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# THE JOURNEY TO SUSTAINED PROFITABILITY: MAXIMIZING NAPHTHA THROUGH HYDROCRACKING

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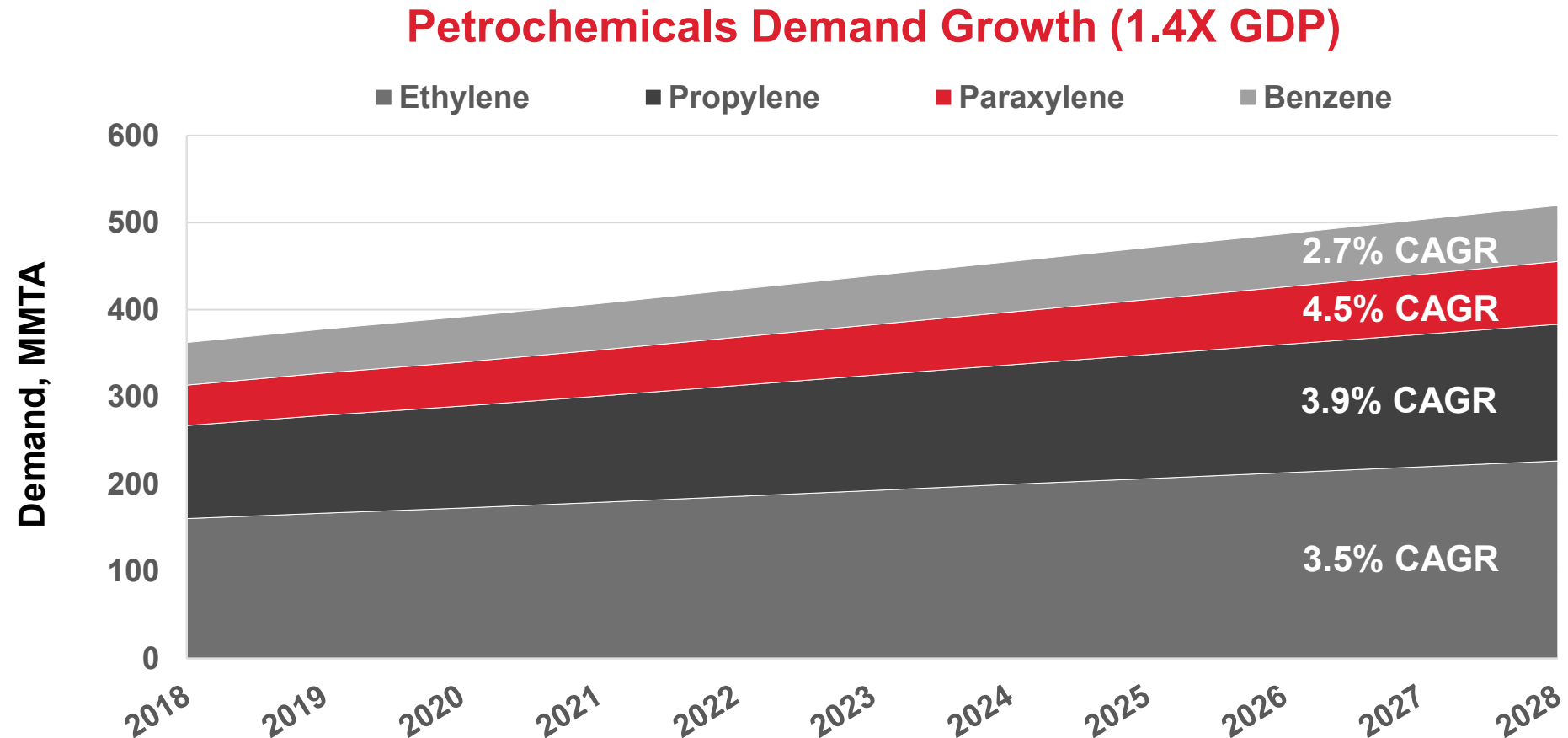
**Honeywell**  
**UOP**

# AGENDA

- Industry Trends and Where the UOP Unicracking™ process Sits
- Case Study – Journey to Petrochemicals
- Impact and Opportunities – Kerosene Unicracking process
- UOP Six-Efficiencies
- Molecular Management with Advanced Catalyst Development
- Wrap-up and Q&A



# PETROCHEMICALS SHOWING STRONG GROWTH



Source: IHS Markit, WoodMac, SBA-CCI, UOP Analysis

**Healthy growth in paraxylene demand fueling need for more naphtha**

# HYDROCRACKING IS ENABLER FOR WORLD SCALE *P-X* PRODUCTION

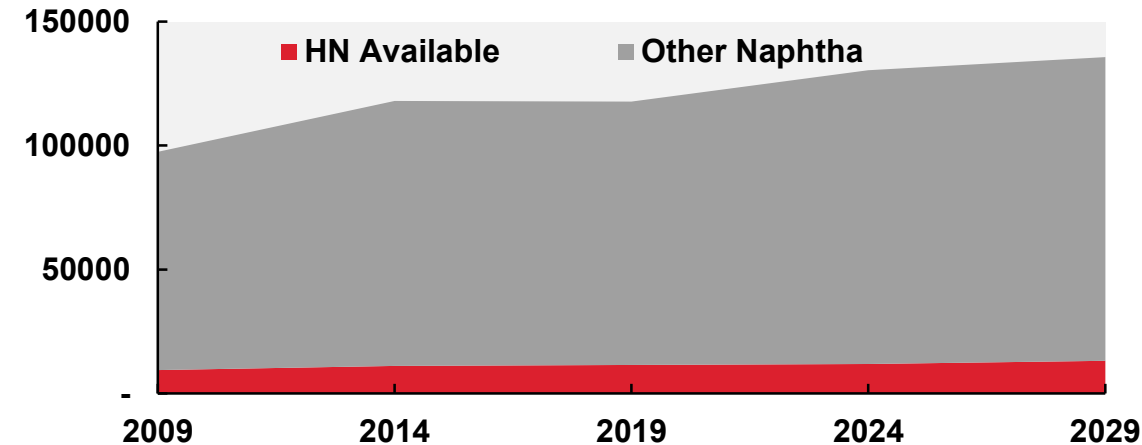
## Issues

- Not all naphtha suitable for aromatics
- Heavy naphtha (HN) is required, but limited supply
  - Only 10% of world naphtha sales
- One world-scale *p-X* plant would consume 40% of global merchant HN supply
- Condensate based *p-X* adds 60% to *p-X* CCOP and makes a lot more benzene
- Issues with purchased naphtha
  - Often depleted of C9+ material (refiner selling naphtha uses for kero/jet production)
  - Typically sold as full range naphtha containing C5/C6 which needs an outlet other than BTX

## Solutions

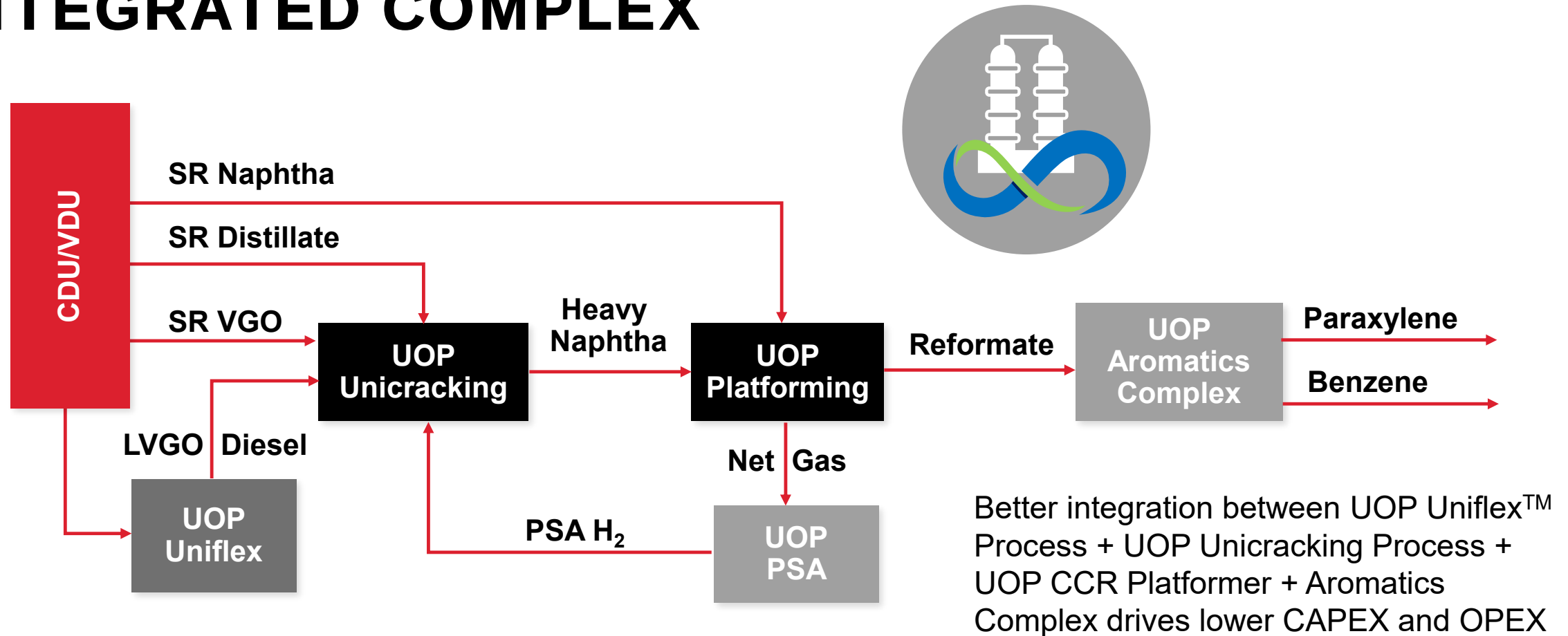
- *p-X* manufacturing back-integrate into refining
- VGO and distillate conversion to Heavy Naphtha via Hydrocracking

World Naphtha Traded (KMTA)



**Solution is to Produce Heavy Naphtha from the Hydrocracker**

# UOP UNIQUELY POSITIONED TO OPTIMIZE THE INTEGRATED COMPLEX

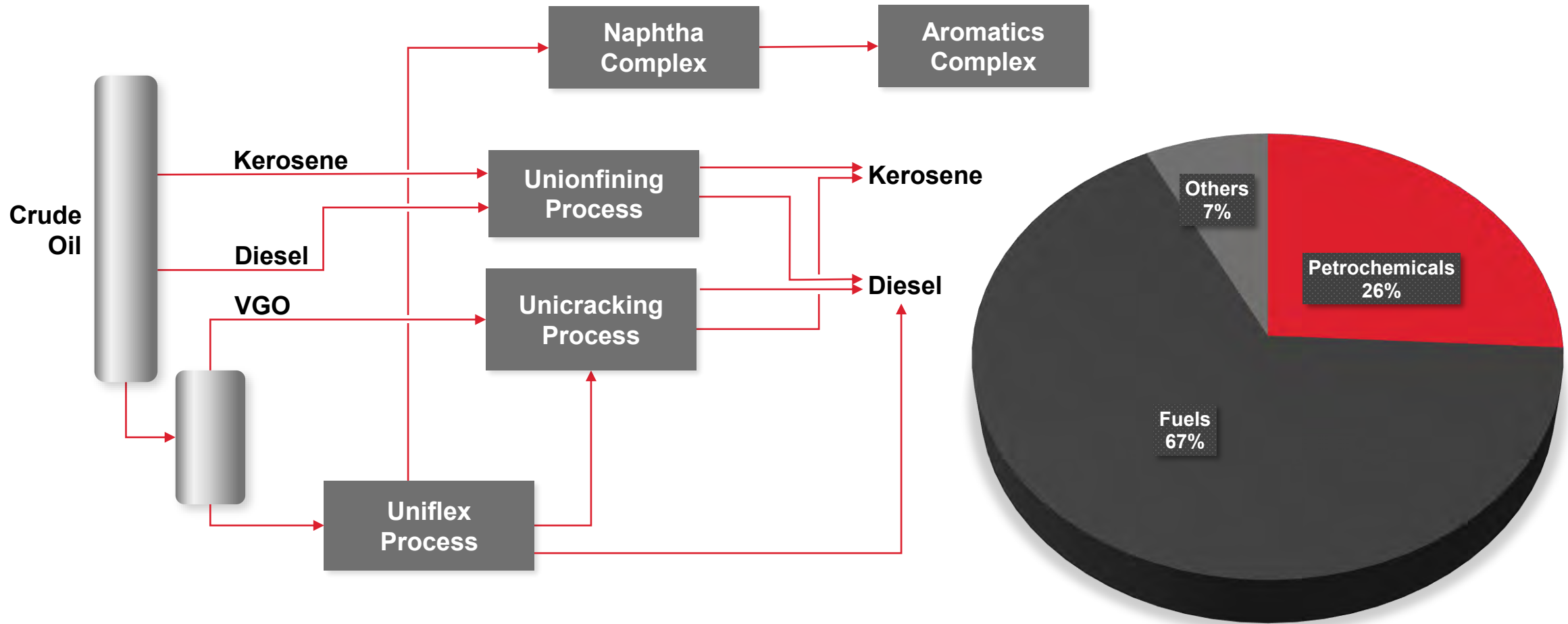


**Comprehensive Technology Solutions from UOP for Improved Economics**



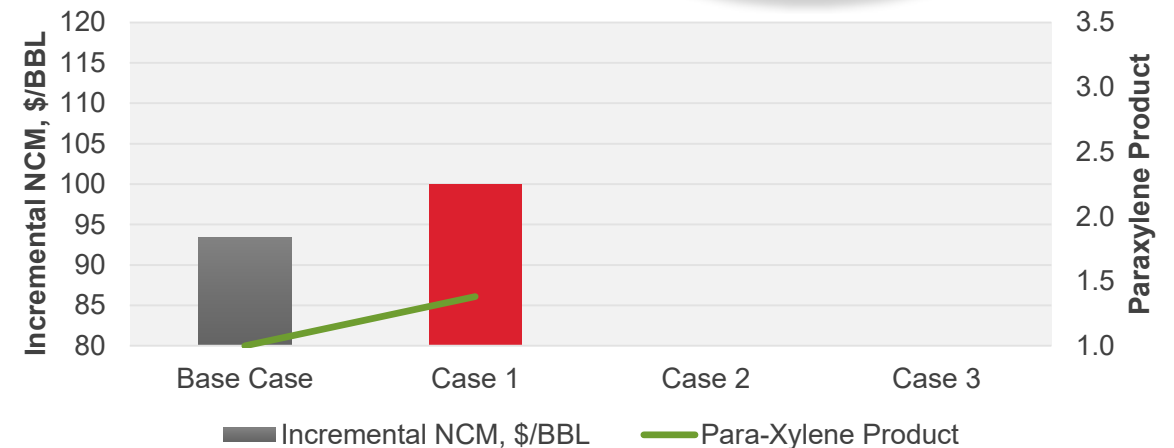
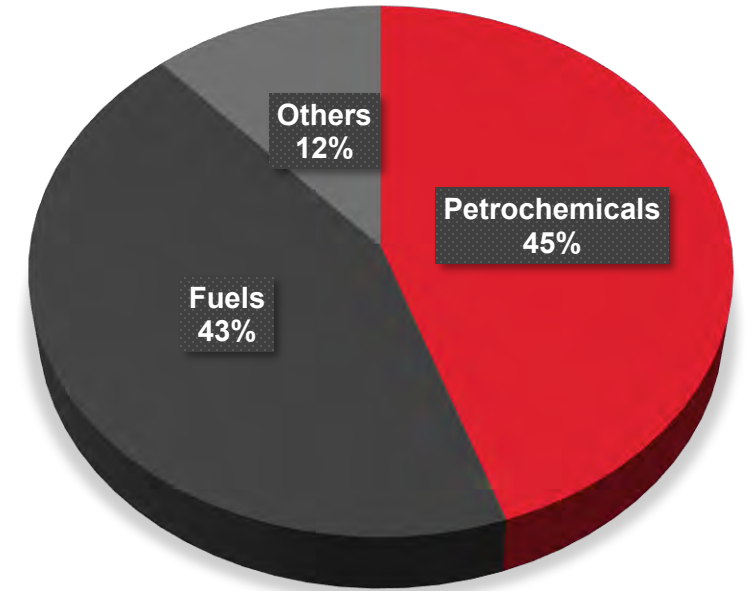
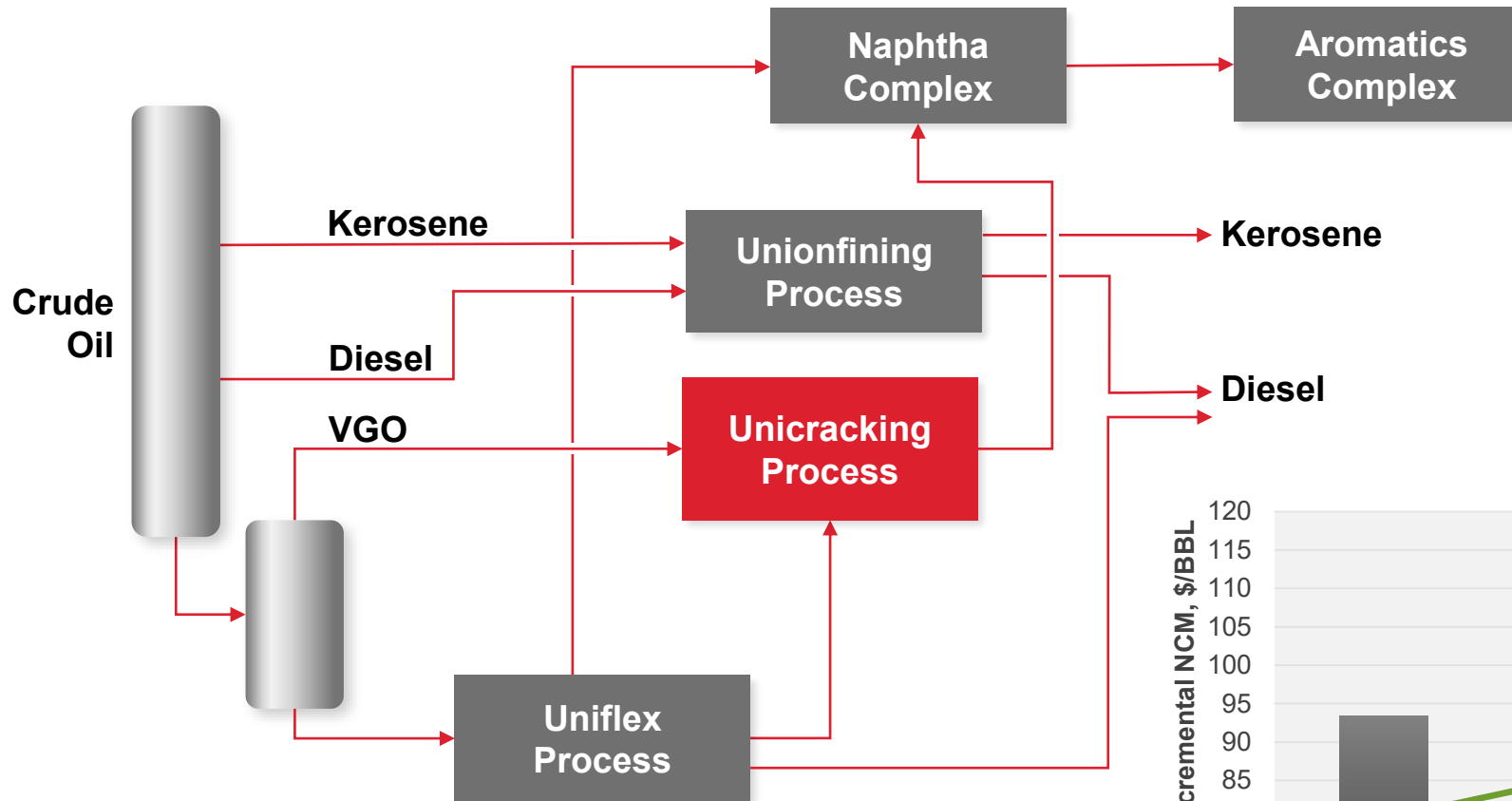
# **CASE STUDY | MOVING TO PETROCHEMICALS** **A STEP WISE APPROACH**

# BASE CASE | INTEGRATED CONFIGURATION



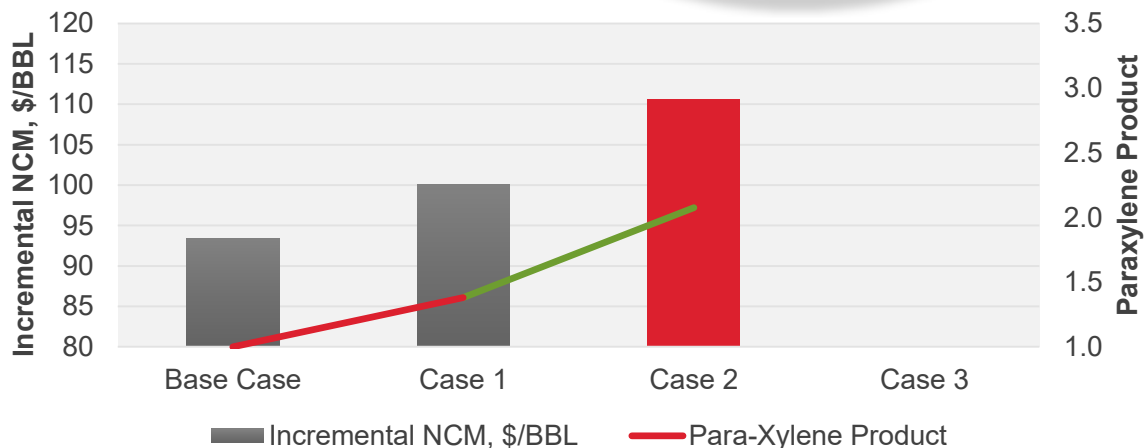
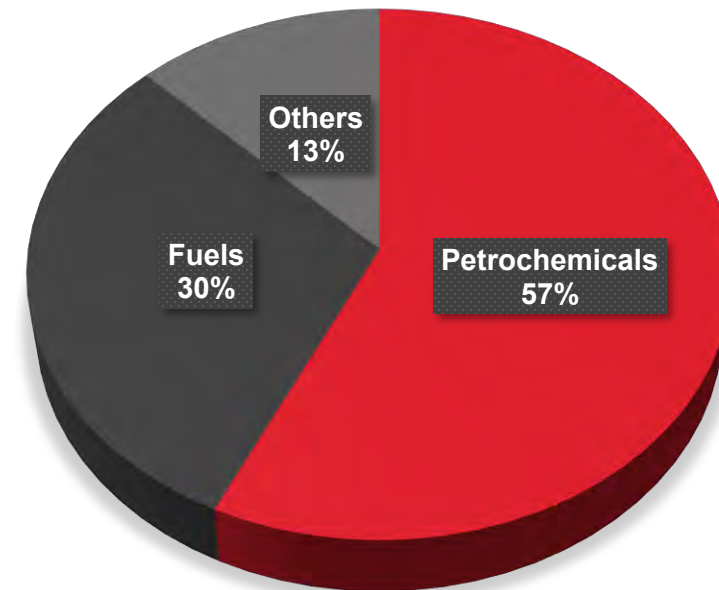
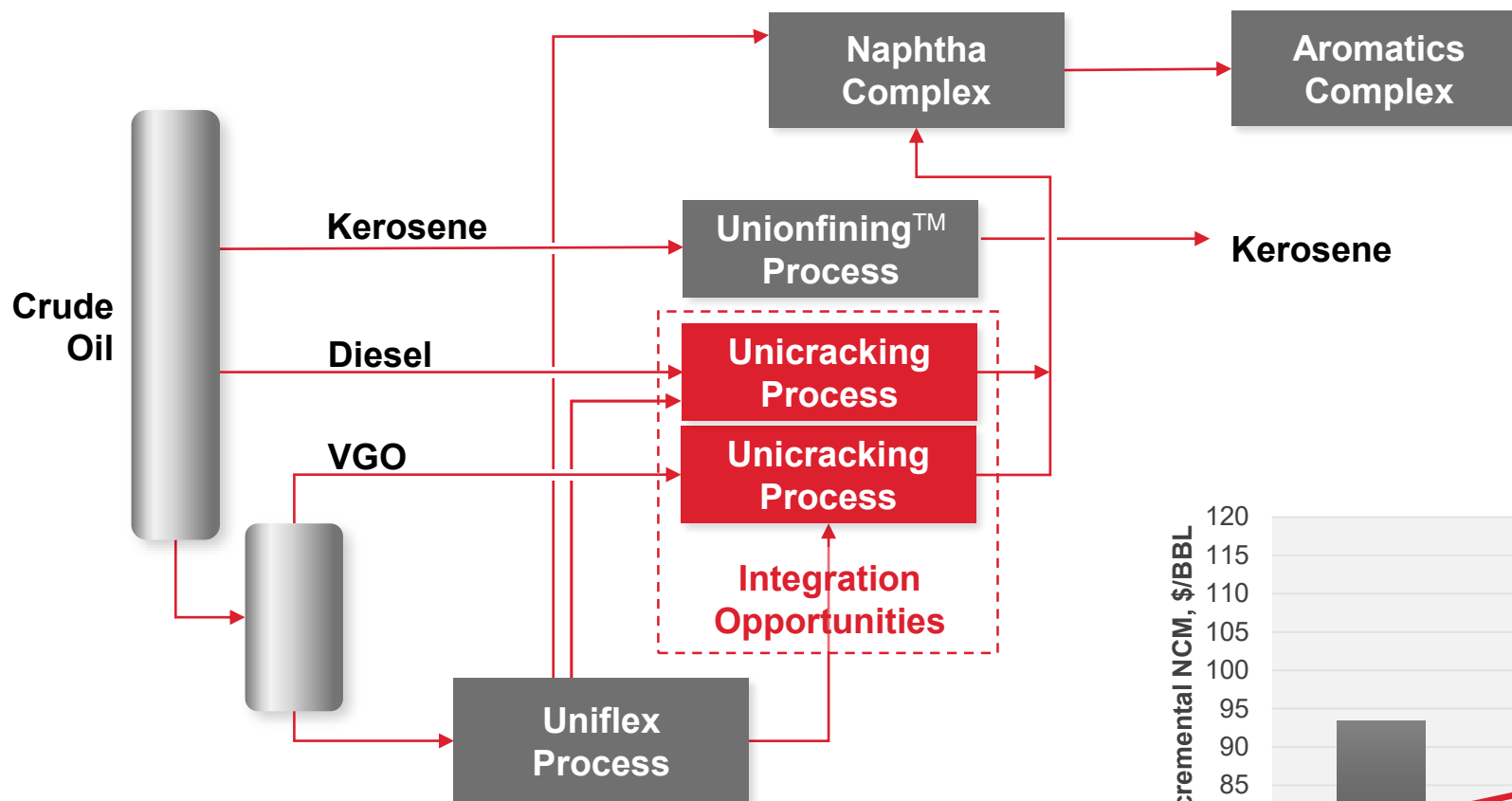
# CASE 1 | VGO UNICRACKING PROCESS

## TARGET HN



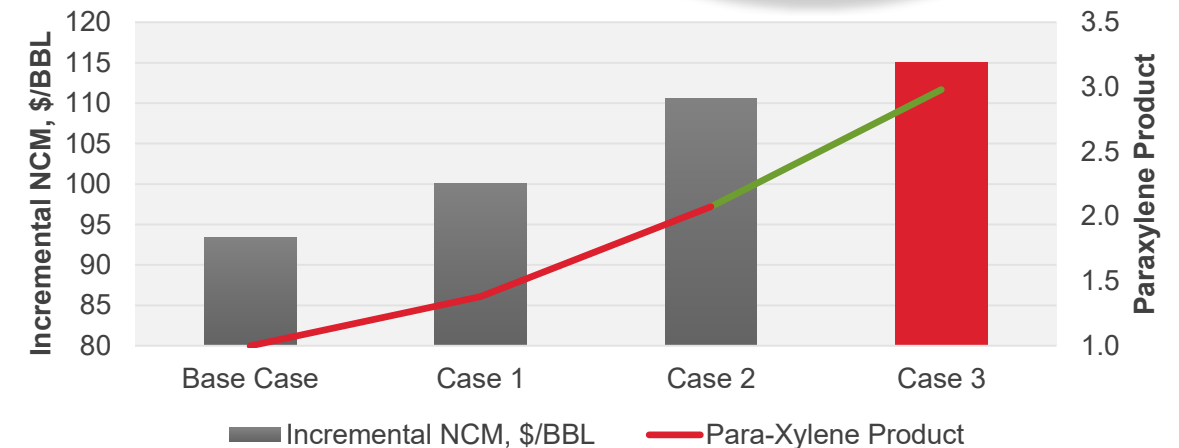
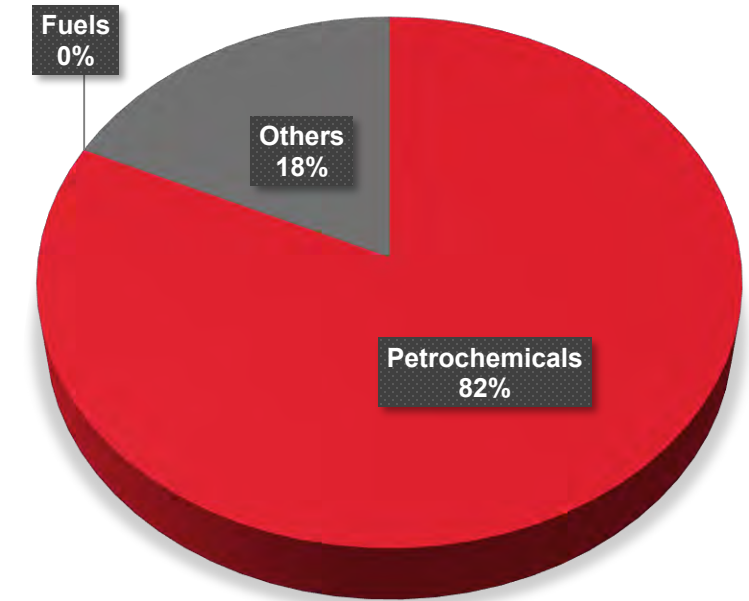
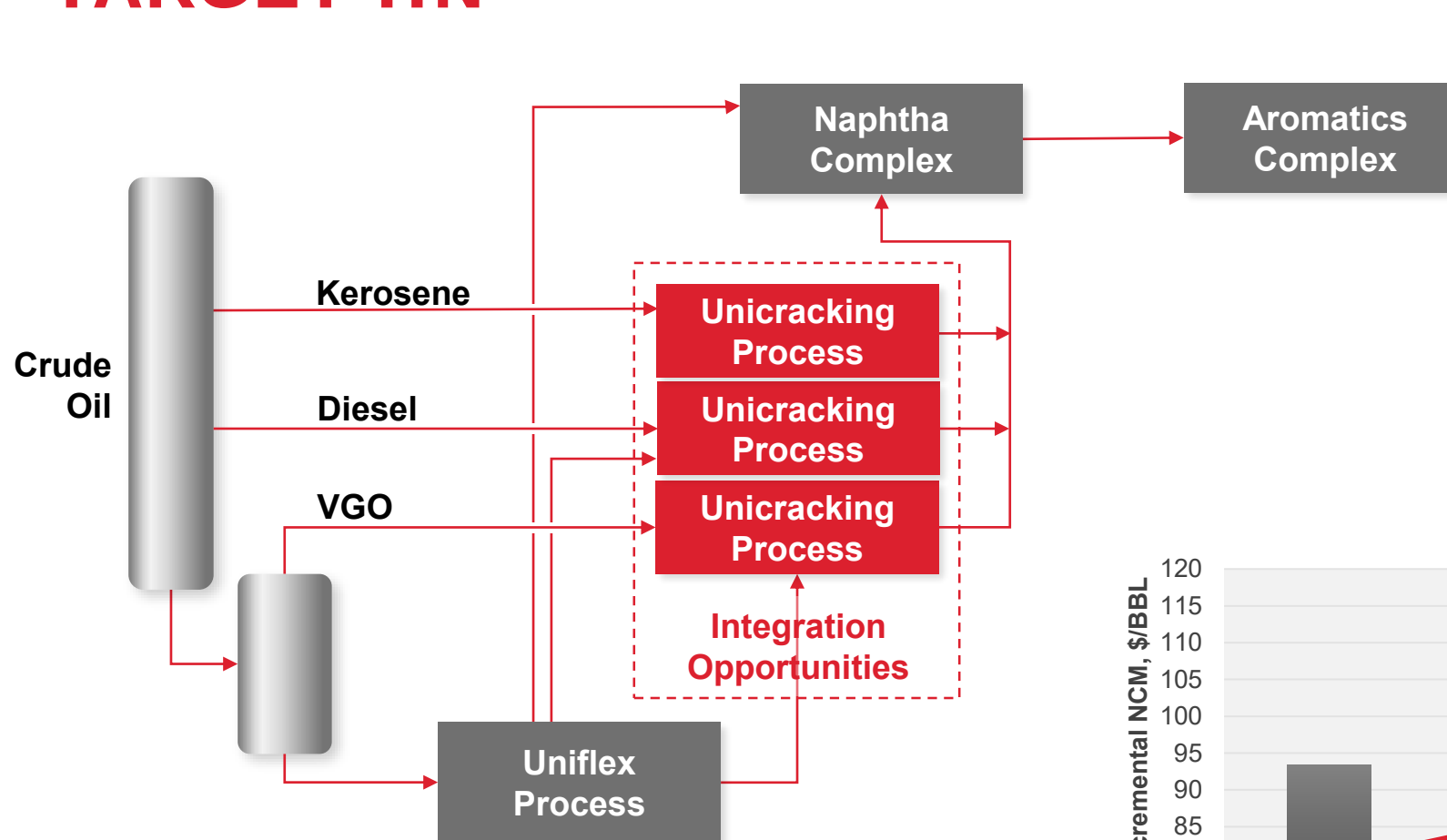
# CASE 2 | DIESEL UNICRACKING PROCESS

## TARGET HN



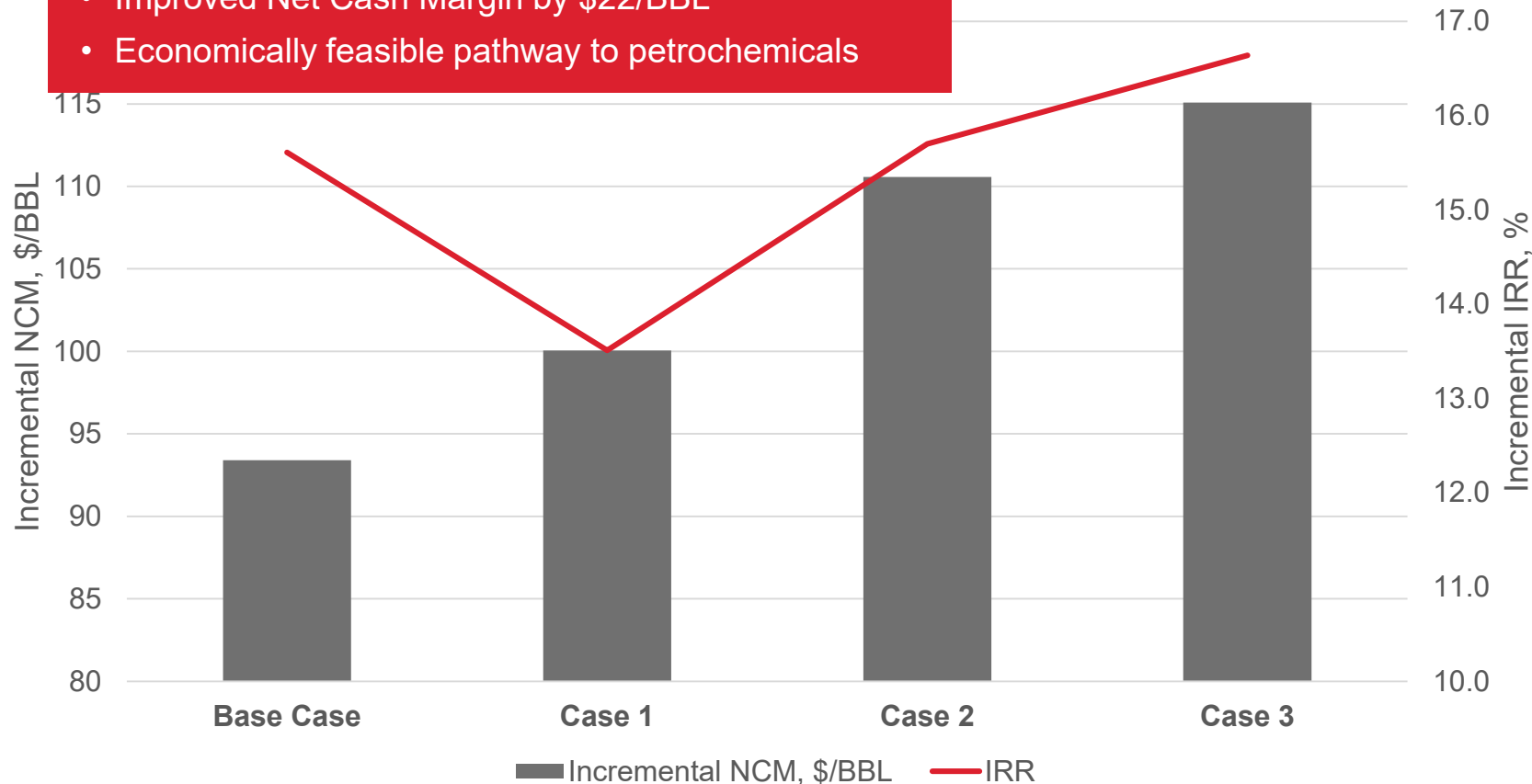
# CASE 3 | KEROSENE UNICRACKING PROCESS

## TARGET HN



# SUMMARY | MOVING FROM TRANSPORTATION FUELS TO PETROCHEMICALS

- Increased p-X production by 3 times
- Improved Net Cash Margin by \$22/BBL
- Economically feasible pathway to petrochemicals



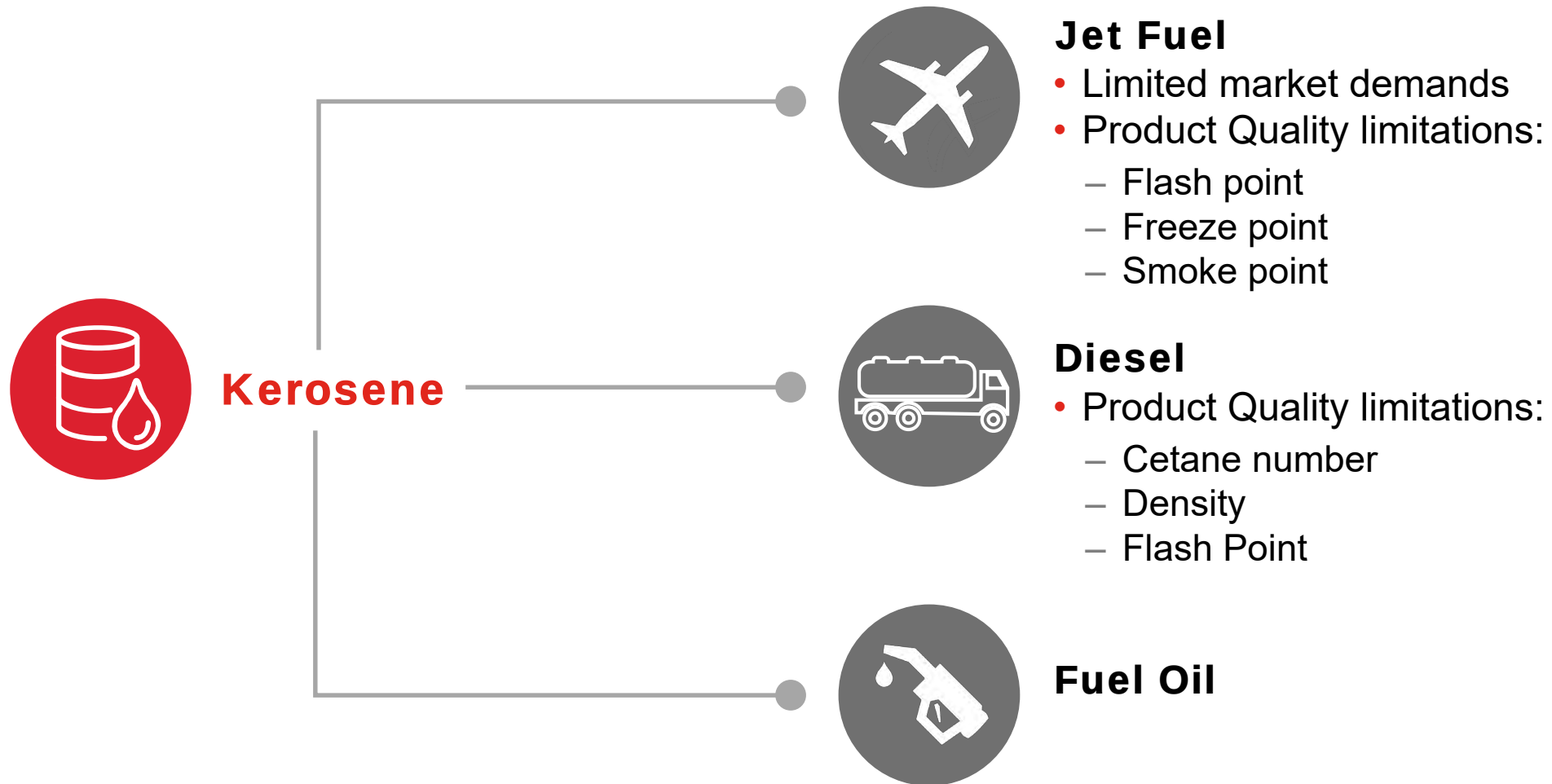
## Assumptions:

- 500 kBPD of Arab Light
- Price set is based on average annual USGC price over a 5 year period (2013 to 2017). Source HIS Markit
- Feeds:
  - Arab Light \$72.2/BBL
  - Natural Gas \$3.22 MMBTU
  - Methanol \$361/MT
- Products:
  - Distillate \$638/MT
  - Benzene \$970/MT
  - Para-xylene \$1,159/MT
  - Polyethylene (HDPE) \$1,094/MT
  - Polypropylene \$1,149/MT
  - Butadiene \$1,214/MT



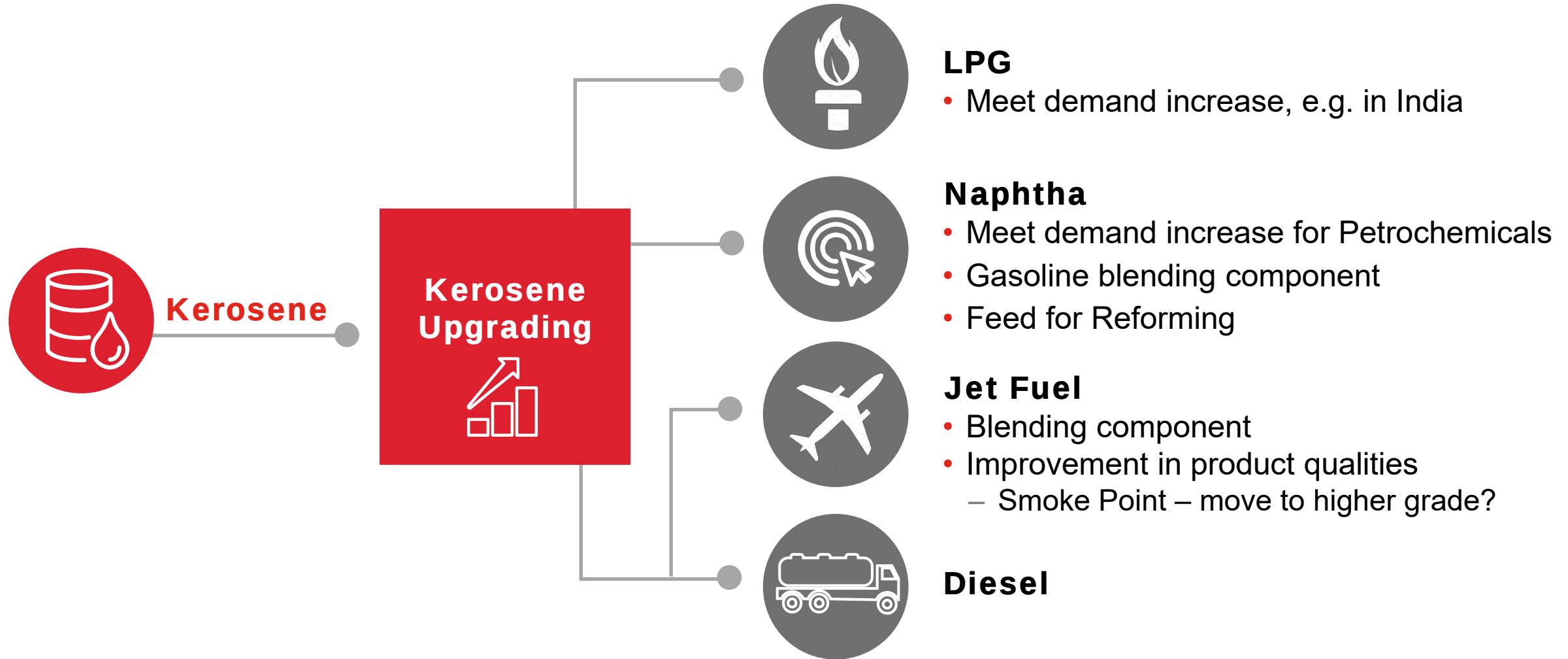
# IMPACT AND OPPORTUNITIES | **KEROSENE UNICRACKING PROCESS**

# KEROSENE DISPOSITION OPTIONS



Is there a better and more profitable solution?

# KEROSENE UPGRADING SOLUTION



Upgrading solution with Product Flexibility

# UOP KEROSENE UNICRACKING PROCESS

## Similarities to traditional hydrocracking unit, however significantly lower pressure operation

- >30% CapEx and OpEx savings over traditional VGO or diesel hydrocracking of similar size

## Proposed solution as:

- **New** standalone Kerosene Unicracking unit
- **Revamp** of existing low pressure hydroprocessing unit – Low CapEx solution

## Flexibility to target product demands

- Higher demand for naphtha:
  - Higher conversion to convert kerosene and target a yield of LPG and naphtha
- Higher demand for kerosene/diesel
  - Operate at lower conversion to improve the quality of kerosene
- Conversion can be targeted for specific quality of kerosene or heavy naphtha yield



# UOP KEROSENE UNICRACKING PROCESS

## PRODUCT QUALITIES



### Light Naphtha

- Higher iso to normal ratios of C5 and C6 compared to SR Light Naphtha

### Heavy Naphtha

- Targeted yields
- Higher N+2A content compared to SR Heavy Naphtha

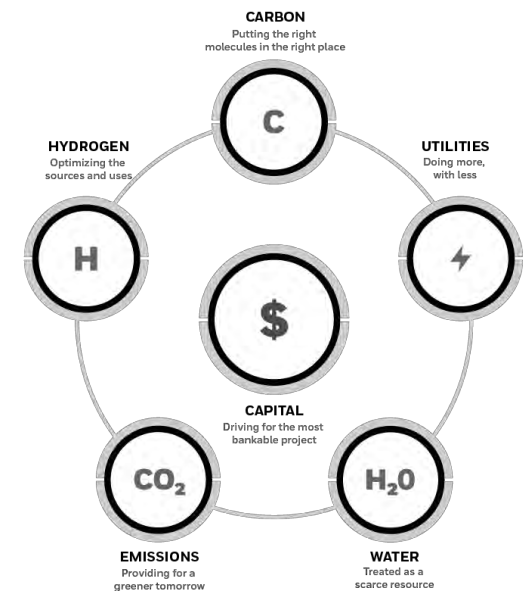
### Upgraded Kerosene

- Significantly improved cetane number and smoke point
- Higher grade of Jet fuel or opportunity for lower value component blending into diesel pool, e.g. LCO

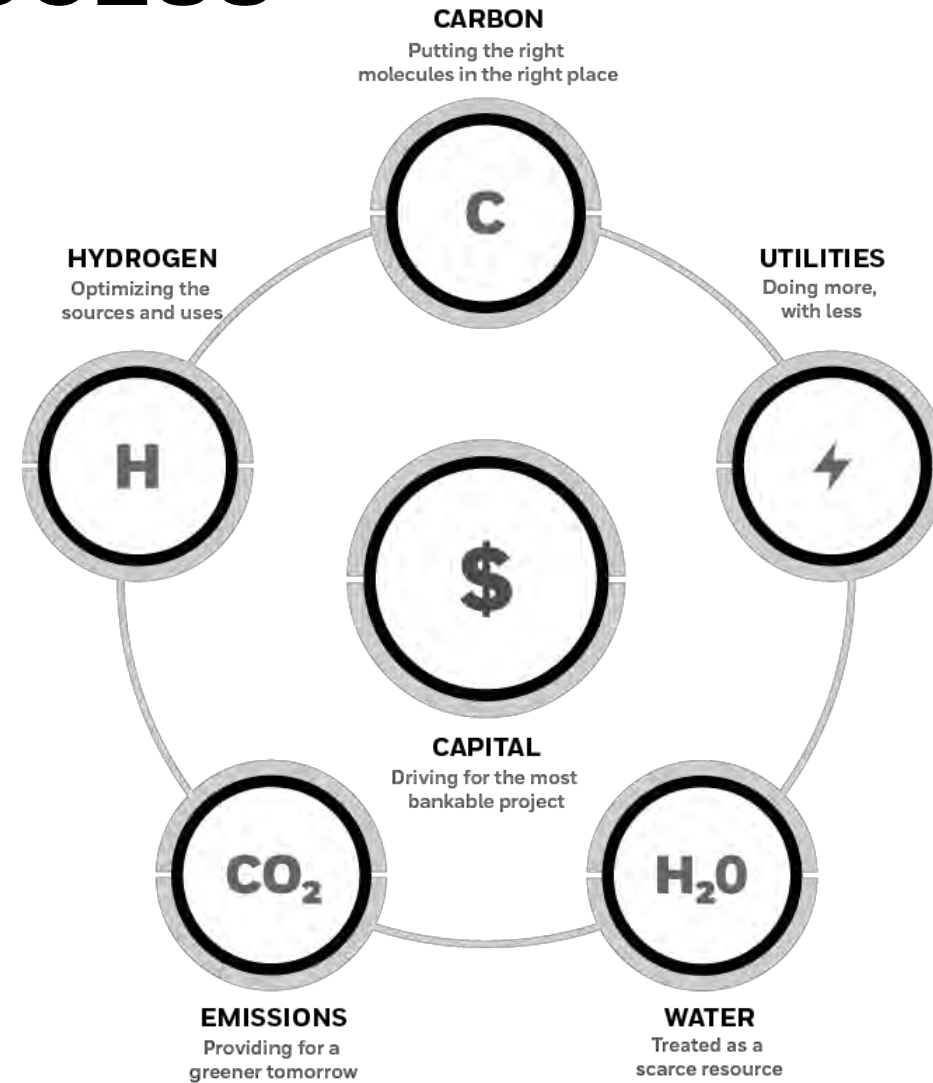




# 6-EFFICIENCIES (E6) | MOLECULAR MANAGEMENT WITH **ADVANCED CATALYST DEVELOPMENT**

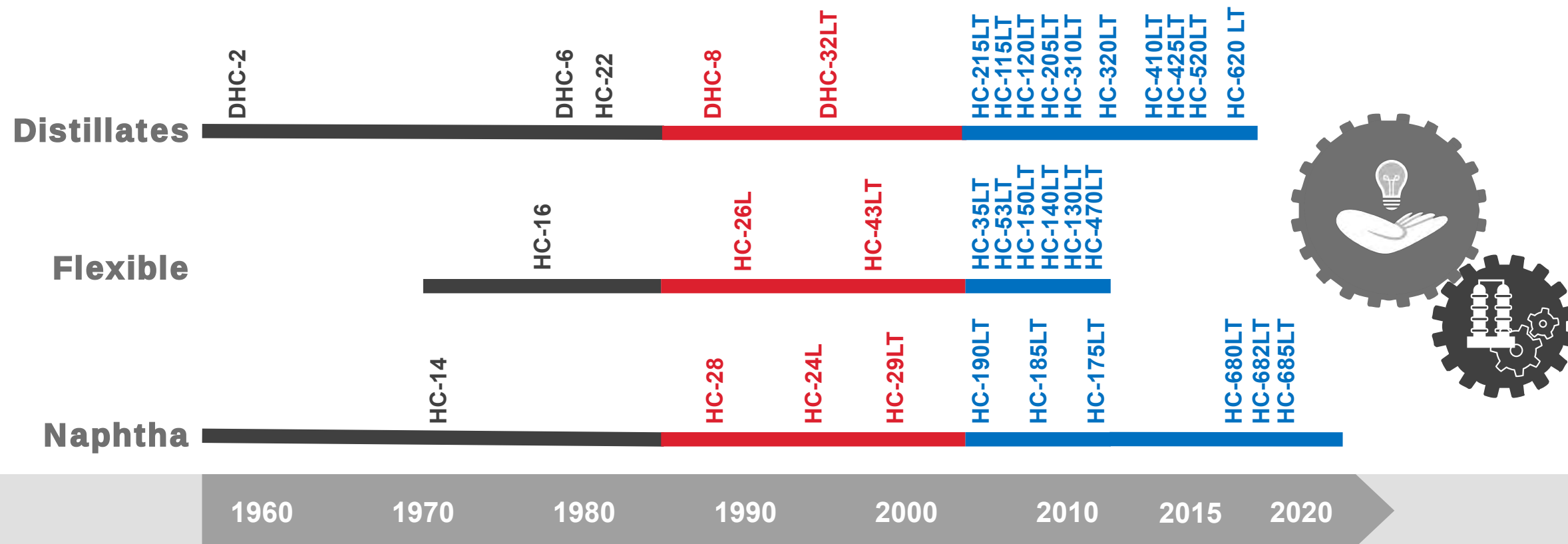


# 6-EFFICIENCIES (E6) HELP DRIVE BUSINESS SUCCESS



# UOP'S CATALYSTS INTRODUCTION OVER TIME

## Knowledge Application Accelerates Innovation



Innovation Confirmed by Commercial Success

# R&D TO MEET A DYNAMIC INDUSTRY

## Diverse Resources

- High Throughput Testing
  - Faster discovery
  - Faster development
- Fit for Purpose Pilot Plants
  - Close simulation of reference unit
  - Longer term stability and feed/application testing

## Advanced Characterization

- State of the Art Capability
- Toolbox for Understanding catalytic materials

## Customer Input – Industry Data

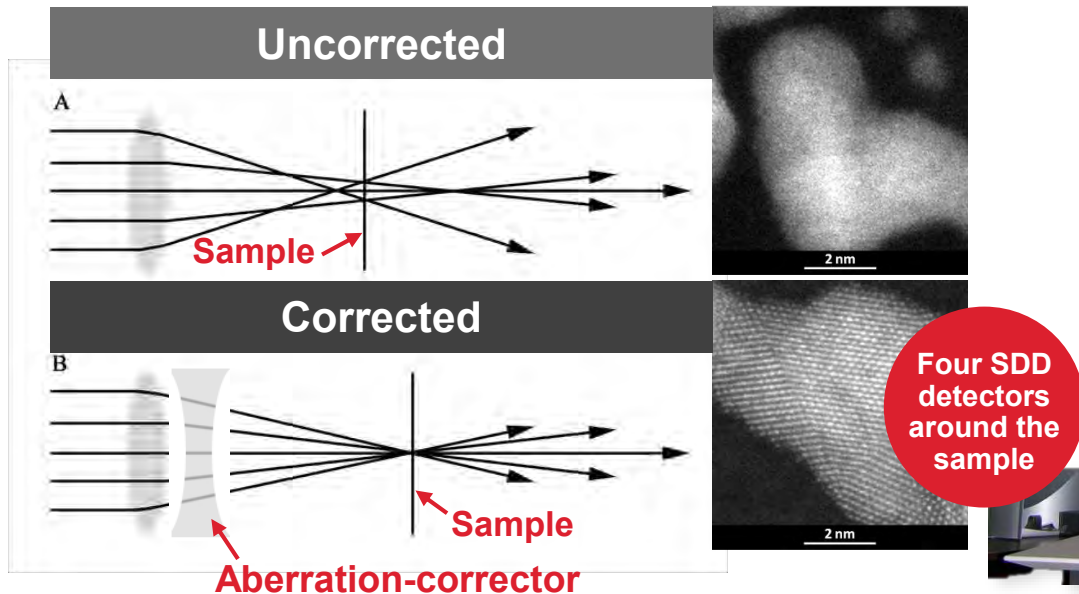
- Incorporating feedback
- Industry trends for shifts in the market



**Continuous loop between customers and R&D**

# ABERRATION-CORRECTED TITAN 80 STEM

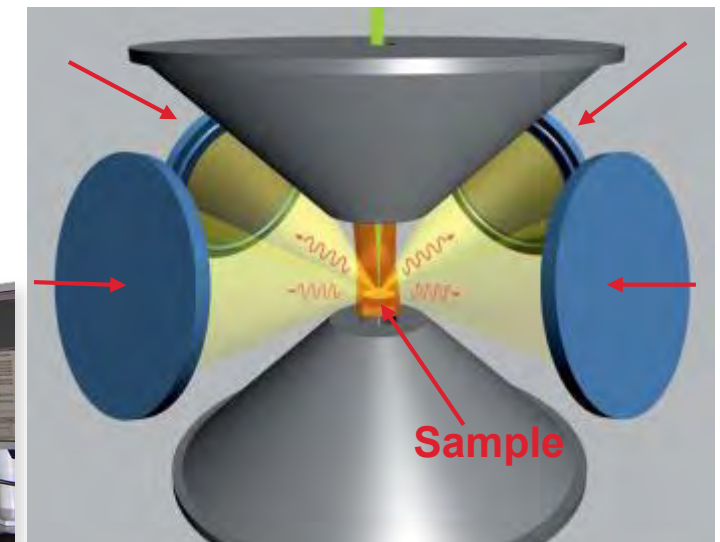
- **Aberration-corrector for electron probe**
  - Enables atomic resolution
- **Advanced Energy Dispersive X-ray (EDX) Spectroscopy system (SuperX)**
  - Enhanced sensitivity for low-level detection



*First Microscope With this Design Combination*



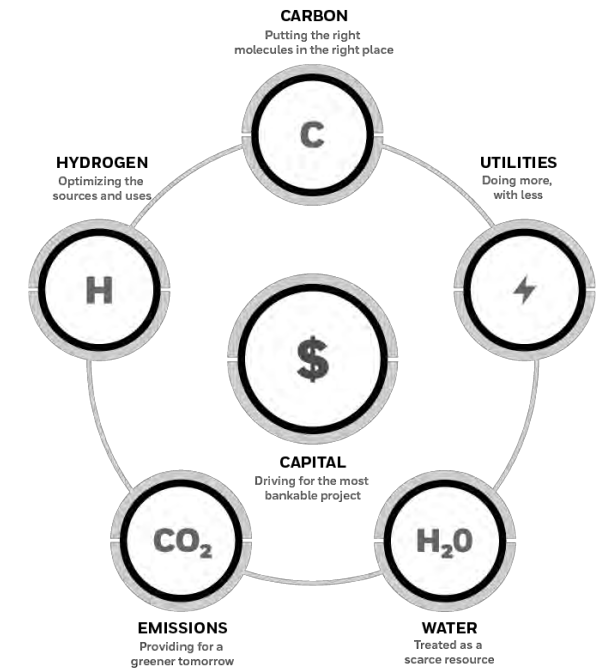
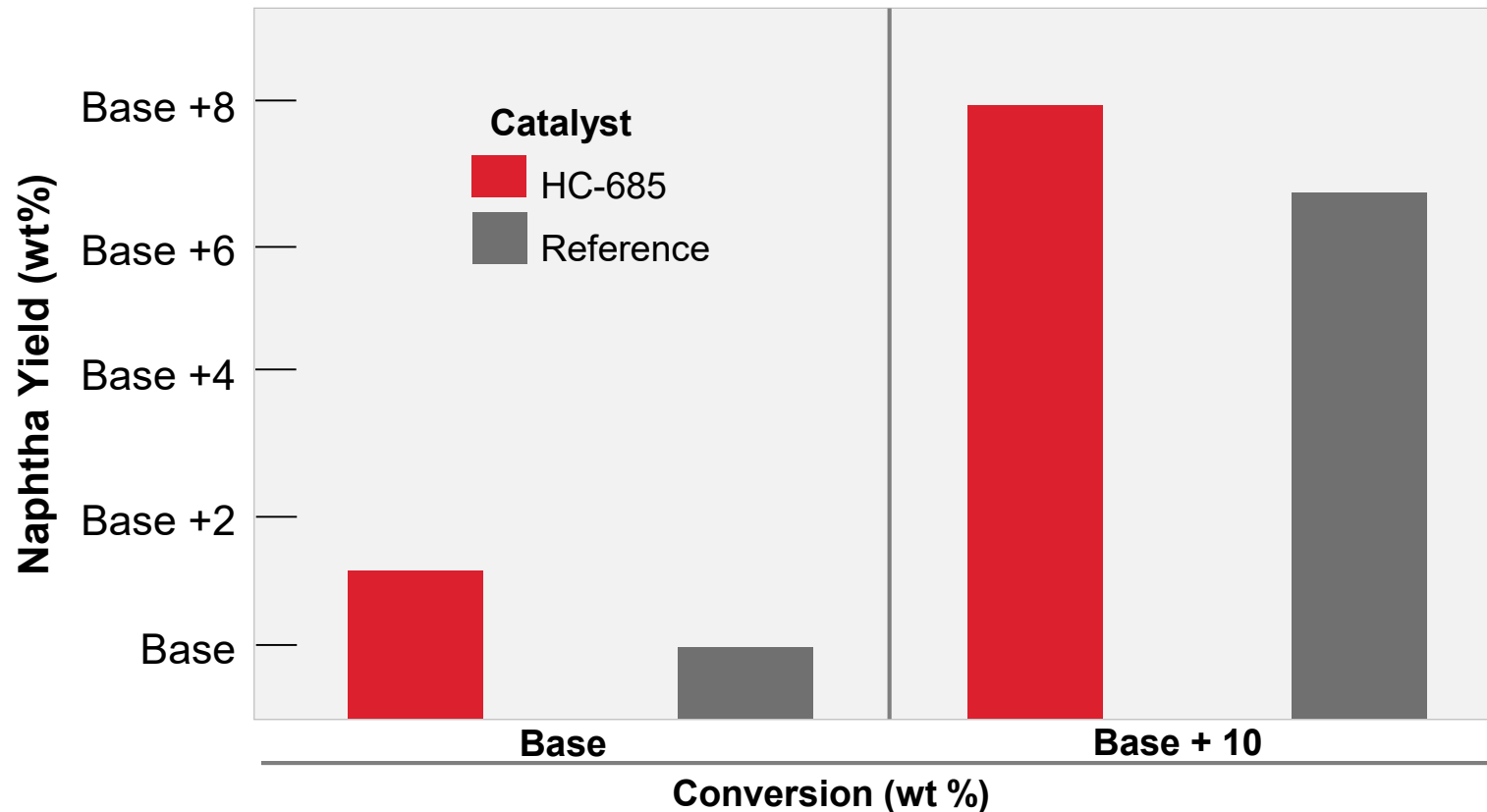
**Titan 80-300 SuperX  
Electron Microscope**



**SuperX Detector Array**

# CATALYST DEVELOPMENT

## Naphtha Yield vs. Naphtha Conversion



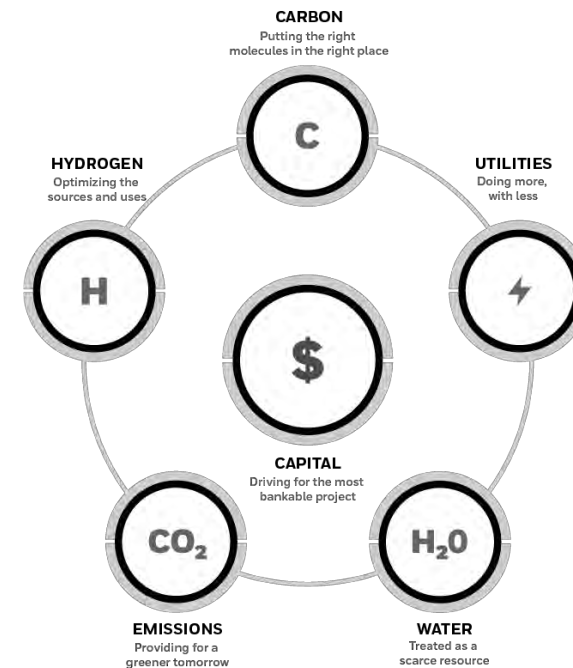
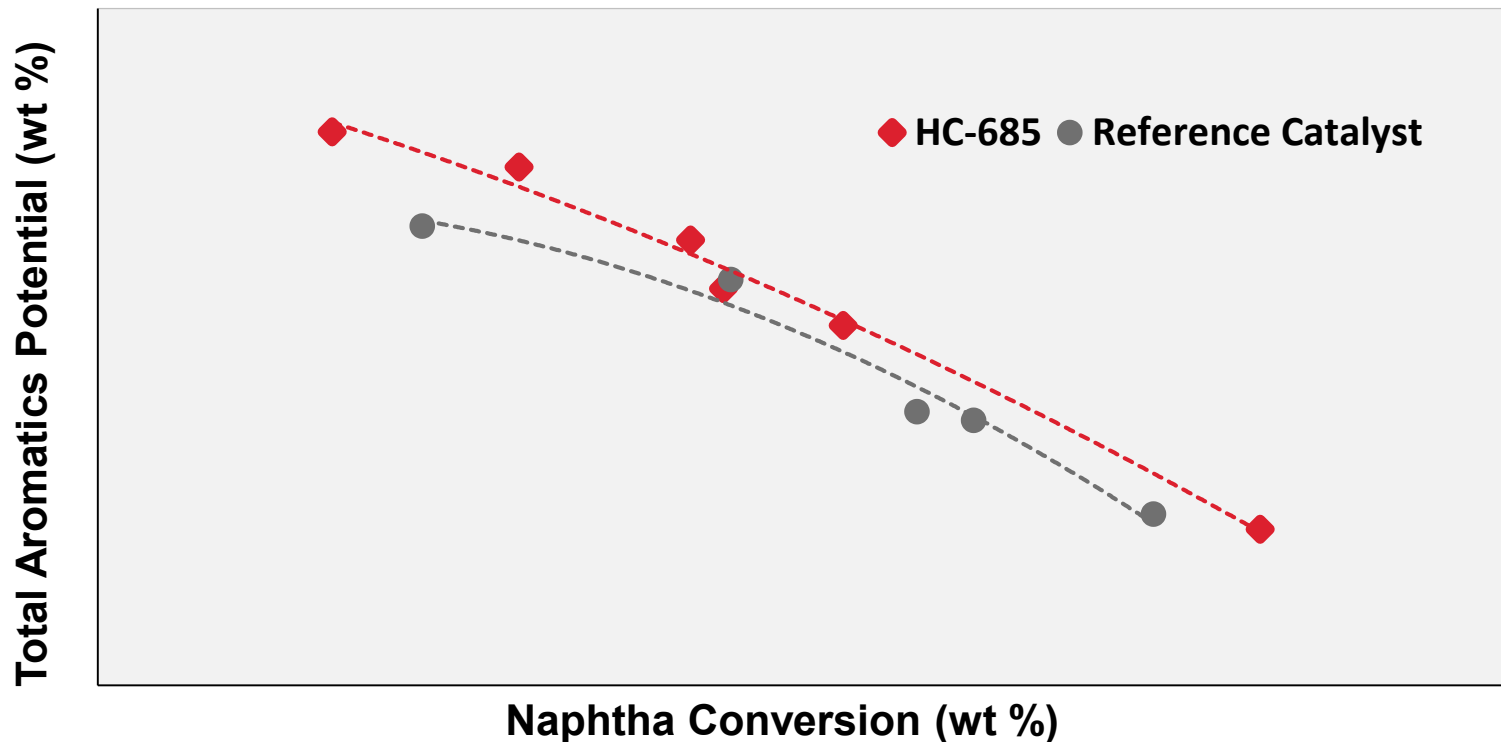
**Higher heavy naphtha yield**

- Increased feed to reformer
- Higher aromatics plant throughput, higher gasoline production

**HC-685 has higher heavy naphtha yield than the reference**

# CATALYST DEVELOPMENT

## Effective **Molecular Management** with Advanced Catalyst Development



### Higher Aromatics Potential

→ Produces naphtha containing molecules that are more suitable for aromatics formation

The future refinery relies, more than ever, on effective molecular management for the best outcome

# SUMMARY

- **Naphtha demand continues to grow on a global scale**
- **The Unicracking process enables the Refinery of the Future.**
  - Flexible solution to do step-wise conversion from transportation fuels to petrochemicals
  - Achieves high yields of high quality heavy naphtha
- **Unicracking process focuses on customer needs through the 6-Efficiencies**
  - Carbon/hydrogen management with optimized catalyst formulation, HPNA management and H2 integration
  - Utility/emission reduction through the Energy Efficient Unicracking process
- **Unicracking process delivers customers with lower overall cash cost of production and improved capital efficiency**
- **Global and extensive experience in hydrocracking – with over 230 hydrocracking units**
- **Over 45 Unicracking units that produce naphtha as the primary product**
- **Backed by world-class engineering and services – guaranteed to provide the best solution.**

**Download the White Paper for more details**

# FOR MORE INFORMATION

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## General Inquiries

- For more information, please contact your UOP representative or visit us online at [www.uop.com](http://www.uop.com)