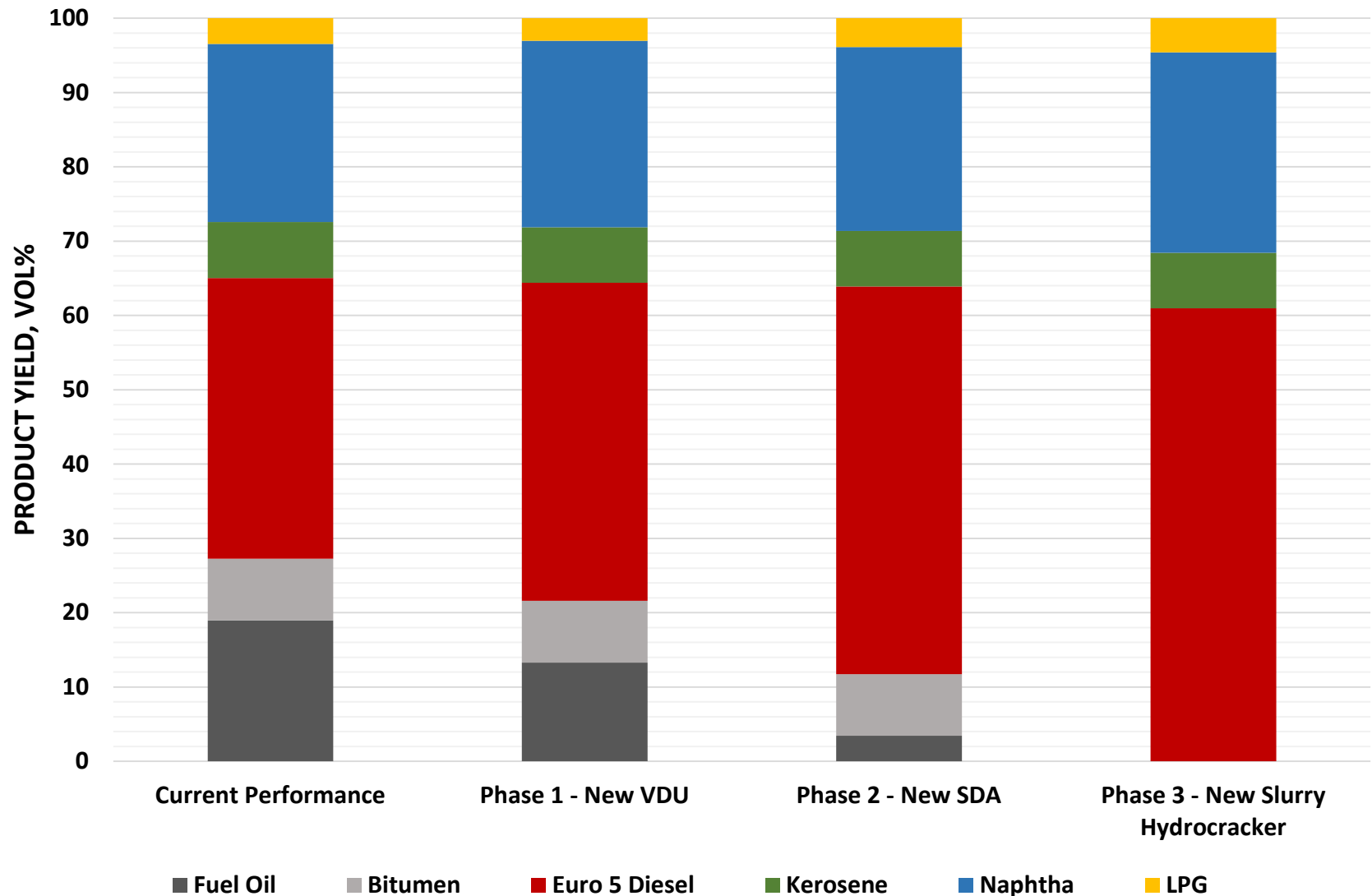
# Existing Unit – Iranian Isomax Unit



# Unit Revamp Options



# Impact on Refinery Yields





# Summary of Case Study

	Phase 1	Phase 2	Phase 3
	+VDU	+SDA	+Slurry HCU
<b>Hydrocracking Unit Revamp Concept</b>	Creep of existing unit	Add additional stage to existing unit	
<b>Euro 5 Diesel (vol% of product)</b>	43 vol%	52 vol%	61 vol%
<b>Fuel Oil (vol% of product)</b>	13 vol%	4 vol%	0 vol%

UOP has the knowledge and capability to provide an integrated revamp solution to phase your project to **maximise transportation fuels** and to **reduce fuel oil to less than 10%** of crude

# MIDOR Refinery Expansion Project

## Boosting Refinery Capacity – 100,000 to 160,000 BPSD

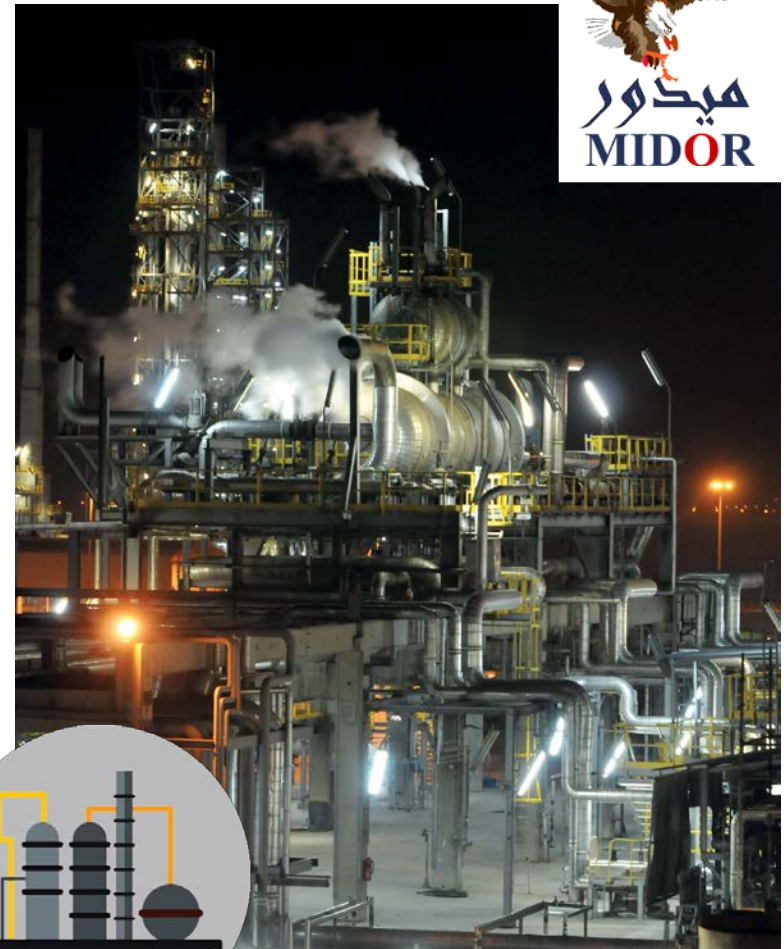


### Project Objectives (all achieved)

- Refinery throughput increased 60%
- Increase middle distillate yield 75%
- Meet future legislation of high quality EuroV specifications
- Zero fuel oil production
- Internal rate of return 30%

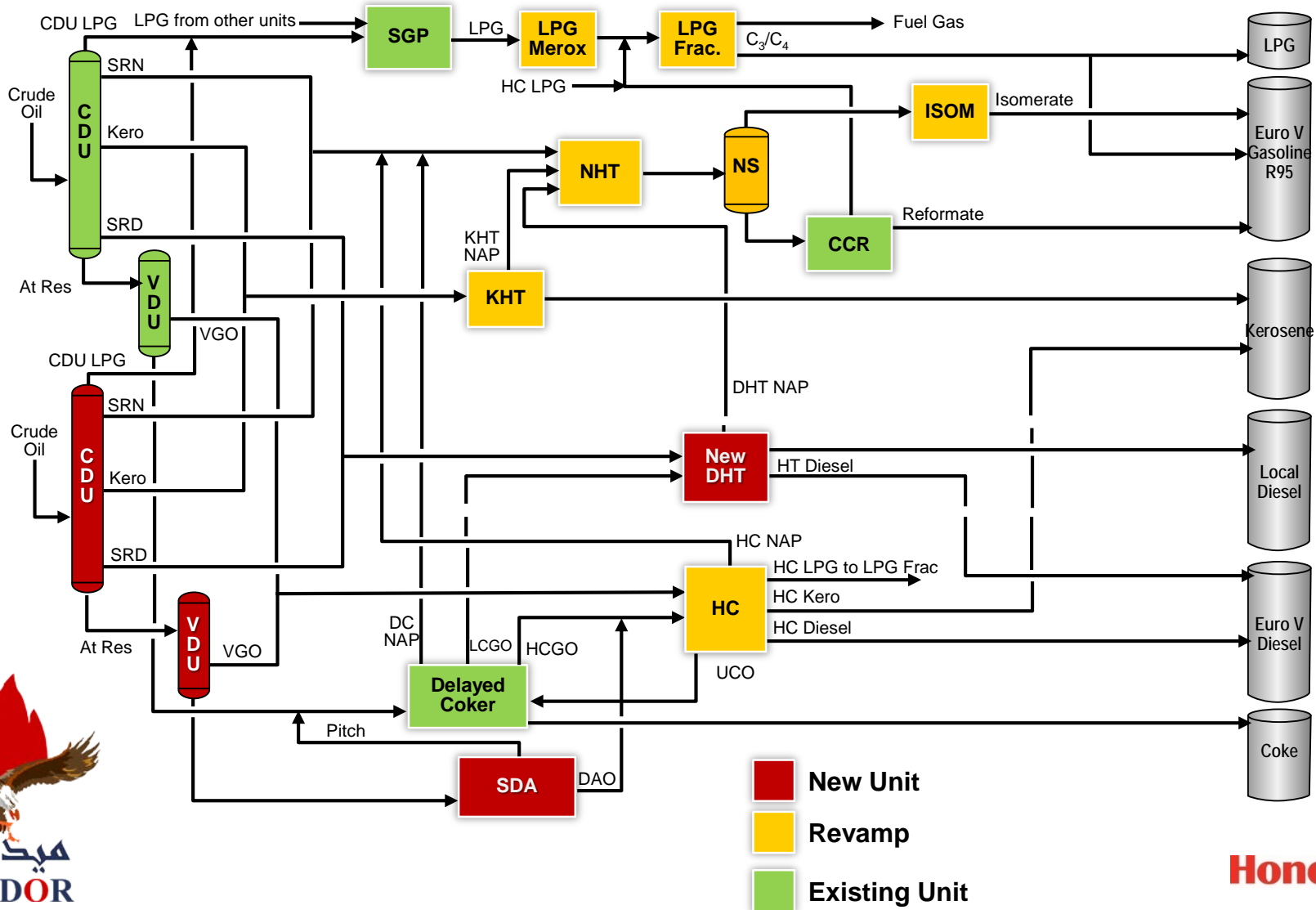
### Additional Requirements

- Maximum utilisation of existing refinery units
- Minimise refinery downtime
- Limited plot space



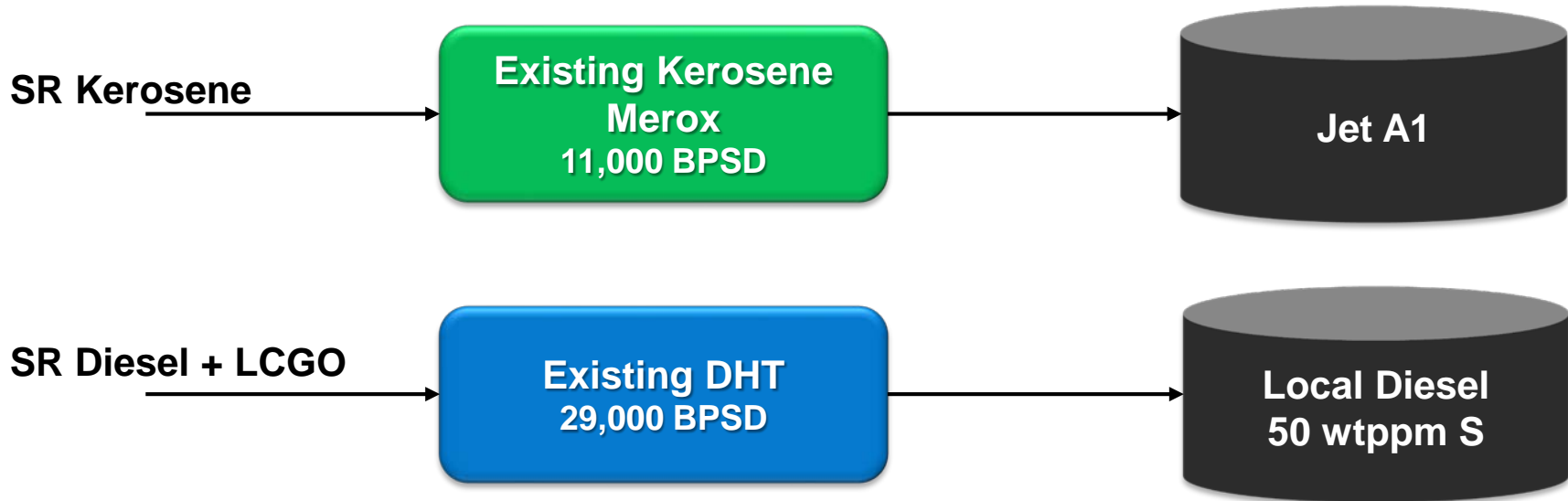
# MIDOR Refinery Expansion Project

## Boosting Refinery Capacity – 100,000 to 160,000 BPSD



# MIDOR Refinery Expansion Project

## Current Kerosene and Diesel Processing Configuration



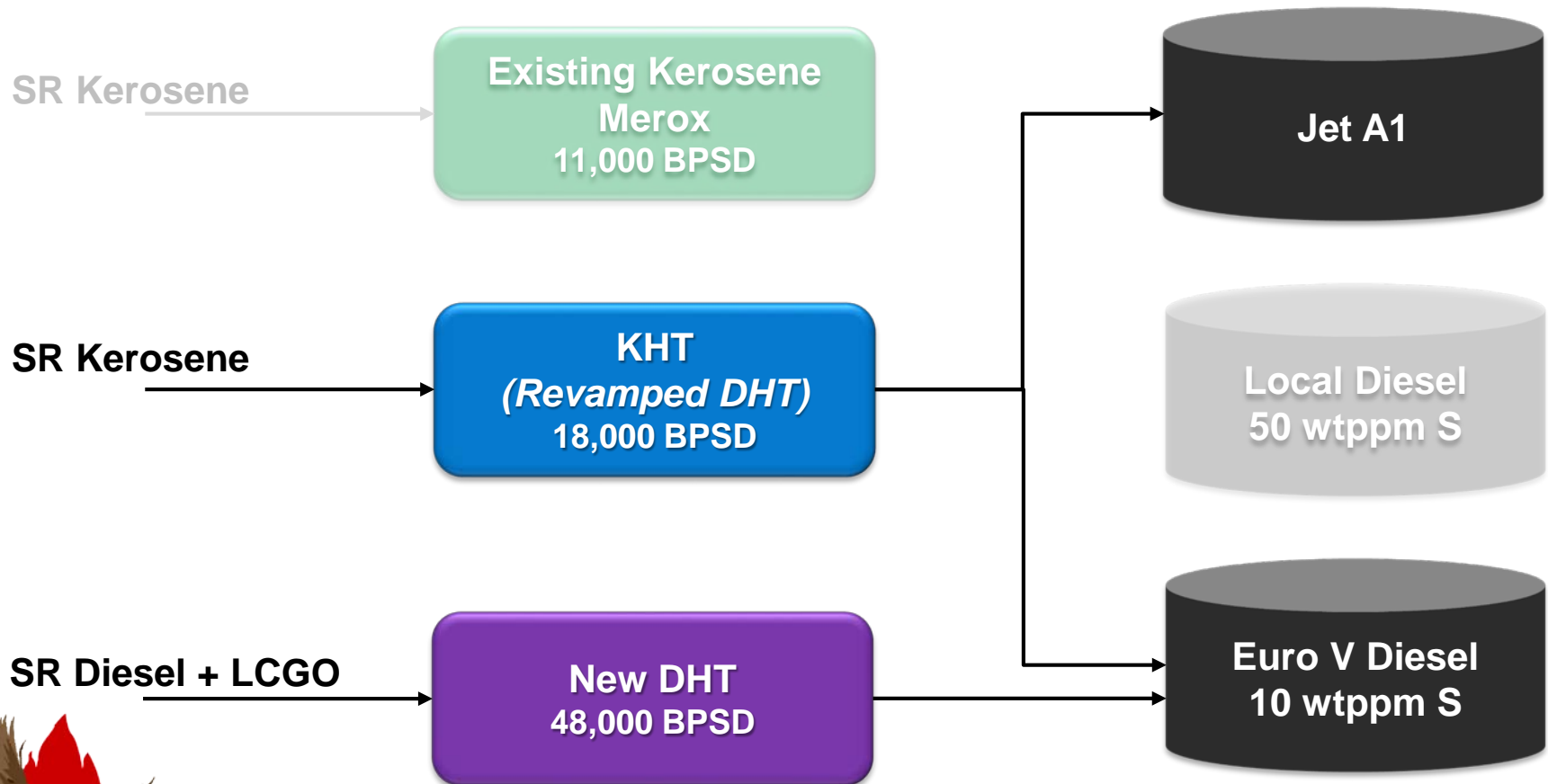
### Current Configuration

- Targets local diesel production
- Kerosene to Jet A1 pool only
- No ability to achieve EuroV diesel specifications



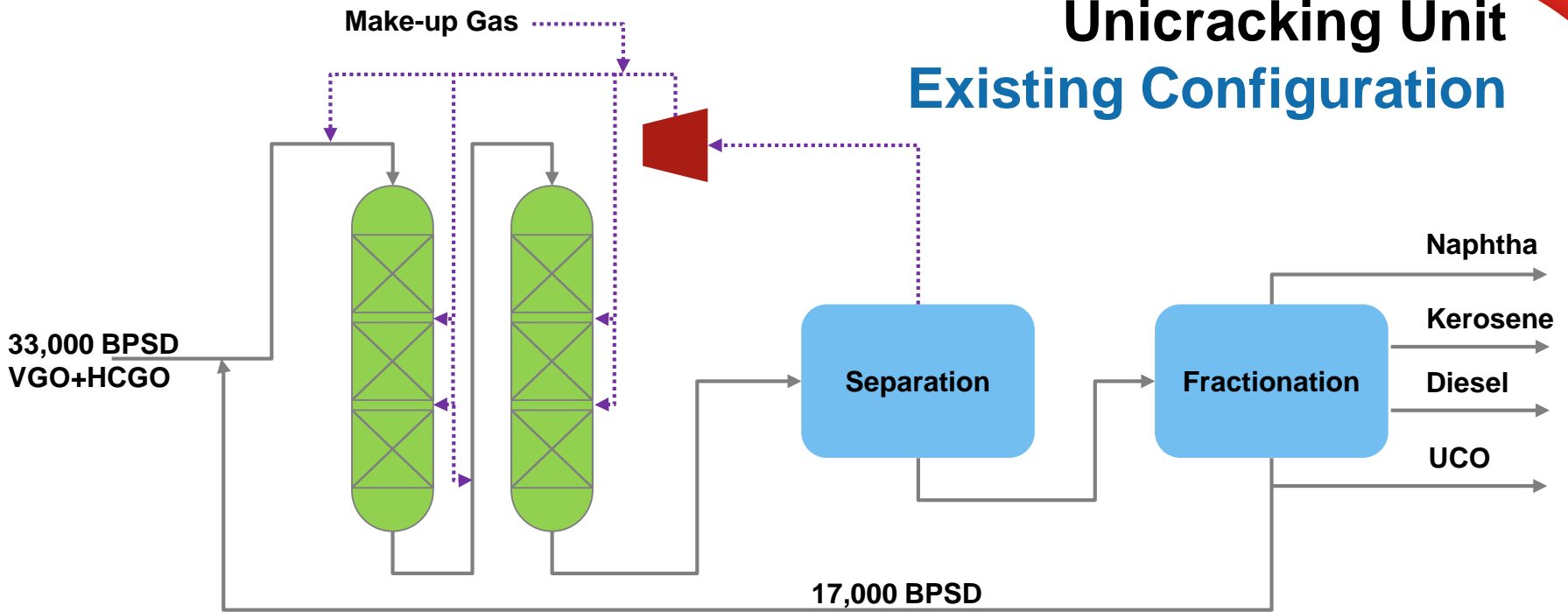
# MIDOR Refinery Expansion Project

## Maximising Euro V Diesel Production

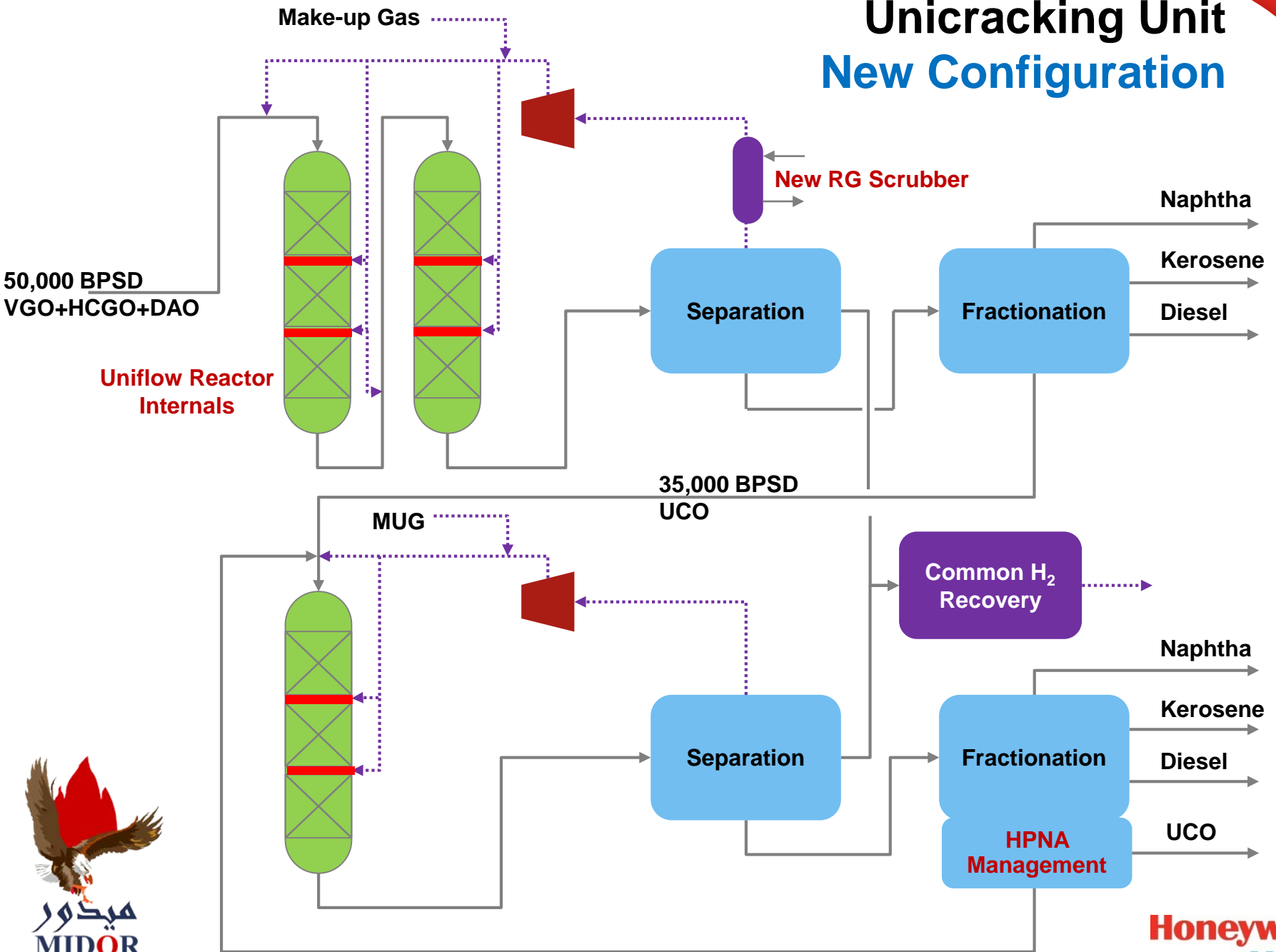


**Ultimate flexibility between Jet A1 and EuroV Diesel production. Minimum shutdown and plot space with optimised investment**

# Unicracking Unit Existing Configuration



# Unicracking Unit New Configuration



# MIDOR Refinery Expansion Project

## Boosting Refinery Capacity – 100,000 to 160,000 BPSD



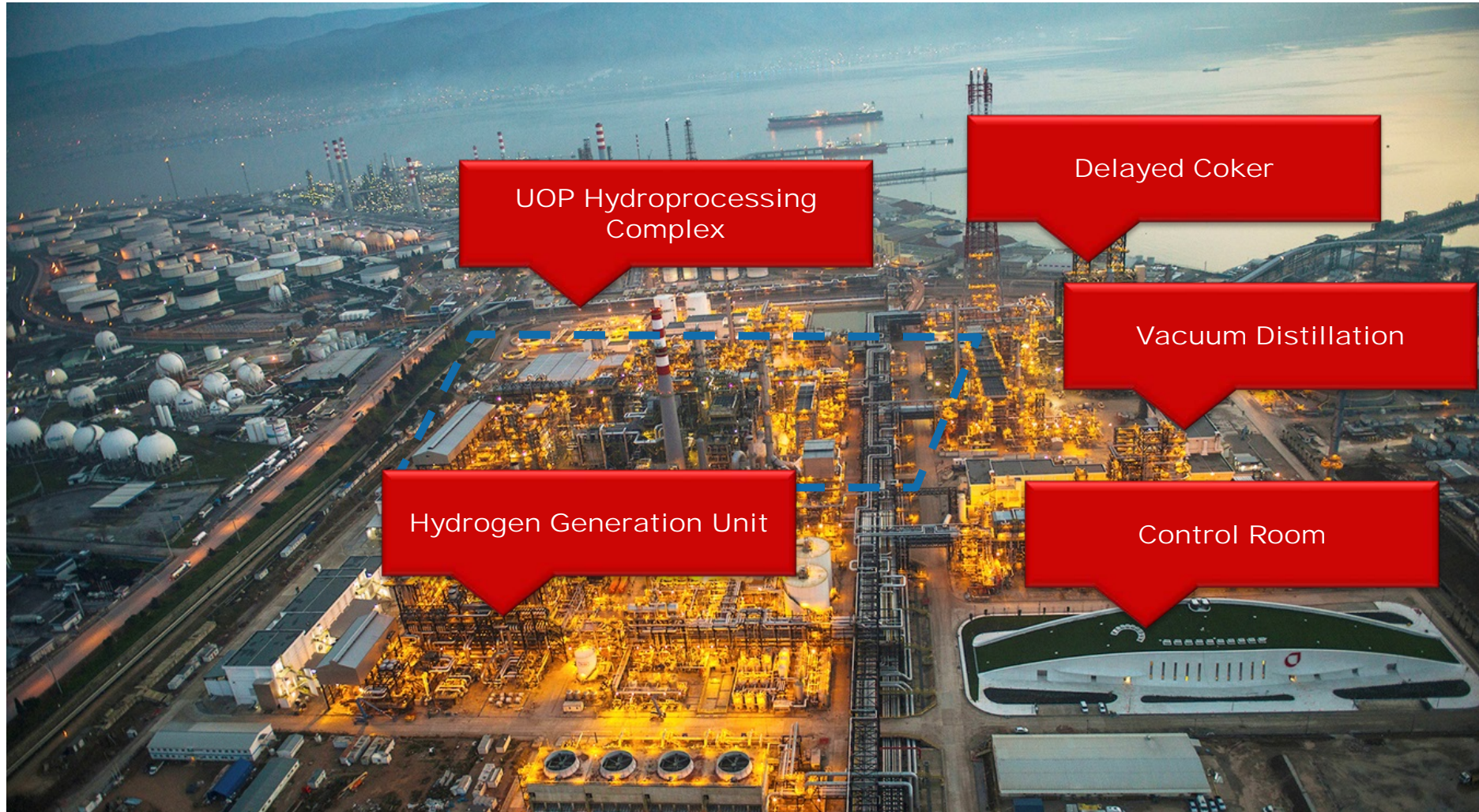
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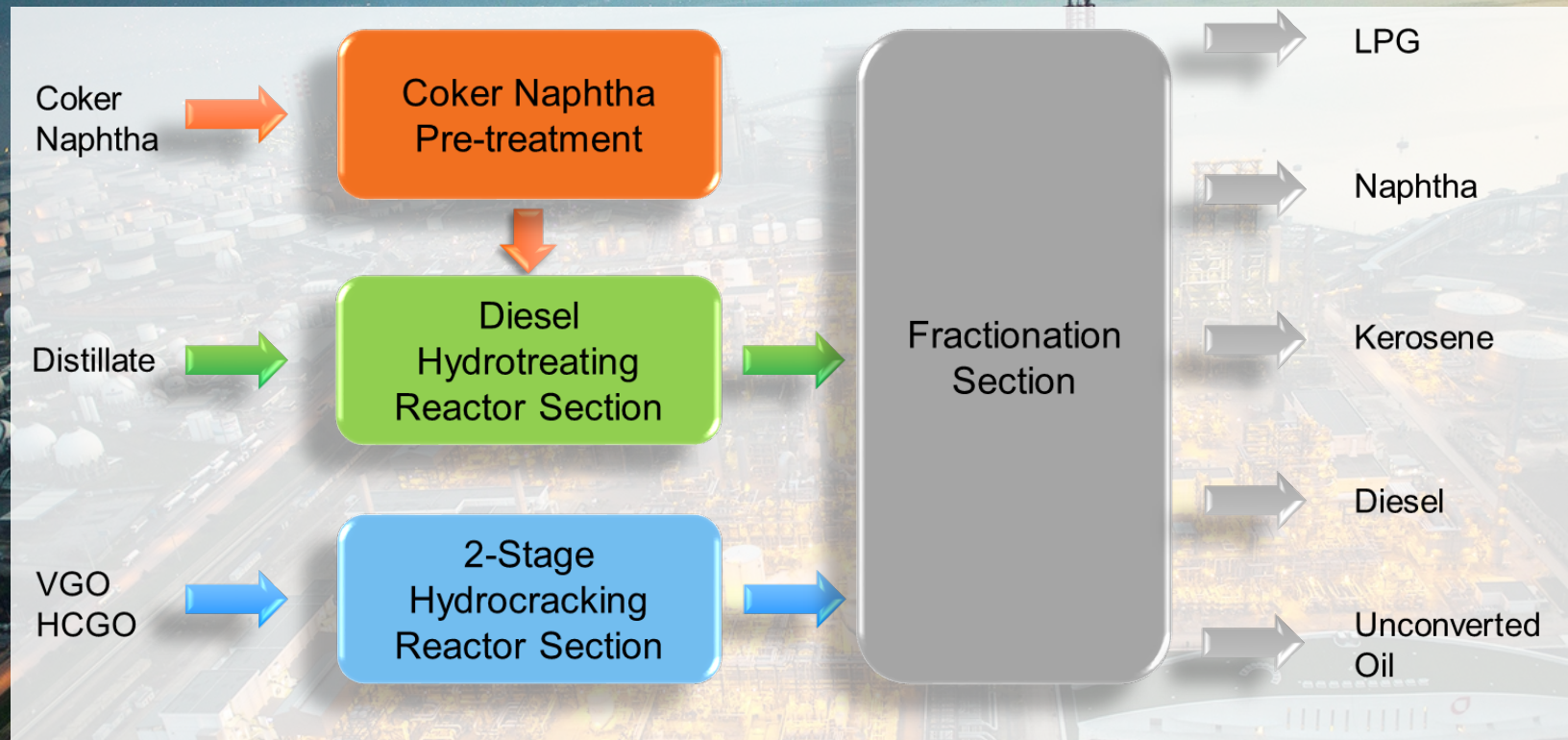
# Enhanced Two-Stage Unicracking

## Tüpras Residue Upgrading Project Success Story



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## Tüpras Residue Upgrading Project Success Story



# Enhanced Two-Stage Unicracking

## Tüpras Residue Upgrading Project Success Story

- Smooth and safe unit start-up
- On spec product with 36 hours of feed introduction
- All guarantees and met in August 2015
- One of the most profitable units in Tüpras
- Operating at 110% of design feed meeting all product qualities
- Forecast to exceed the catalyst cycle length

# Summary – UOP Hydrocracking Technology

## Upgrading Fuel Oil to Euro V Fuels

- Licensor of choice for integrated hydrocracking solutions
- Technology to enable the phasing of Iranian bottom of the barrel projects
- Existing hydrocracking units are key enablers for staged investment
- Extensive experience of revamp design to align with existing unit constraints and minimize downtime
- History of partnering with customers for successful bottom of the barrel upgrading projects





The information contained in this presentation is provided for general information purposes only and must not be relied on as specific advice in connection with any decisions you may make.