

UOP INTEGRATED OLEFIN SUITE: IMPROVE PROFITABILITY & MAKE THE PRODUCTS YOU WANT

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UOP

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ETHYLENE BACKGROUND

- Ethylene is the largest petchem market (178M MTA with CAGR of 3.1%)
- Steam cracking produces >97% of the world's ethylene
- Ethane and naphtha are most common feeds with each supplying ~45% of globally
- Ethane supply is regional and insufficient to meet global ethylene demand
- Naphtha used in most other regions
- Naphtha cracking has several disadvantages

Naphtha Cracking Disadvantages

- Cost disadvantaged feedstock
- Low ethylene yield (30%-35%)
- Large number of by-products with range of value
 - High value (e.g., propylene, butadiene)
 - Medium value (e.g., butenes, BTX)
 - Low value by-products (e.g., fuel oil, fuel gas)
- By-products may or may not be strategic but consume valuable CAPEX and operating resources
- Tend to be price setter for ethylene

How can the efficiency of naphtha crackers be improved?

MOLECULE MANAGEMENT

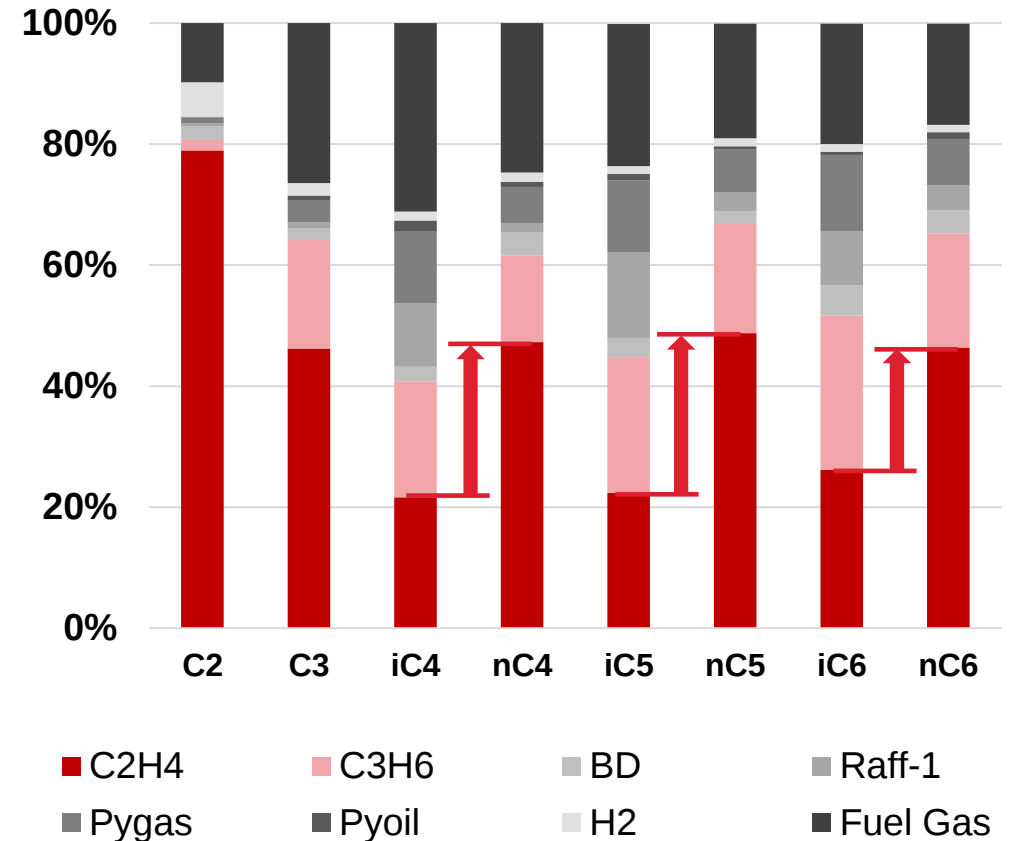
n-paraffins are **preferred feed stock**

Benefits include:

- **~2x yield of ethylene and >30% higher yield of ethylene+propylene vs. i-paraffins**
- Lower yield to lower-value by-products such as pygas, fuel gas, heavy residues and coke
- Longer operating cycles
- Lower operating severity
- Lower utilities/MT of olefins
- Low CO₂/MT of olefins
- Lower CAPEX/MT of olefins

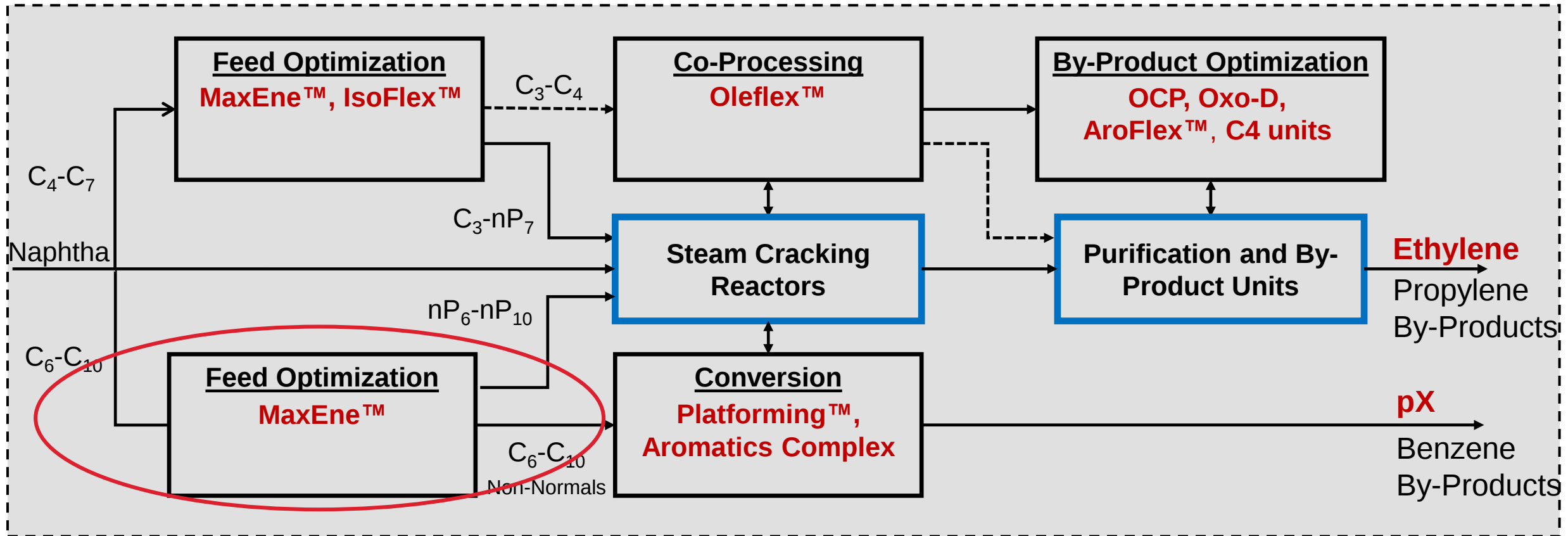
Difficult to purchase feeds with high *n*-paraffins

Steam Cracking Yields, wt%



The UOP-IOS includes technologies for generating high *n*-paraffin streams

UOP INTEGRATED OLEFIN SUITE - INTRODUCTION



UOP **Integrated Olefin Suite** is an innovative take on proven technologies that gives steam cracking investors and operators **the ability to meet their needs to improve ROI, increase operating profits, reduce CO₂ footprint and enjoy an unprecedented level of control over by-products**

Increase yield of high-value products and tune by-products to match needs

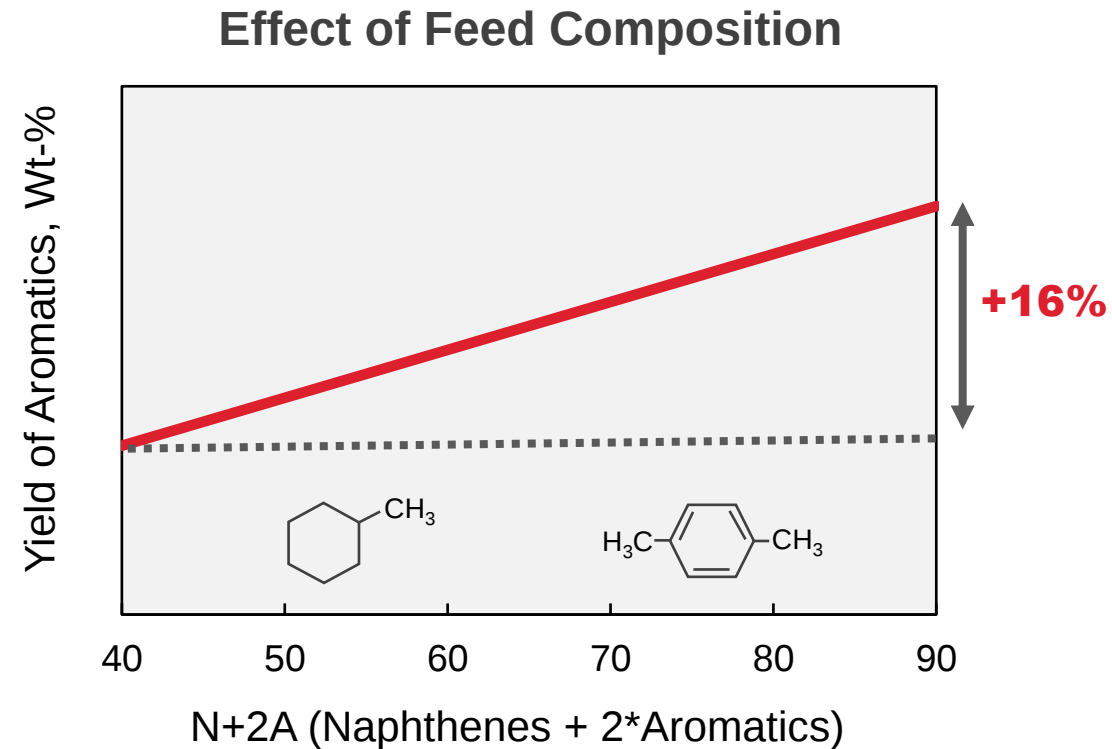
IDEAL CATALYTIC REFORMING FEEDS

For catalytic reforming units, **feeds rich in aromatics and naphthenes** are preferred

Typical benefits include:

- Higher yields to aromatics
- Reduce light end yield
- Lower coke on catalyst
- Require less heater duty
- Debottlenecks catalytic reforming units

Increases aromatics production for *para*-xylene or gasoline blending

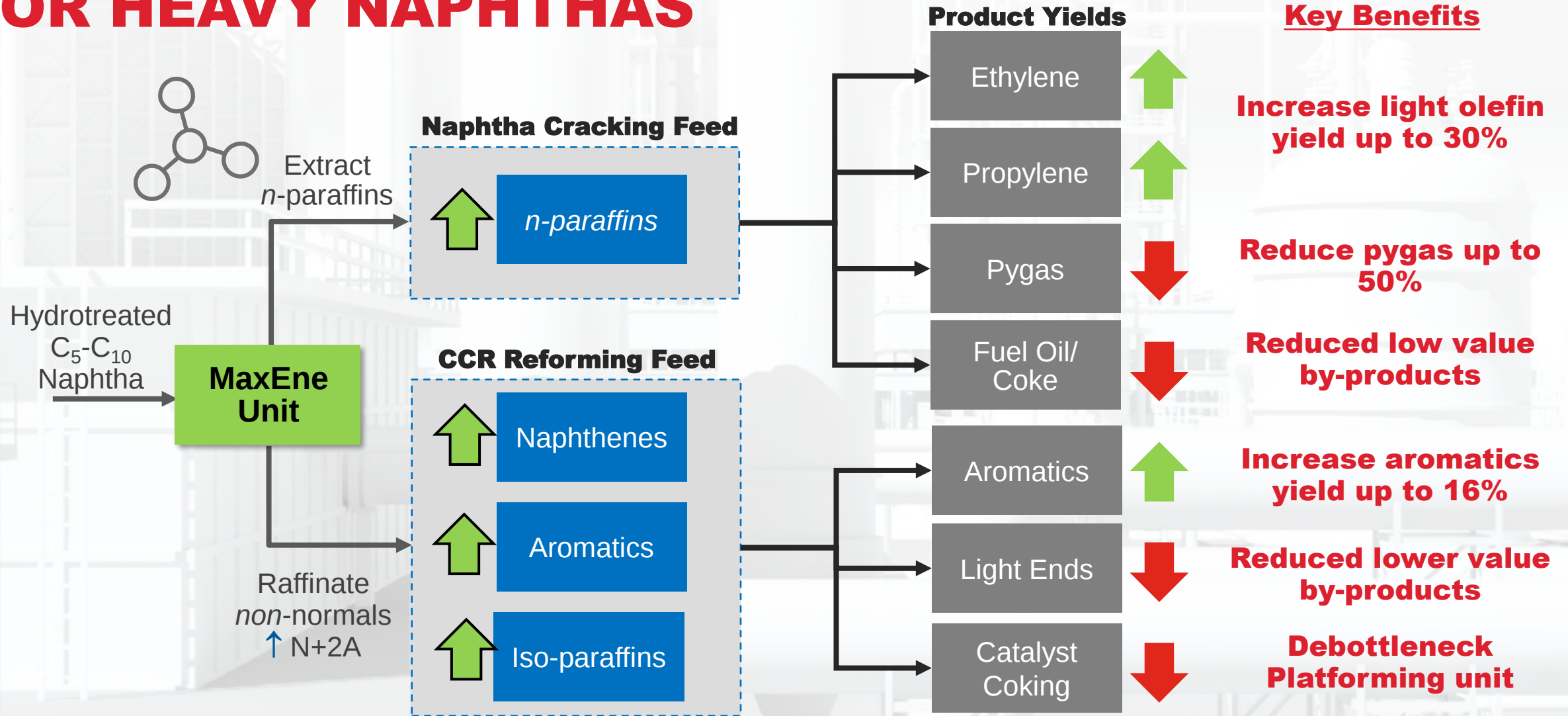


Aromatics are desired products
Naphthenes easier to convert
than paraffins

The UOP-IOS includes technologies for optimizing catalytic reforming feeds

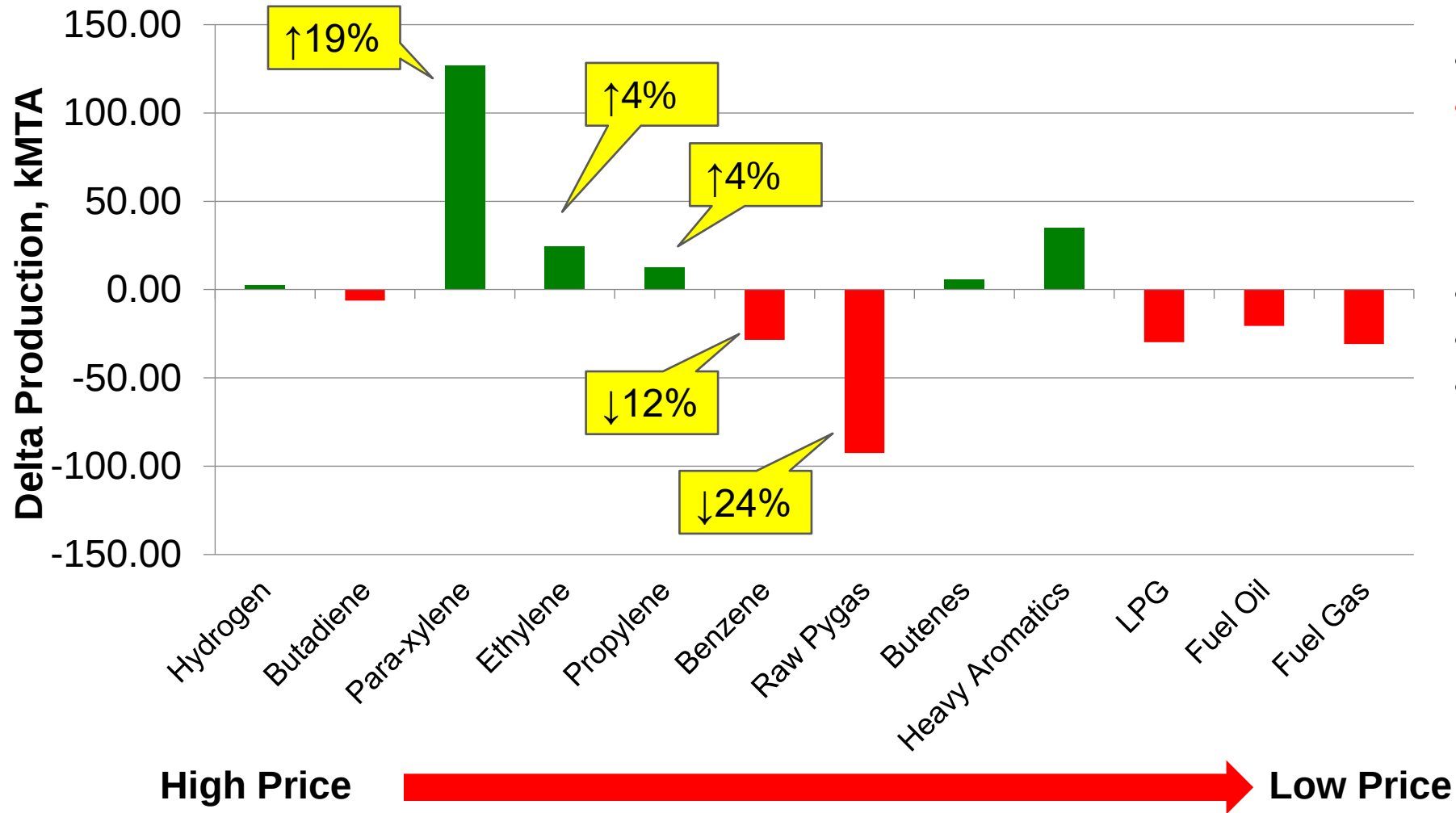
INTEGRATED SOLUTIONS FOR HEAVY NAPHTHAS

Commercially proven at Sinopec's YPC facility
Also licensed by PKN (Poland)



Typical capital payback times < 3 years, may require incremental heavy naphtha

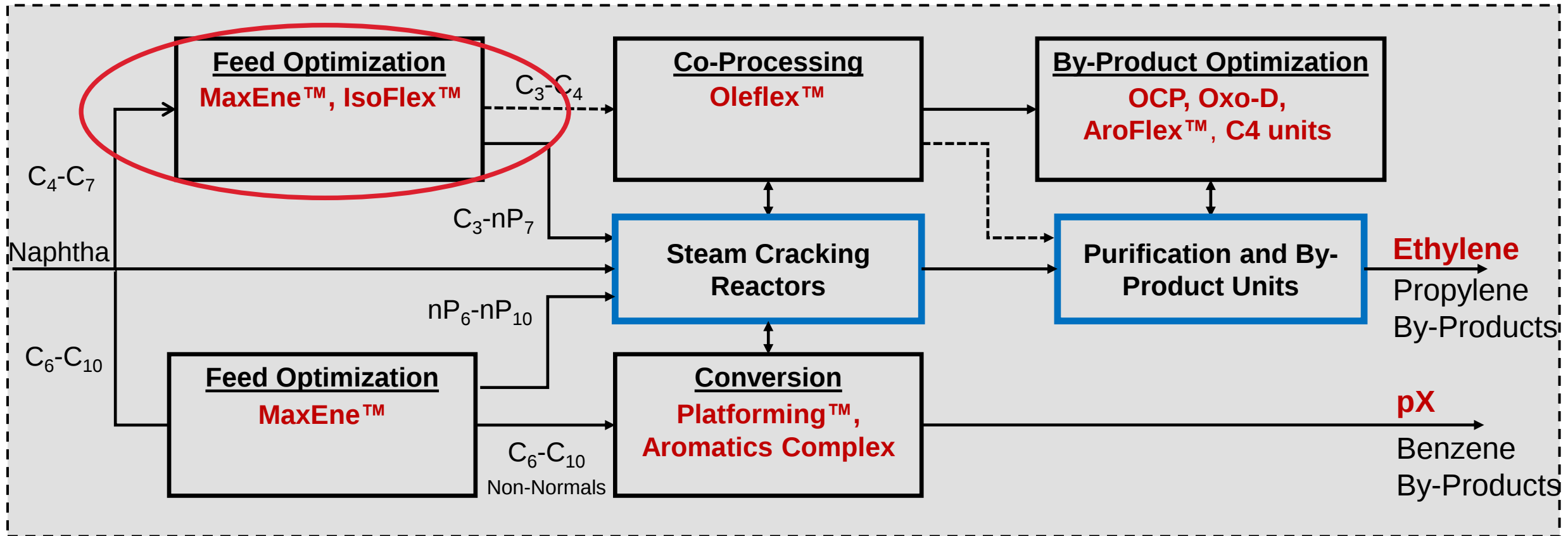
HEAVY NAPHTHA OPTIMIZATION



- Constant feedstock
- Increase product slate value \$81M/yr by increasing production of high-value products
- Project investment = \$85M
- Project NPV = \$185M
- Project payback = 1.8 years

Increase production of high value products and reduce production of low value products

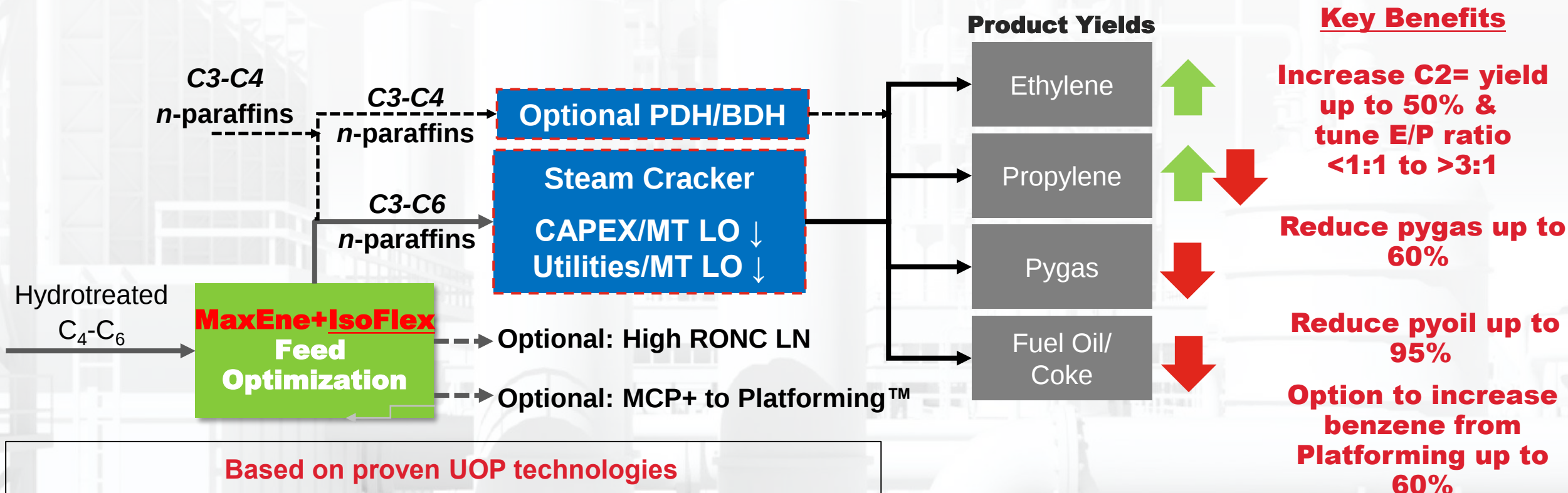
UOP INTEGRATED OLEFIN SUITE GEN-1 - INTRODUCTION



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LIGHT NAPHTHA OPTIMIZATION



- *Increase concentration of n-paraffins to steam cracker*
- *Increase ethylene yield up to 50% versus traditional naphtha cracker*
- *Increase or decrease the production of by-products (fuels, BD, butenes, benzene)*

Improved economics vs. traditional naphtha cracker - make the products you need!

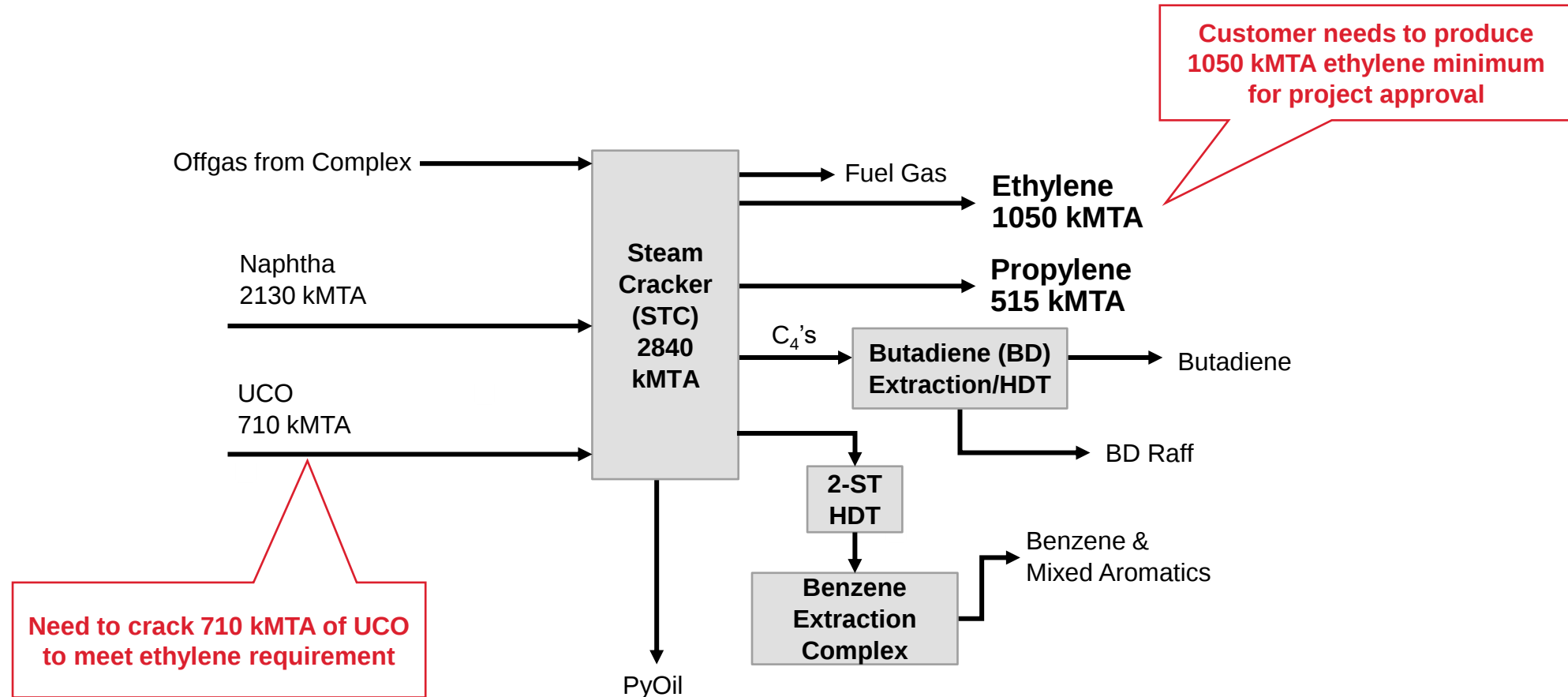
STEAM CRACKER PETROCHEMICAL INTENSIFICATION THE UOP INTEGRATED OLEFIN SUITE (UOP-IOS)

UOP-IOS provides a step change in product yields and profitability of naphtha crackers

Overview of project and customer needs:

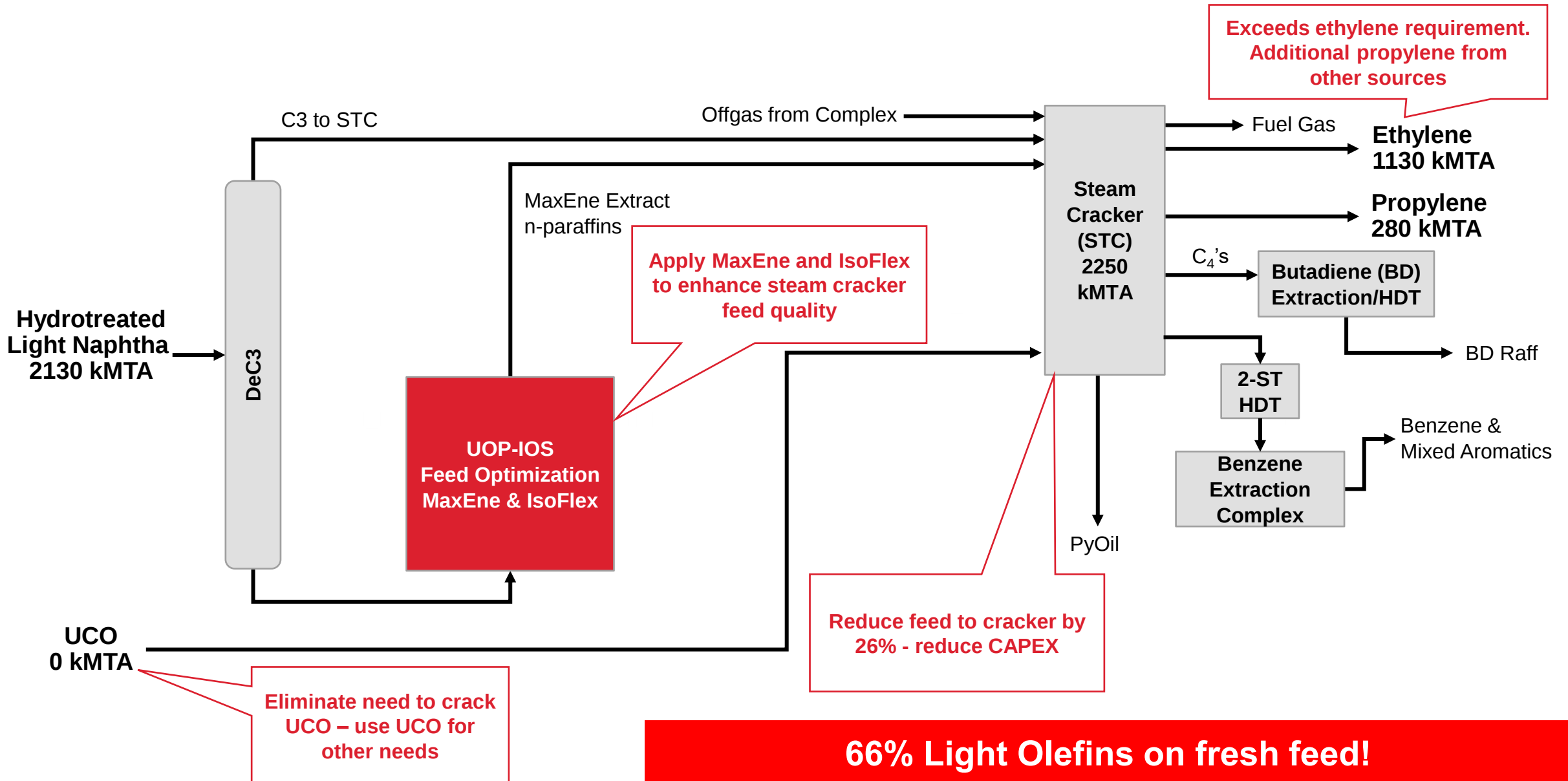
- 1 MMTA ethylene capacity for project approval
- 2130 kMTA of available naphtha insufficient to produce 1 MMTA of ethylene
- Conventional design requires supplemental UCO feed to produce 1MMTA ethylene
- Minimize UCO for other attractive applications
- Minimize fuels and other by-products
- Maximize ROI

LIGHT NAPHTHA STEAM CRACKER

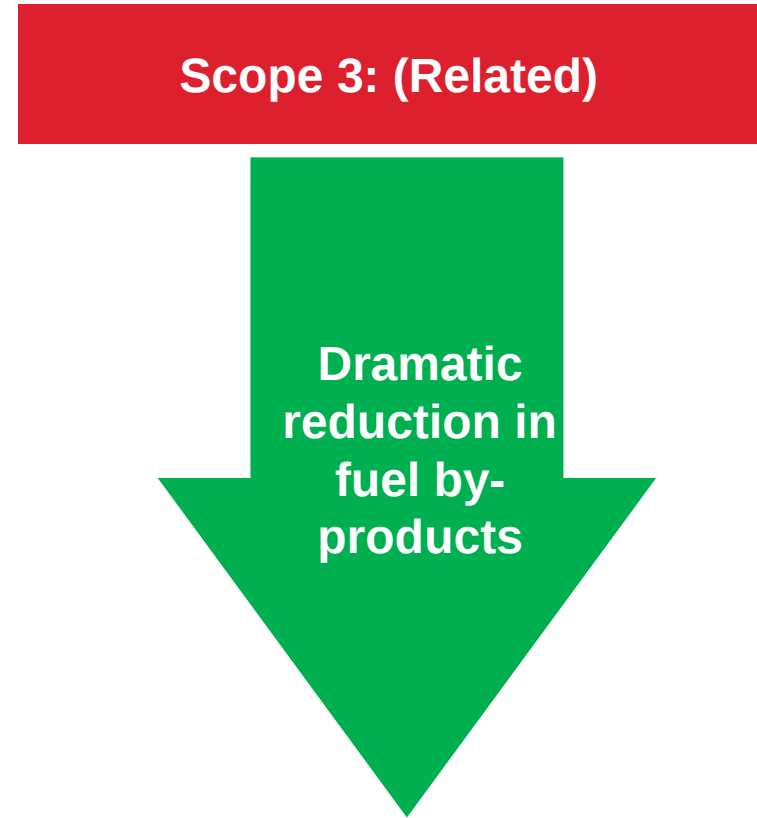
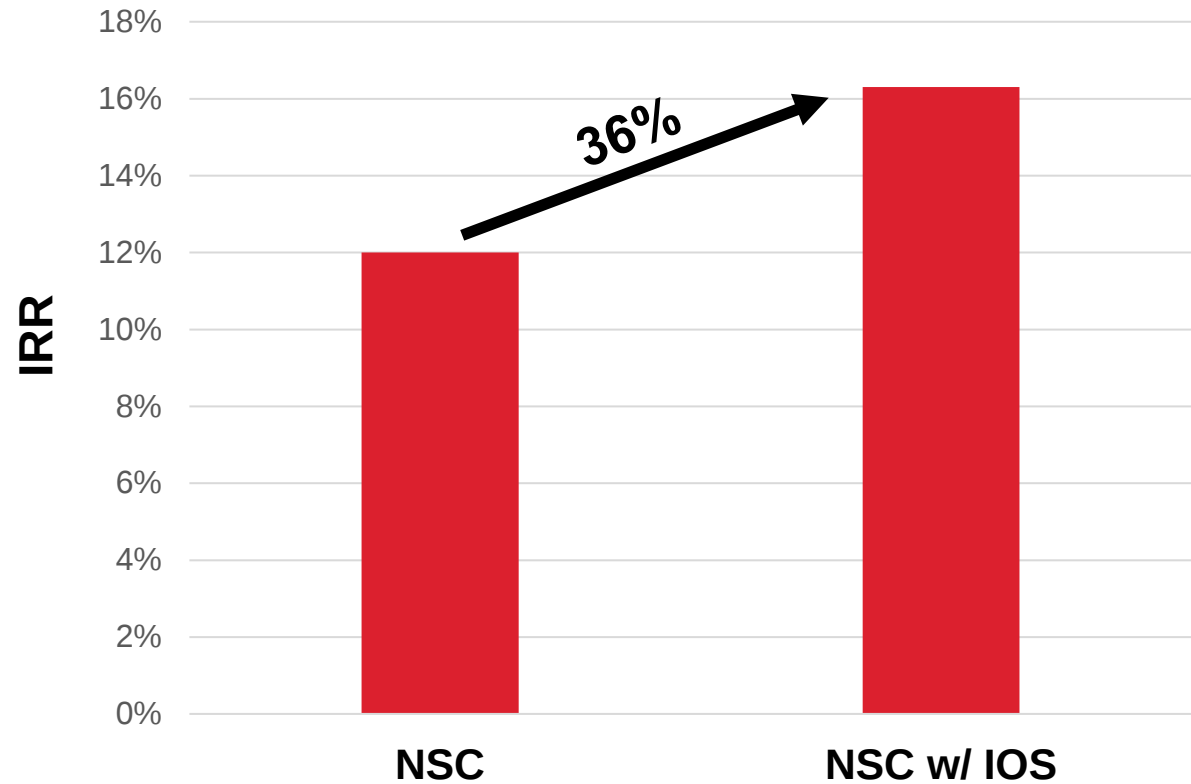


55% Light Olefins on Fresh Feed

LIGHT NAPHTHA STEAM CRACKER WITH IOS

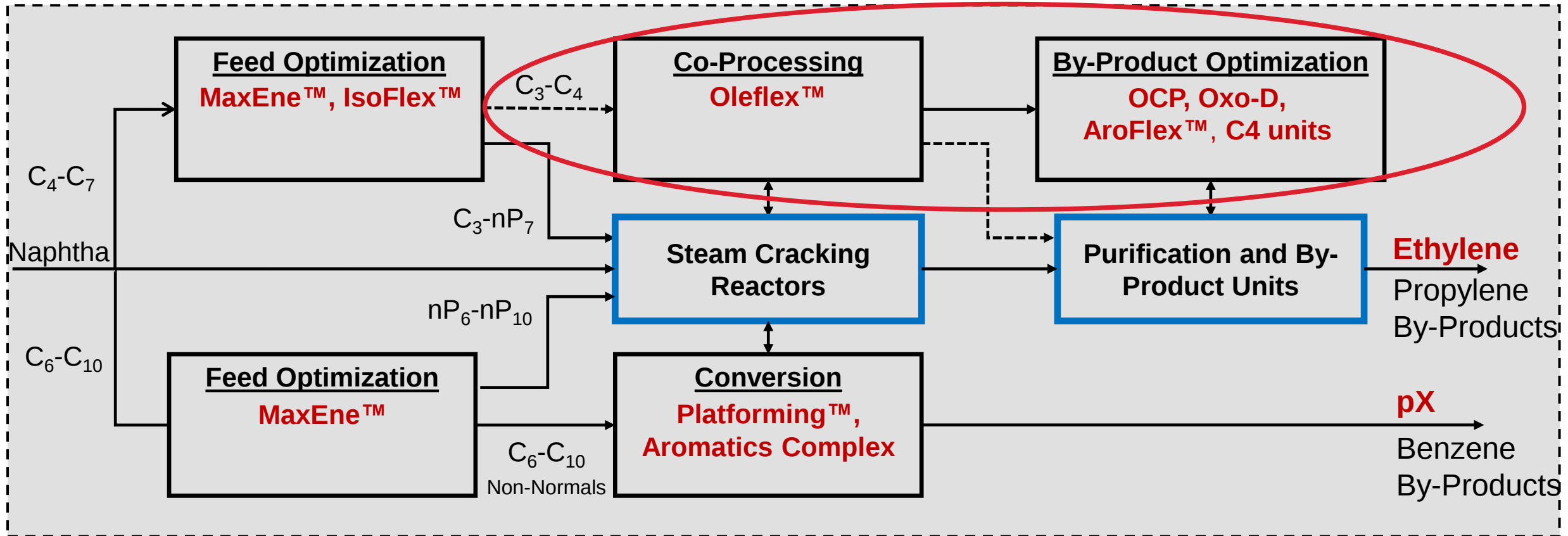


LIGHT NAPHTHA STEAM CRACKER SUMMARY



Driving Value AND Reducing Fuel By-Products

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UOP-IOS CAPABILITIES

By-Product	Increase	Decrease	Eliminate
Propylene	✓	✓	-
Butadiene	✓	✓	✓
Butenes	✓	✓	✓
C4+ Olefins	-	✓	✓
BTX (Pygas)	✓	✓	✓

- ***Solutions to increase, decrease or eliminate key naphtha cracker by-products***
- ***Improve economy of scale for strategic by-product derivatives***
- ***Reduce feedstock purchases***
- ***Strong synergies between process units in the UOP-IOS***

Make the by-products that match your business strategies

COMPLEX OPTIMIZATION TO MAXIMIZE PETROCHEMICAL INTENSIFICATION

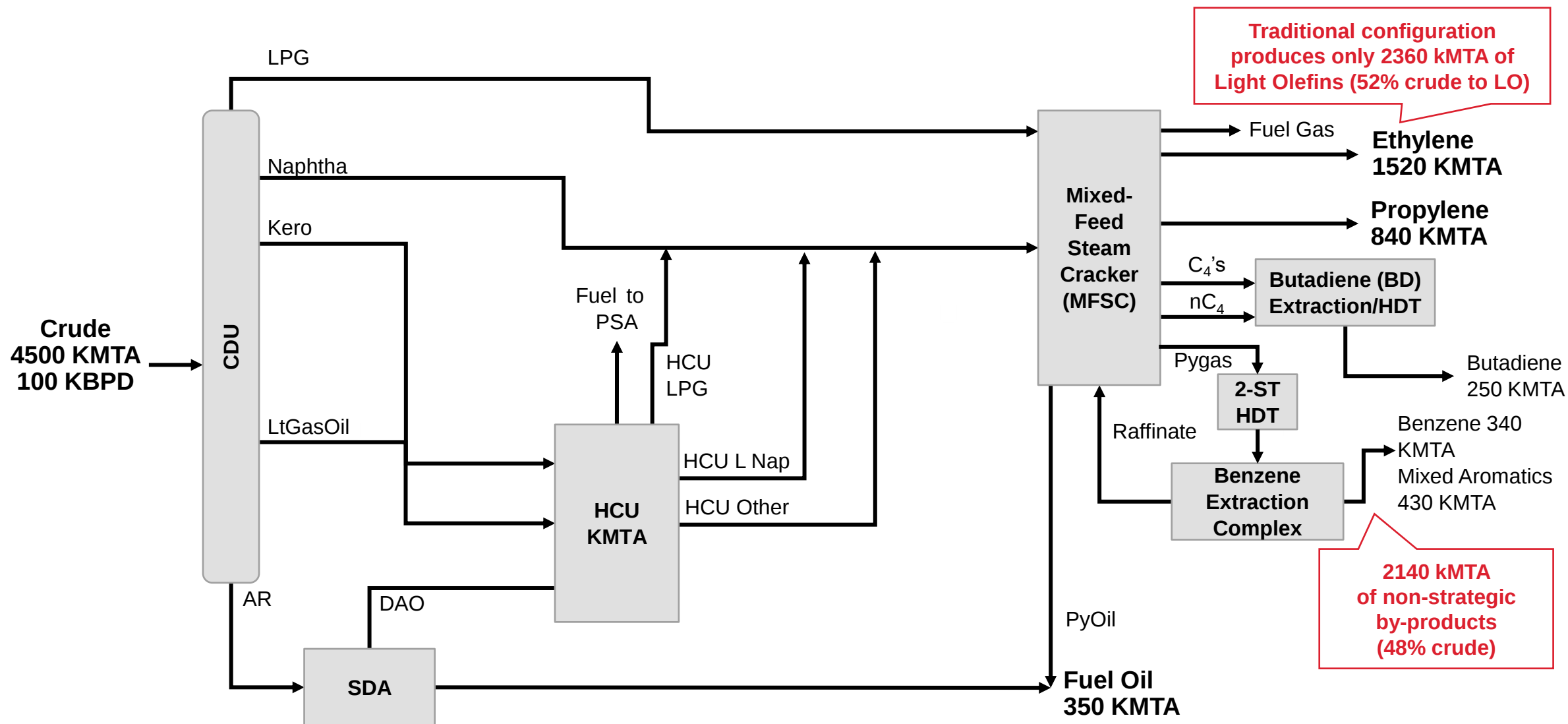
THE UOP INTEGRATED OLEFIN SUITE (UOP-IOS)

UOP-IOS provides a step change in flexibility and ROI of naphtha crackers

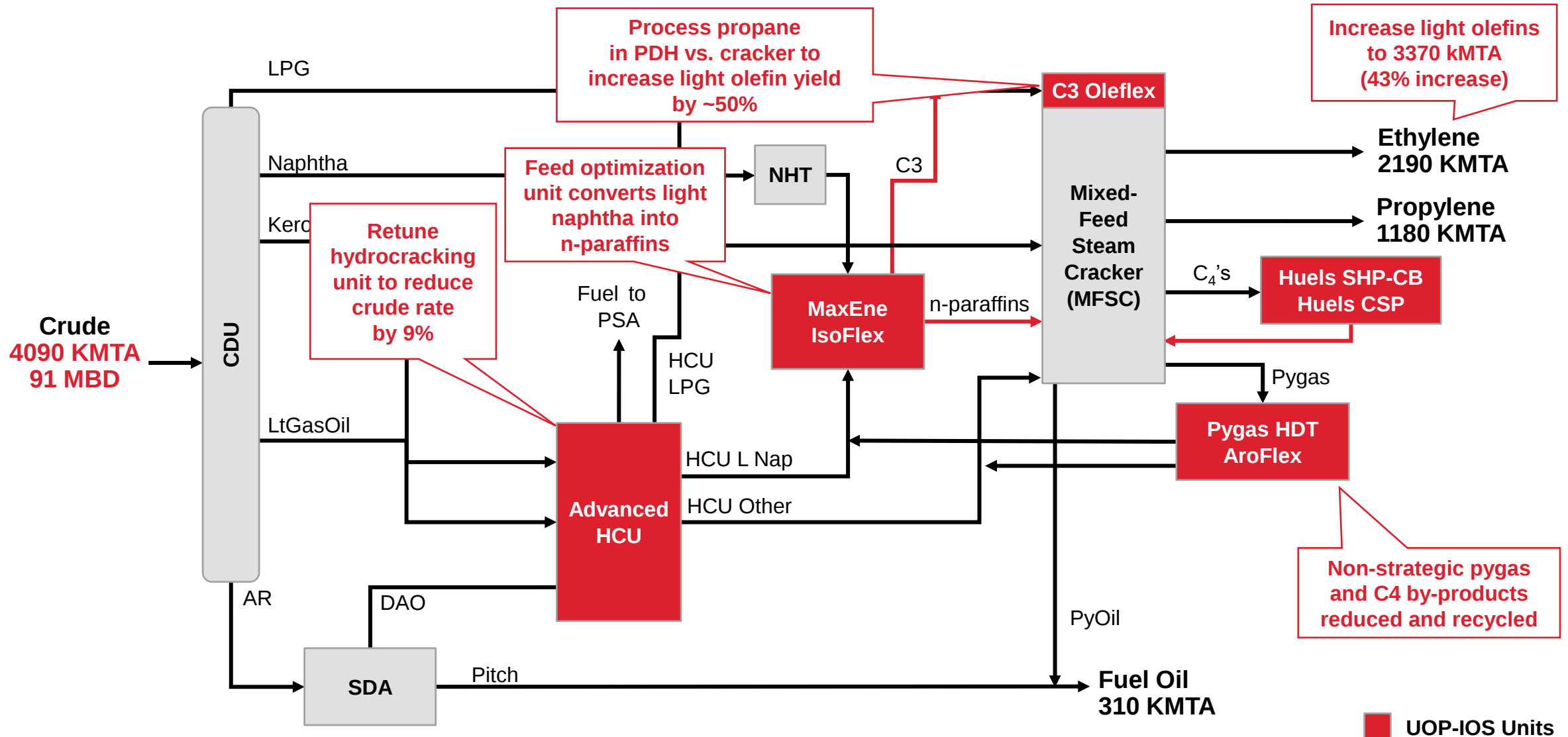
Overview of project and customer needs:

- 100 kBPSD (4500 kMTA) of crude available
- Maximize ethylene and propylene
- C4 olefins, BTX considered non-strategic by-products
- No aromatics complex
- Minimize fuels
- Maximize ROI

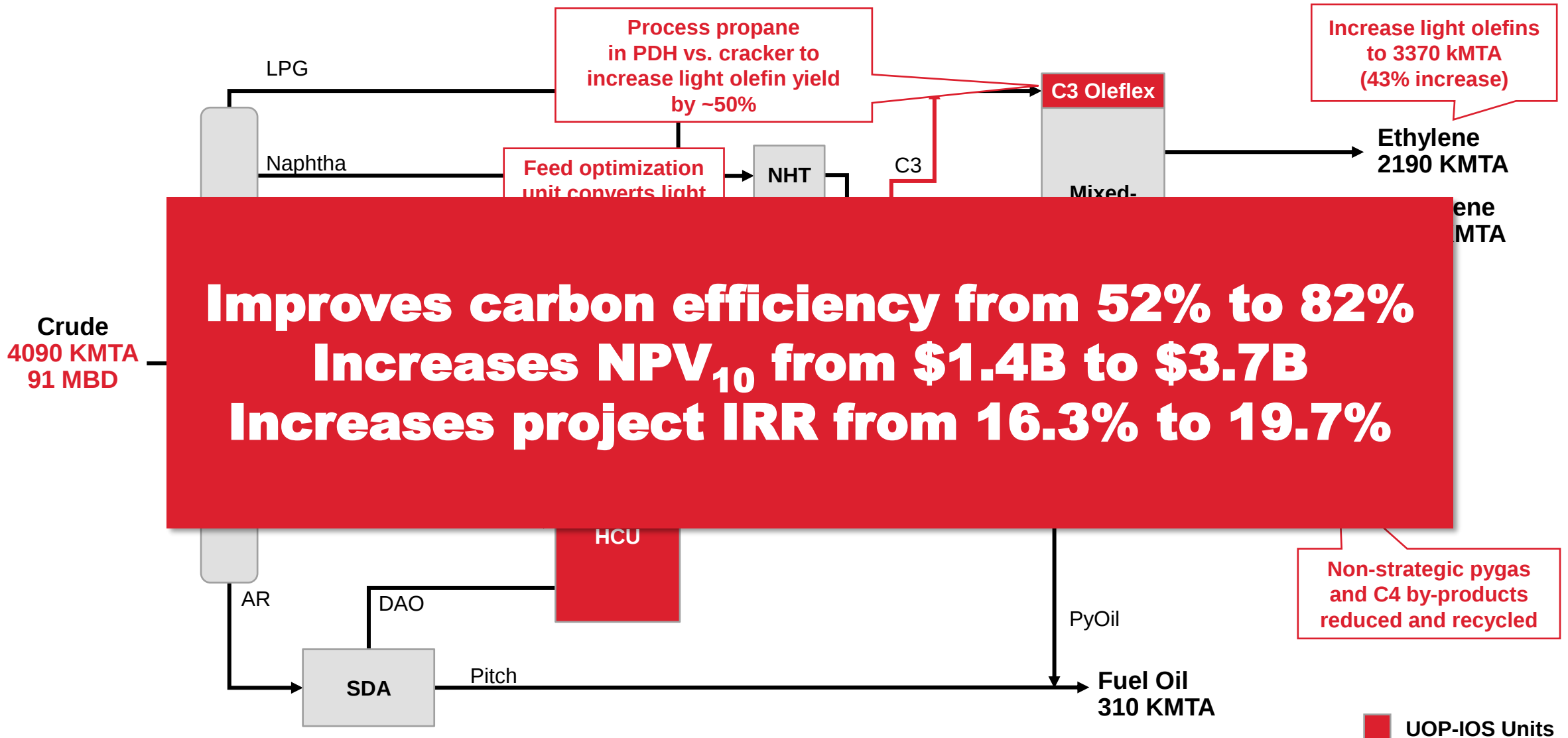
CRUDE TO OLEFINS: BASE CASE



CRUDE TO OLEFINS: UOP-IOS SOLUTION



CRUDE TO OLEFINS: UOP-IOS SOLUTION



ANOTHER KEY BENEFIT OF UOP-IOS

	100% Net Fuels ¹	64% Net PetChems	100% Net PetChems
Base Refinery Emissions	8,420	26,304	34,422
Fuel Products Burned	56,746	16,313	0
Total, TPD CO₂	65,167	42,617	32,422
Add Carbon Capture to the H ₂ SMR Stack	(1,304)	(2,072)	(4,326)
Net, TPD CO₂	63,682	40,545	28,096

¹1.80% LSD / 10% Gasoline / 10% LPG
Not a complete LCA of the Refinery.

UOP-IOS can reduce net CO₂ by 31% vs traditional naphtha cracker

INTEGRATED OLEFIN SUITE - SUMMARY

- The UOP Integrated Olefin Suite is a collection of technologies that “wrap” around the steam cracker to:
 - Increase the production light olefins
 - Increase operating profits and ROI
 - Provide unprecedented level of flexibility to manage by-products
 - Reduce environmental footprint
- Optimizes feedstocks for aromatics production
- Ideally considered during configuration stage or earlier
- Applicable in grass root or revamp situations
- Facilitates efficient transition from fuels to petrochemicals focus including crude to chemicals and crude to olefins strategies
- Based on commercially proven technologies that are applied in new, creative configurations
- UOP is prepared to assist you with the capabilities to transform your naphtha complex



Increase production of light olefins and tune your product slate to increase profitability and ROI

**PLEASE LET US KNOW
YOUR QUESTIONS**

