October 29, 2026

脱碳新路径
以更少的资源创造更大的价值

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霍尼韦尔科技UOP石化行业技术支持负责人

Honeywell Technologies

减碳四支柱: 以流程、技术+分子管理生产低碳排强度产品

- 新技术驱动
- 油品到化学品的转型
- New Technology PIVOT from FUELS to CHEMICALS

- 碳的固化取代车辆燃料的可持续解决方案
  Sequester carbon instead of burning it in vehicles
- 匹配需求趋势
  Aligns with demand trends
- 可盈利解决方案
  Bankable solutions – very active & evolving space

- 原料替代 – 新碳和老碳之选
- FEEDSTOCK SUBSTITUTION – NEW CARBON vs OLD
  - 可再生燃料和废塑料循环
    Renewable fuels & plastics circularity
  - 可盈利
    Bankable where credit subsidies are available
  - 新建，改造，共炼
    New Units, retrofits, and co-processing
    - **Ecofining™**
    - **Ethanol to Jet**
    - **E-fuels**
    - **Upcycle™**

- 碳捕捉，利用和封存
- CARBON CAPTURE, UTILIZATION & STORAGE
  - 封存和驱油
    Ready now - Capture → Transport → Sequester or use for EOR
  - 捕捉的碳变成电子级燃料
    Ready soon - Capture → convert to e-fuels

- 技术和能耗优化
- TECHNOLOGY & ENERGY IMPROVEMENTS
  - 多种路线选择 – 新建或改造
    Many options available - new units or retrofits
  - 技术示例 / **Examples**
    - **RecoveryMax™**
    - **NViroFCC™**
    - **CatMax™**
    - **Energy efficient dual stripper/fractionator**
    - **Fugitive emissions monitoring & mitigation**
    - **Dividing Wall Columns**

能源转型低碳发展需要可盈利投资项目

CI – Carbon Intensity

NAPHTHA TO ETHANE & PROPANE

NEP IS A NEW SOLUTION FOR PETCHEMS & REFINERS

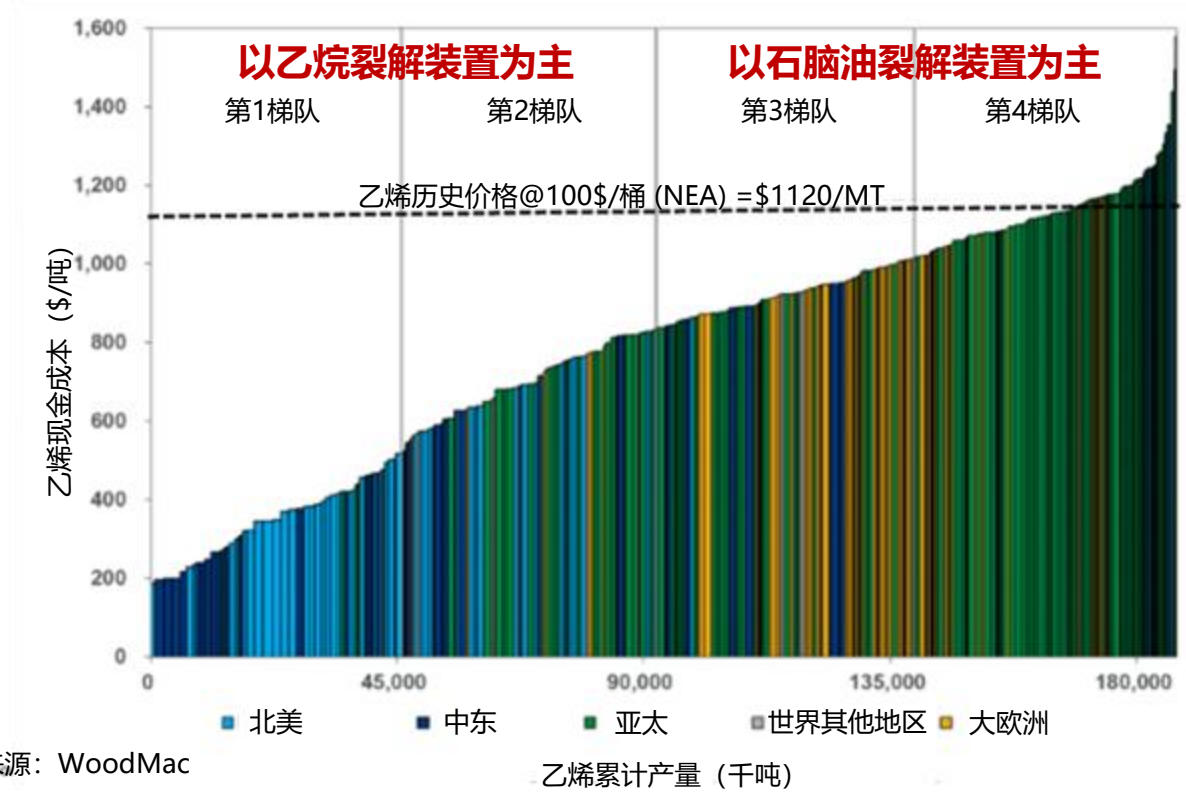


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蒸汽裂解技术面临的挑战

- 由于缺乏乙烷，亚洲主要依赖石脑油裂解来生产乙烯
- 乙烷裂解装置优于石脑油裂解装置，但受制于乙烷供应有限
- 可持续发展日益受到重视
- **蒸汽裂解装置是石化行业中最大的CO_2来源**
- 液体燃料需求预计呈下降趋势——源于电动汽车和强制性法规
- 地缘政治影响国家战略并改变贸易流

$100/桶原油下，乙烯装置现金成本曲线



来源：WoodMac

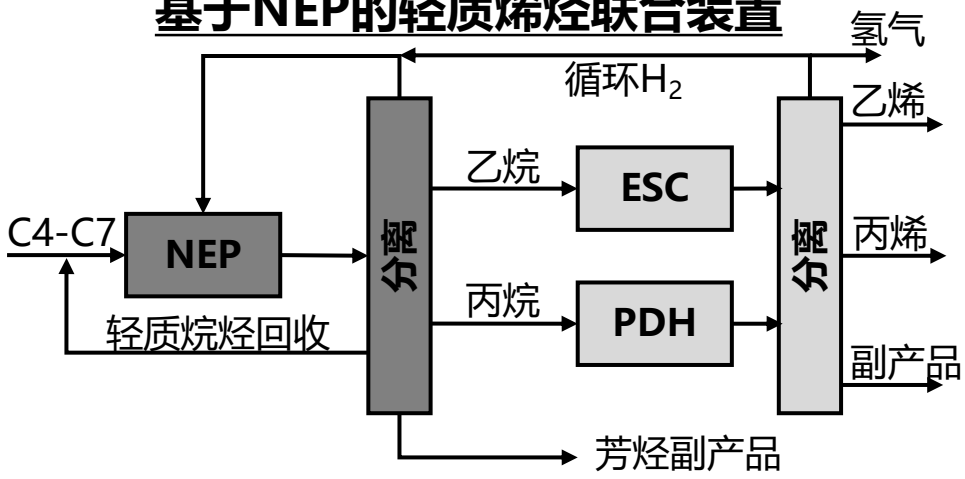
亟需一种改良的轻质烯烃生产方法

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新一代原料优化技术 NEP

- **将石脑油(C_4-C_7)转化为可调比例的乙烷/丙烷——增加乙烷或丙烷**
  - **将乙烷送入*乙烷裂解 (ESC)*** 以优化乙烯/H_2比
  - **将丙烷送入*PDH*** 以优化丙烯/H_2比
- **NEP工艺：**
  - 温和的操作条件
  - 现有催化剂的延伸
  - 低的公用工程消耗
  - 采用标准分馏技术来分离产品
  - 适用于新装置和旧装置改造
- **购买石脑油和/或利用UOP先进加氢裂解技术以重质原料生产石脑油（HN+到LN和LPG）**

基于NEP的轻质烯烃联合装置



优点

- 乙烯和丙烯收率更高，每吨烯烃的原料消耗量更少
- 减少了低价值燃料副产品的产量
- 能大范围调整乙烯/丙烯比
- 最高单线乙烯产能高于石脑油裂解装置
- 氢气自给自足
- 原料来源多样化（无需再进口乙烷/丙烷）

以领先的分子管理解决方案优化轻质烯烃生产

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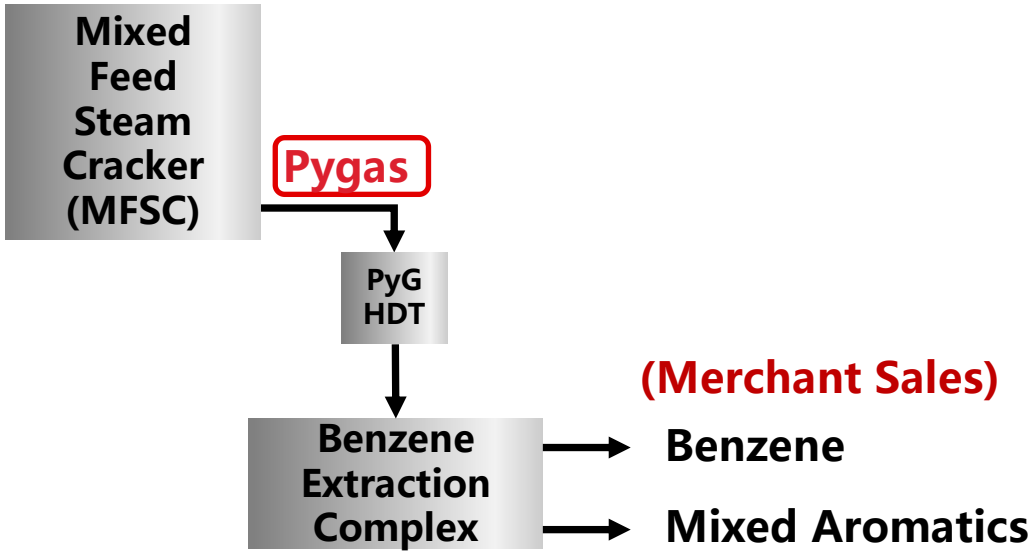
乙烯裂解汽油
减少裂解汽油可减少CO2排放

从工艺角度看，裂解汽油的碳排是重整生成油的3.6倍

- **Pygas 裂解汽油: ~53% Aromatics**
- **重整生成油: ~80% Aromatics**

从单吨芳烃角度看，裂解汽油的碳排是重整生成油的5.5倍

- **高碳排放的芳烃**
- **高碳排放的汽油调和组分**



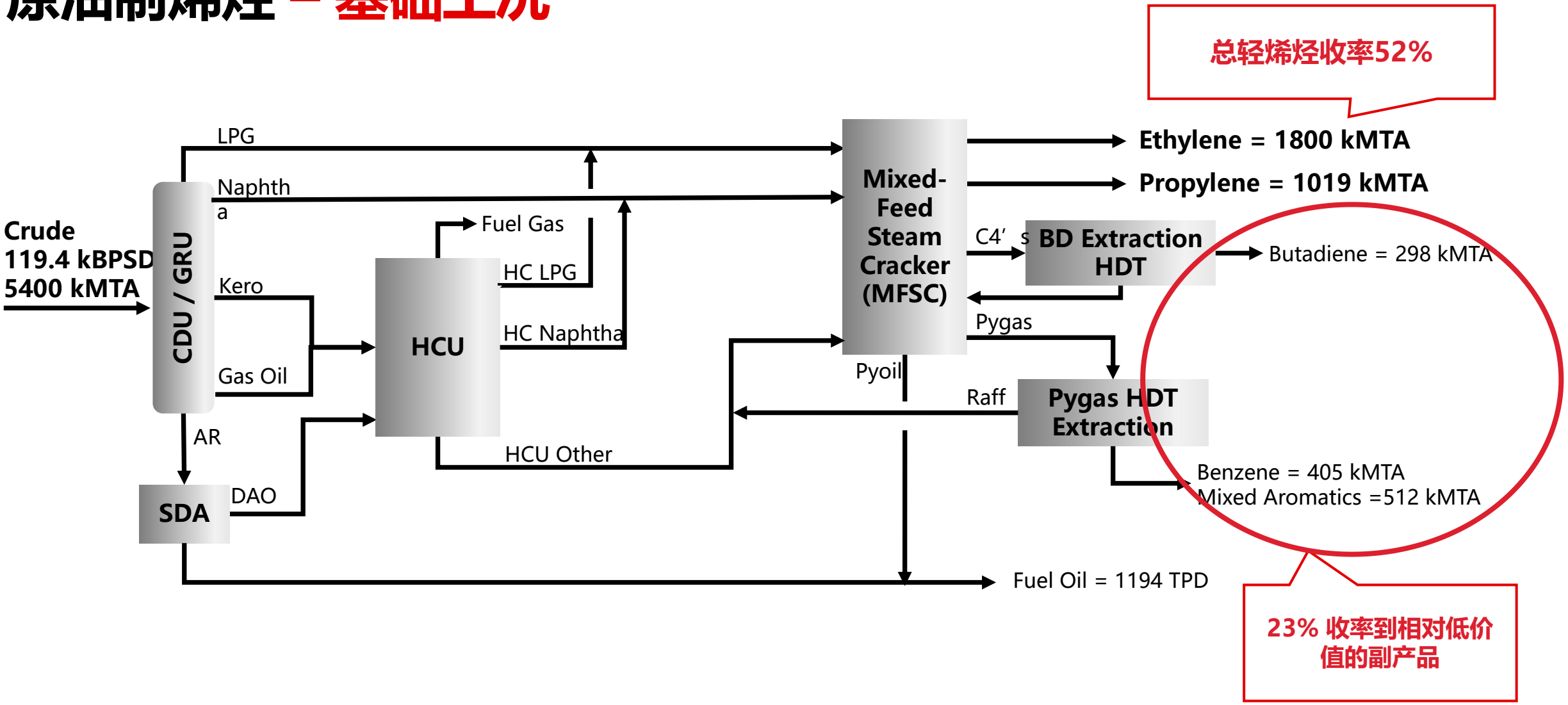
1. Scope 1 and 2 emissions calculated based on net power, fuel gas, steam, cooling water, BFW, and condensate use
2. 5.5 = CO2 ratio for aromatics from pygas: aromatics from reformate = 0.47/0.53 /(0.13/0.8)
3. 1.2 = CO2 ratio for burning cracker methane vs natural gas = (0.47/2205/19000 *1e6+0.058)/0.058 MTCO2/MMBTU

以重整技术生产芳烃是更加可持续的选择

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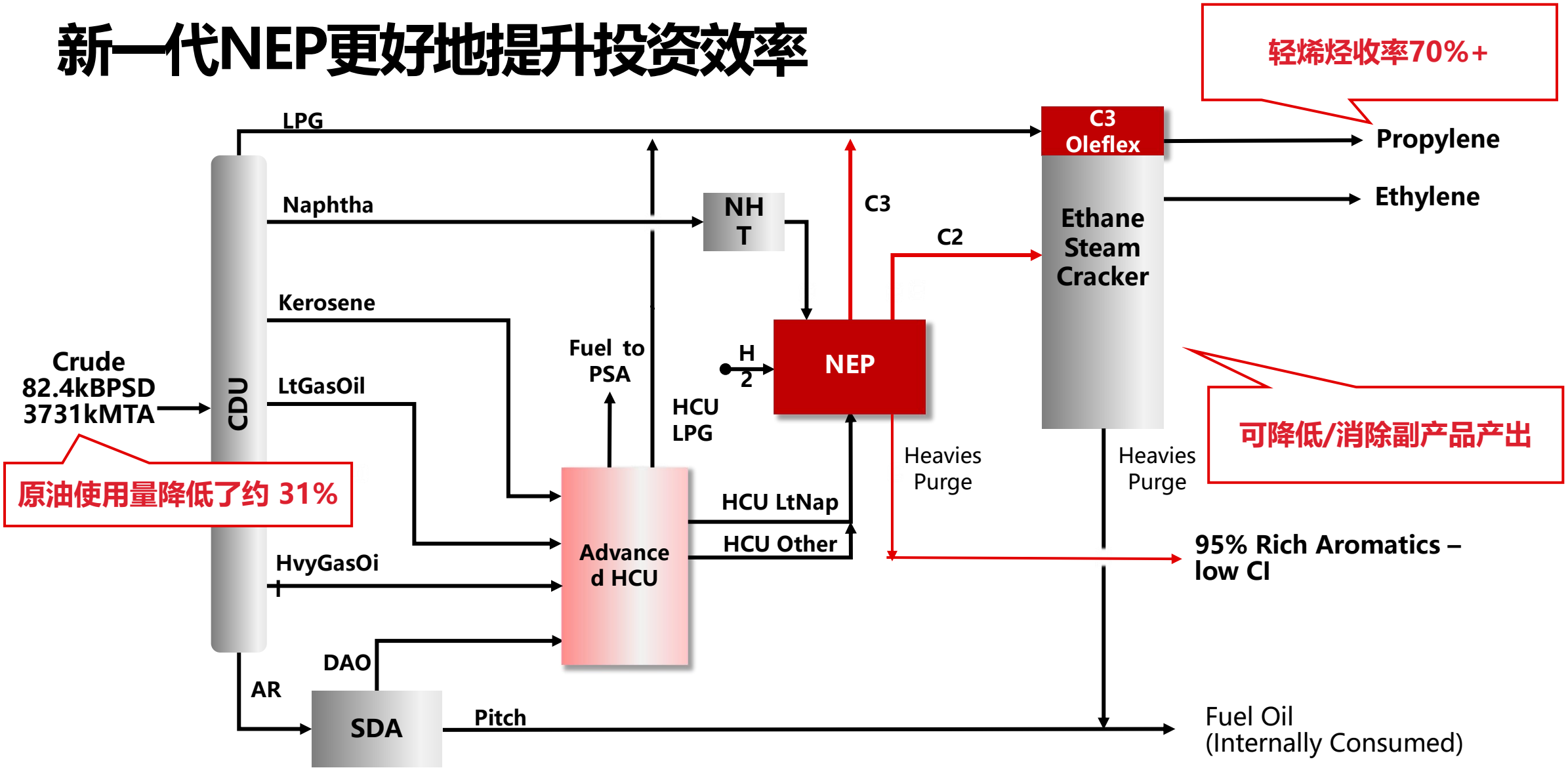
原油制烯烃 – 基础工况



常规的原油制烯烃一体化装置生产大量的副产物

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新一代NEP更好地提升投资效率



NEP流程的轻质烯烃收率更高，所需装置数量更少，且无需成本较高的MFSC

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UOP NEP可持续资质

案例分析 / Case study[1]

	Base Case	NEP Case
Total light olefin (Ethylene + Propylene), TPD 双烯产量	8,054	8,054
Crude rate, kMTA 原油加工量	5400	3731
CO_2 from operations + imported utilities[2,3], TPD 第1和第2类碳排	28,944	27,285
Tonne CO_2 from operations + imported utilities per tonne light olefin[4],	**3.6**	**3.4**
Net export of petrochemicals, % 化工品比例	64	100
Net export of fuel by-products, % 油品比例	36	0
CO_2 from fuel by-products combusted[5], TPD 第3类碳排	19,484	0
Total CO_2[4], TPD 总的碳排量	48,428	27,285
Total CO_2 per total light olefin[4], - 单吨轻烯烃的碳排	**6.0**	**3.4**

1. Based on customer study (ID000030) using UOP standard Linear Programming methods and customer data
2. CO_2 emissions estimated from refinery based on information from Linear Programing with utilities based on imported natural gas
3. Both cases include carbon capture sequestration on steam methane reforming unit
4. From sources listed above in table
5. CO_2 emissions from fuel byproducts estimated from standard combustion calculations

NEP工艺可助力联合装置实现单吨烯烃减碳40%

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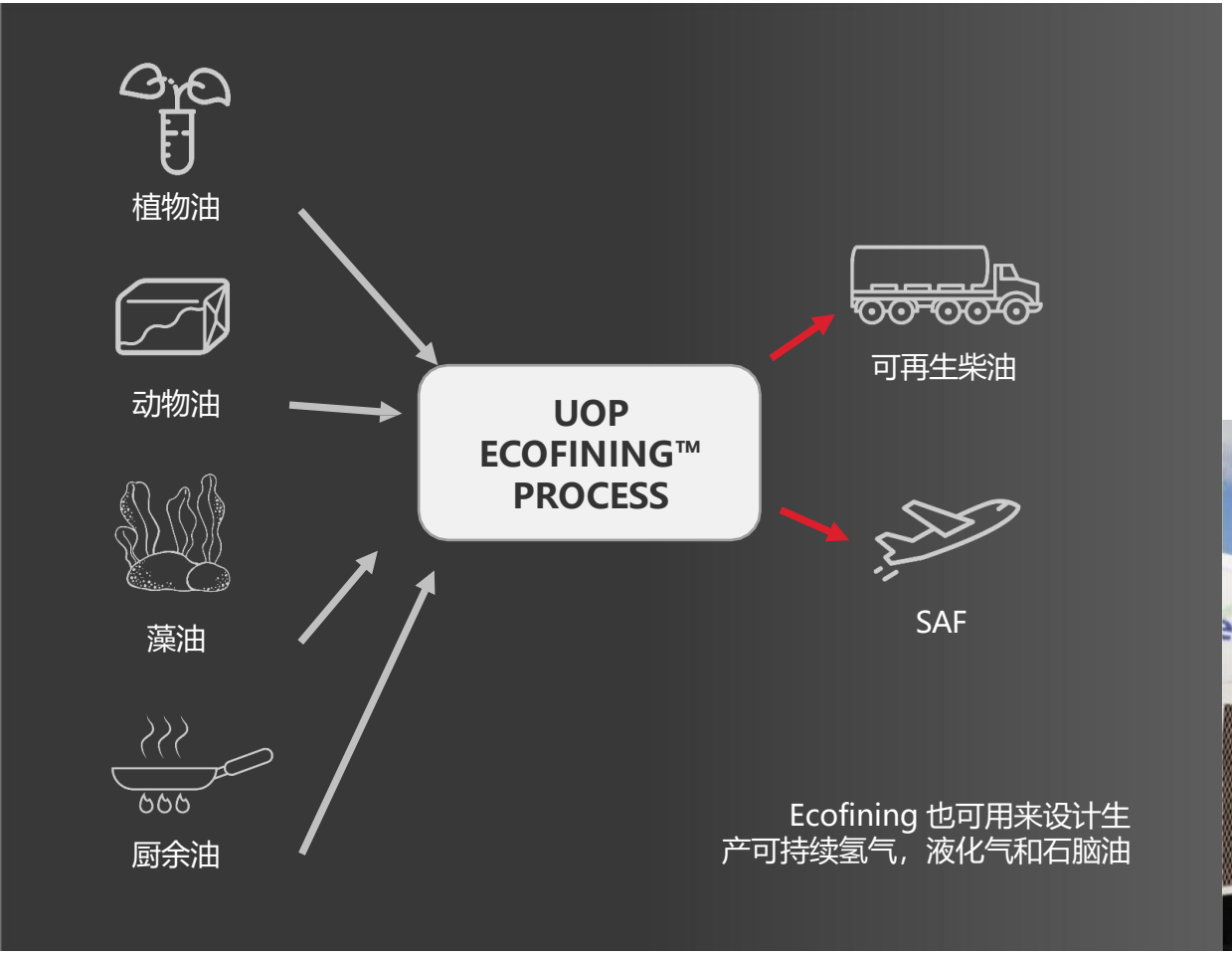
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A TOTAL SOLUTION
FOR LOW CARBON INTENSITY RENEWABLE FUELS

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可持续燃料
霍尼韦尔 UOP Ecofining™ 工艺技术

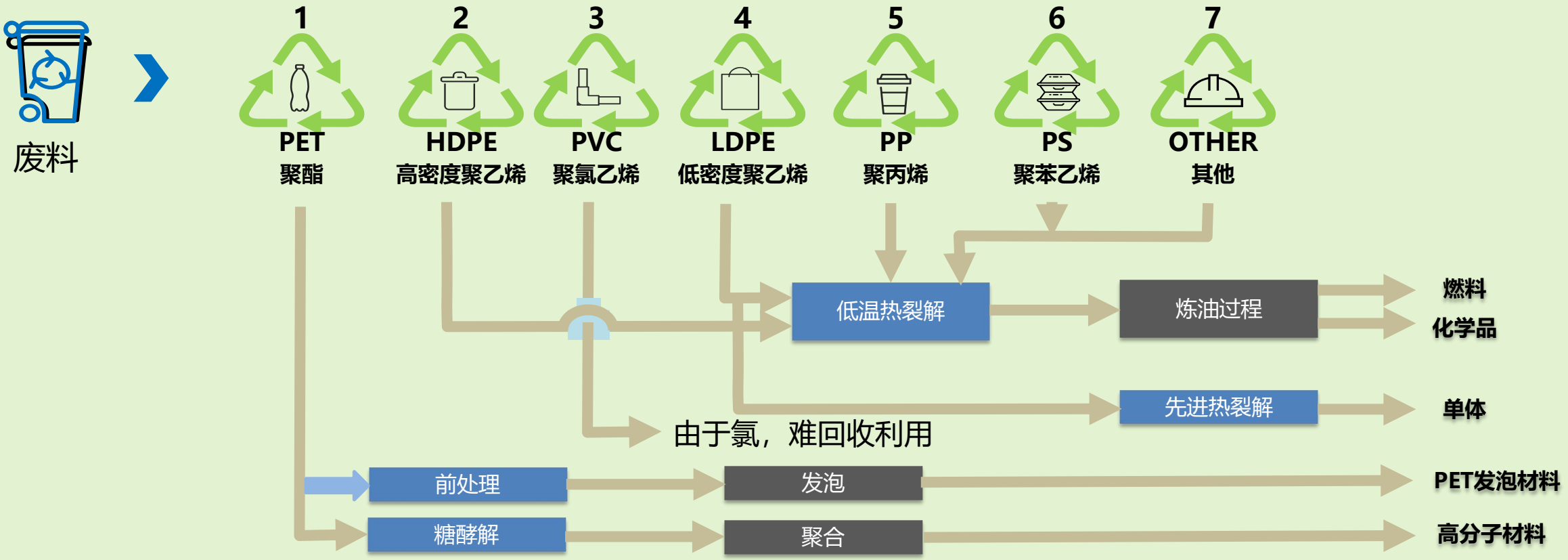


- 霍尼韦尔UOP是可再生燃料领域公认的专利商
  - 领先的可持续燃料经验
  - 超过25年的运行经验
  - 经过商业验证的装置



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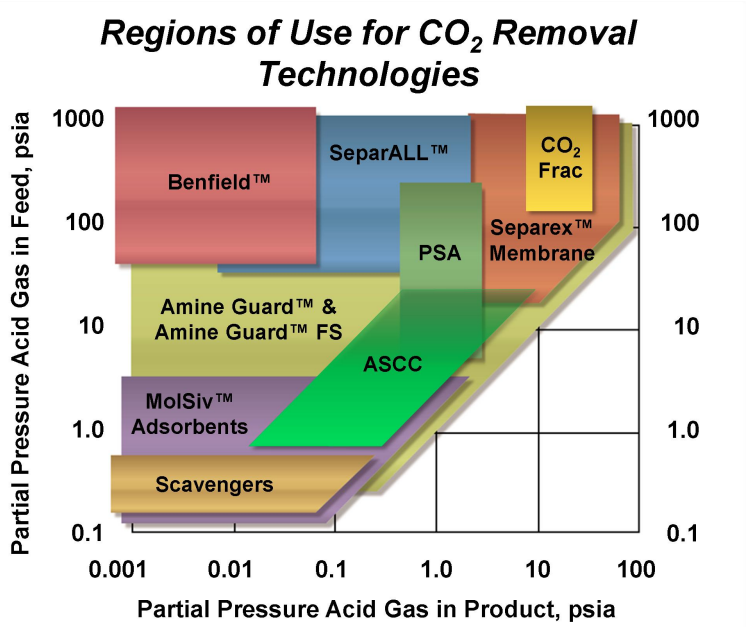
霍尼韦尔 UpCycle™ 先进塑料回收工艺



霍尼韦尔UOP致力于开发塑料循环技术，将全球可回收塑料比例提高到90%

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霍尼韦尔 碳捕集技术总览



化学溶剂法

- **AMINE GUARD™ & AMINE GUARD FS 工艺**
  UOP 是全球最大的高浓度且以MEA为溶剂基础的系统专利商; 配方溶剂与传统的MEA相比能节省操作费用 (> 600 套)
- **BENFIELD™**
  用于加压烟气和工业过程的完全无机溶剂 (> 650 套)
- **ASCC先进溶剂法**
  从炼油、电力、钢铁、水泥和天然气行业的烟气中直接捕获 CO_2 (尤其适用于氧含量高，CO2浓度低，便于采用高压再生减少下游电耗)

物理溶剂法

- **SEPARALL™ 工艺**
  使用 Selexol溶剂（聚乙二醇二甲醚）对含硫来源进行 H_2S/CO_2分离-适用于中国煤造气系统应用， 且在氧化条件下稳定性高 (>50 套)

  Note: 溶剂吸收工艺可以其他技术耦合，如：PSA, 膜分离, 和深冷分离等，以优化CO_2捕集

吸附分离

- **Polybed™ 变压吸附 (PSA) 系统**
  先进的吸附剂和快速循环以捕捉 CO_2(>1100 装置, 3 套用于CO_2捕集)

深冷 & 膜分离

适用于较高CO_2分压下的碳捕集

- **SEPAREX™ 膜分离**
  在海上平台CO_2捕获和封存方面拥有丰富的经验 (>300 套)
- **ORTLOFF CO_2 精馏**
  不仅能捕获而且提供 CO_2 作为高纯度液体产品(2 套)

霍尼韦尔拥有丰富的CO_2捕集技术，能满足不同的应用场景

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CO_2 TO JET

IMAC & LEAP Approach



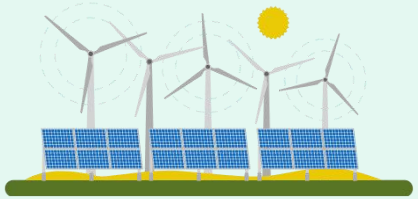
Integrated Operations & Enterprise Data Management

Honeywell FORGE

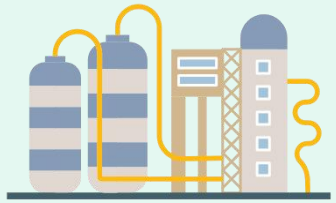
Integrated Industrial Cyber Security



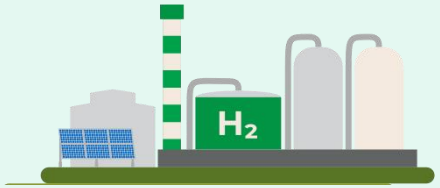
Carbon Capture



Renewable Energy

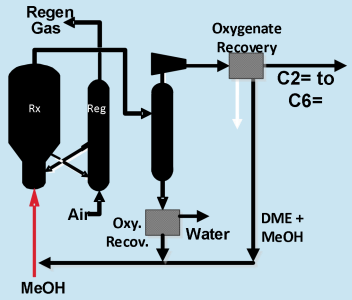


Making Methanol



Green H_2

Making Jet Fuel



Methanol to Olefins (MTO process)

Light olefins



Oligomerization & Hydrogenation

Integrated Safety and Security with Controls



SAF

Equipment Effectiveness

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Advanced Alarm Management

Workforce Competency

Advanced Control

REFORMING ADVANCEMENTS

SCOPE 1&2 DRIVING LOWER EMISSIONS



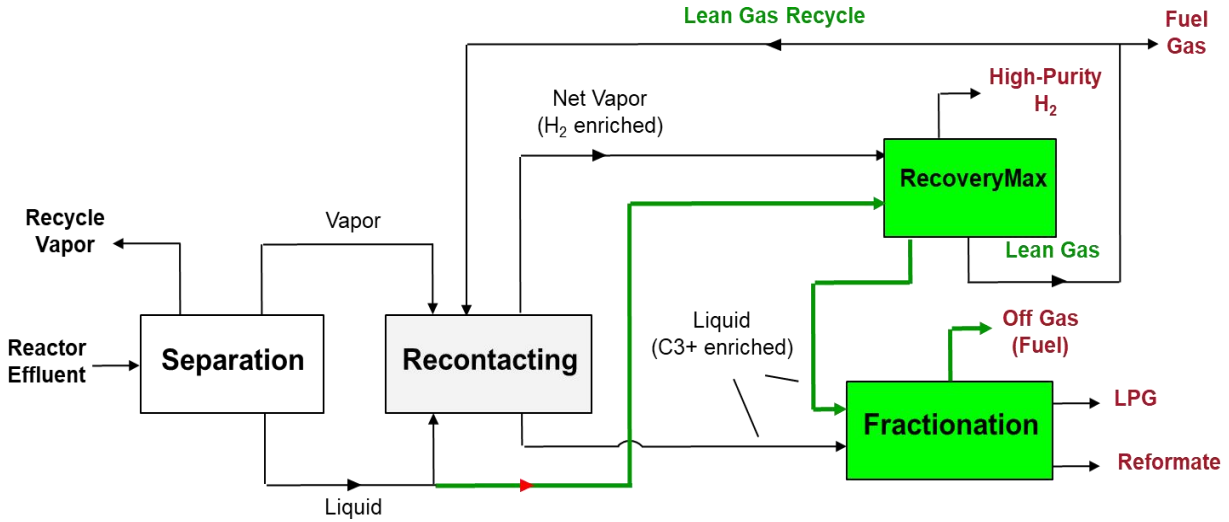
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RecoveryMax™ 适用于炼油和石化

什么是 RecoveryMax?

- 一种节能，低成本的回收系统，用于从铂重整气体中回收高价值的H_2，LPG和重整生成油
- **在炼厂氢气平衡中发挥关键作用**
- 可通过模块化供货用于改造
- 设计经商业验证



它如何帮助您实现目标?

通过优化炼厂氢气与燃料平衡，显著相抵CO2排放→ 最多减排:

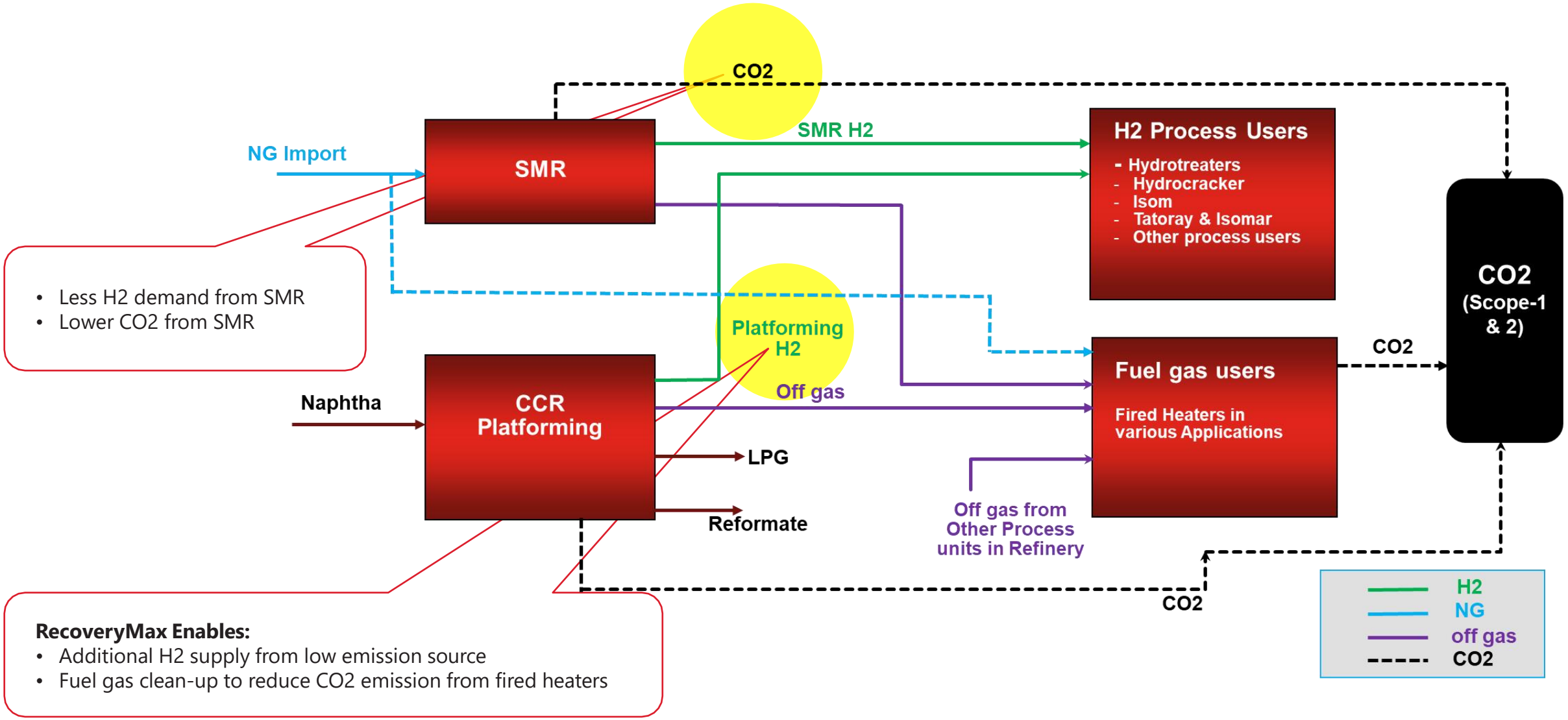
- 通过低 CO_2 足迹的工艺来源增加氢气供应，减少对 SMR 制氢的需求

实现更高的经济汇报→ ~40kbpsd 典型重整NPV约提升$37M

- 铂重整净气体中的 H_2 回收率提高（H_2 回收率由 88% 提高到 98+%）
- LPG 回收率提高（LPG 回收率由约 60% 提高到约 90%），重整生成油回收率接近 100%

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RECOVERYMAX™ REFINERY H2 AND FUEL GAS



- Less H2 demand from SMR
- Lower CO2 from SMR

RecoveryMax Enables:
- Additional H2 supply from low emission source
- Fuel gas clean-up to reduce CO2 emission from fired heaters

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RECOVERYMAX 在提升盈利能力的同时降低范围 1 和 2 排放

Parameters		Conventional Recovery Scheme	RecoveryMax Flowscheme
Hydrogen	kMTA	57	64 ↑ (+12%)
LPG	kMTA	39	65 ↑ (+60%)
Reformate	kMTA	1492	1494 ↑ (+0.13%)
Off-gas	kMTA	76	41 ↓ (-46%)
EEC	$MM	Base	+9
Utility	$MM/yr	Base	+0.7
NPV from Process improvements	**$MM**	**Base**	**+36.7** ↑
CO2 emission (Scope-1 & 2)	kMTA	Base	(85) ↑
CO2 credit	**$MM/yr**	**Base**	**+4.2**
NPV including CO2 credit	**$MM**	**Base**	**+68.6**

Notes / Assumptions:
1: 40,000 bpsd Platforming unit with 104RON
2: CO2 reduction credit $50/MT.
3: 8400 hours operation per year.
4. Conventional Recovery case includes once-through PSA

Utility Price basis:
1: Fuel gas: $4/MMBtu. 2: H2 price: $1100/mt. 3: Electricity: $0.08/KWh.

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WE
BELIEVE
The technologies needed for the decarbonization and transforming are not new – they're built on the foundation of proven technologies applied in new ways.
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THANK YOU

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