

PLATFORMING TECHNOLOGY **ENABLING THE HYDROGEN ECONOMY TODAY** **AND TOMORROW**



VALENTINA DI MAURO

7 March 2024

Honeywell
UOP

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OPPORTUNITIES



Tomorrow- Clean Hydrogen Economy

Leverage existing reforming assets with Honeywell LOHC solution

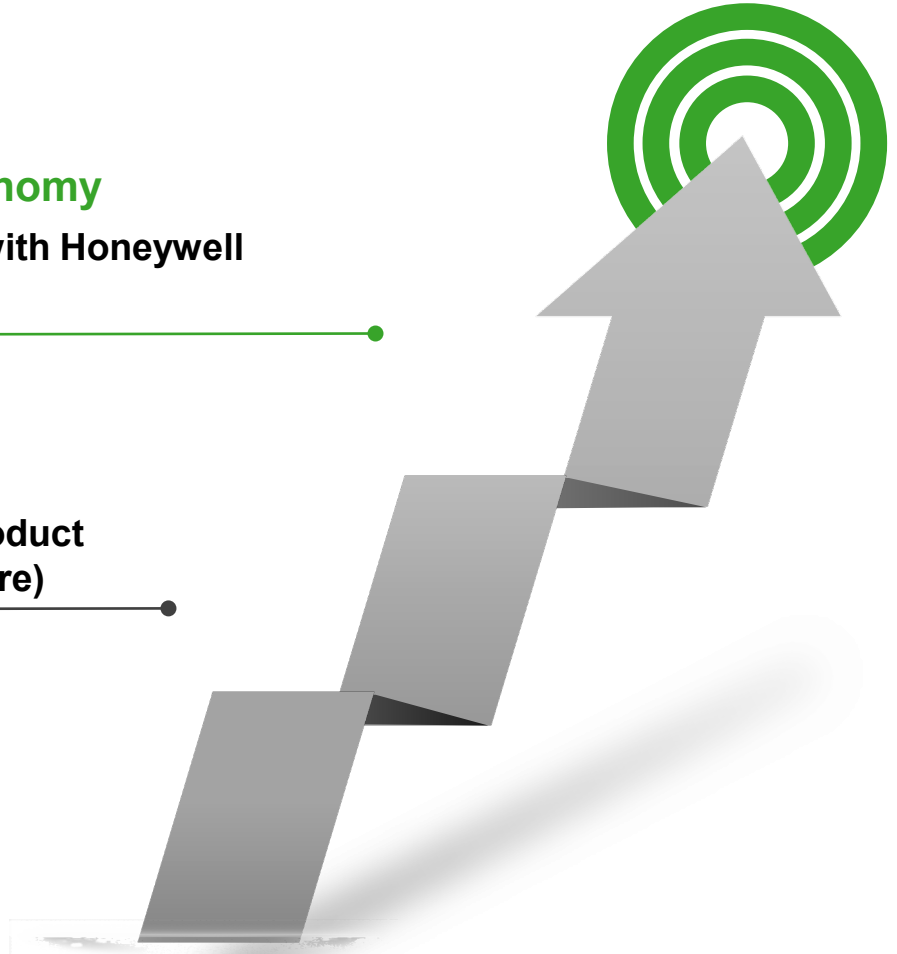


Today- CO₂ footprint reduction

- Emissions reduction as key strategic decision
- Combination of approaches (feedstock and product pivots, technology upgrades and carbon capture)



100+ UOP Platforming units in North America



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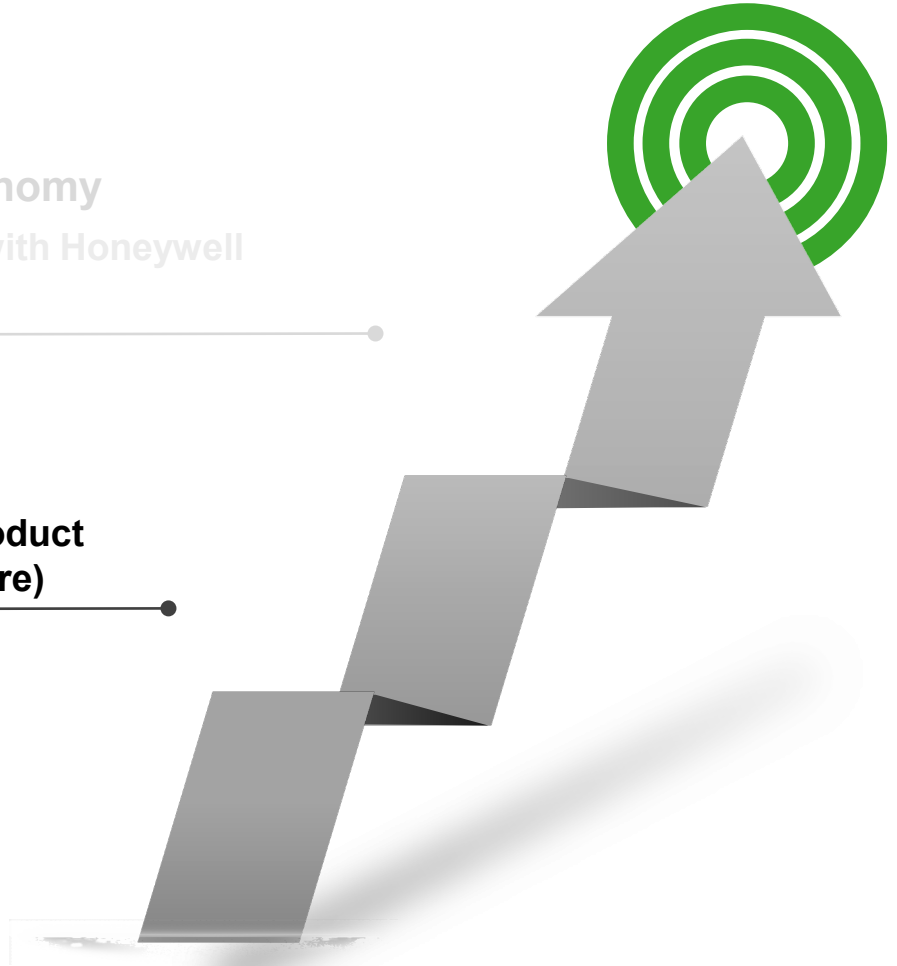


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JOURNEY FOR REDUCING CO₂ FOOTPRINT

What you should be focused on / looking at now –

Establish base CO₂ footprint & benchmark to identify gaps, then...

ENERGY EFFICIENCY NO/LOW-COST¹

- Reduce slops reprocessing
- Reduce/eliminate flaring
- Avoid over-refluxing columns
- Minimize recycles
- Steam trap maintenance
- Fired heater excess O₂ minimization
- Assess turndown protocols to avoid energy throwaway
- Lower (e.g., lighter / sweeter) CO₂ intensity crudes

ENERGY EFFICIENCY LOW-COST²

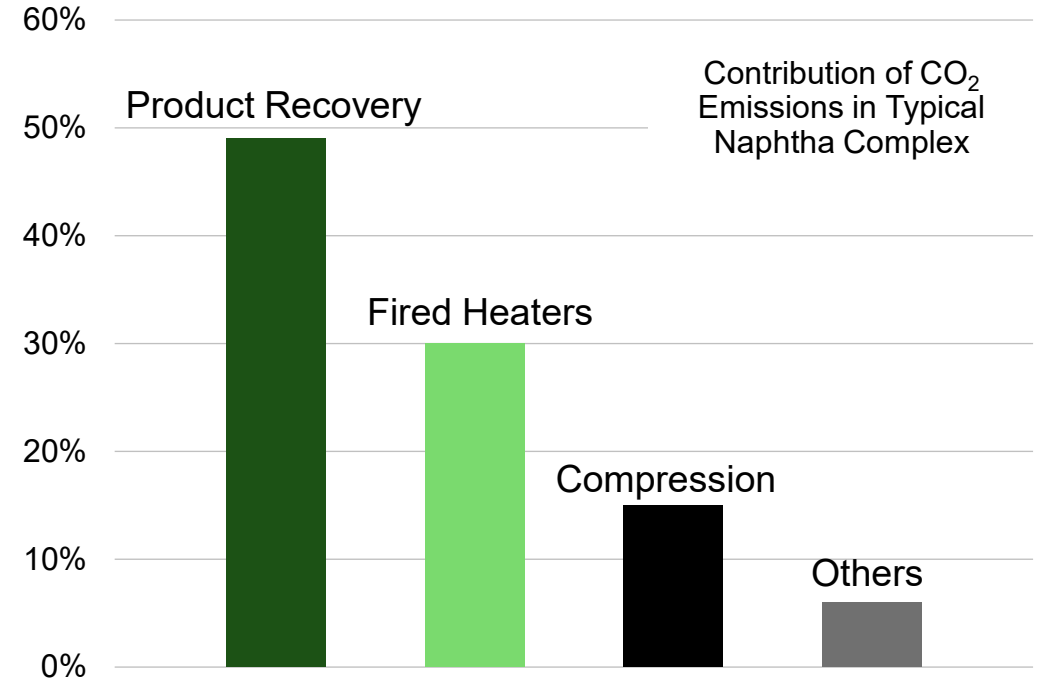
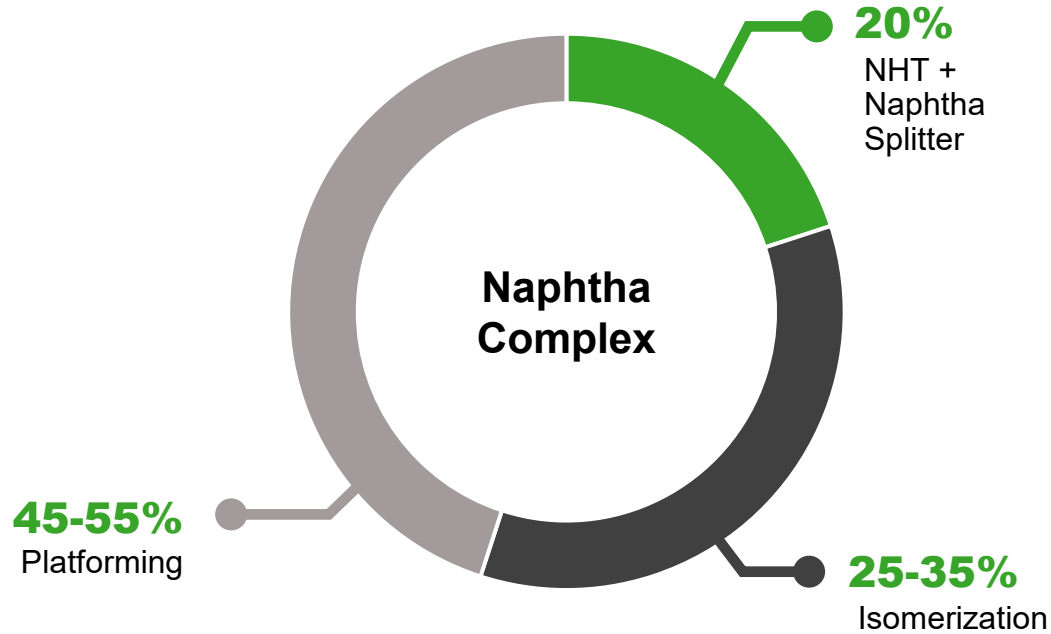
- Higher activity catalysts
- Column upgrades (trays and packing) to improve separation efficiencies
- Tube inserts to achieve better approach and/or manage fouling
- Impeller/control valve sizing to optimize pump efficiencies
- Improved compressor anti-surge control system

ENERGY EFFICIENCY MODERATE/HIGH COST³

- Heat exchanger network additions/spares for cleaning
- Hydrogen network optimization
- Electrification
- Fugitive emissions monitoring and mitigation
- Replace exchangers w/ higher efficiency plate and frame or other
- VFD Motor upgrades
- Cogen - CCGT

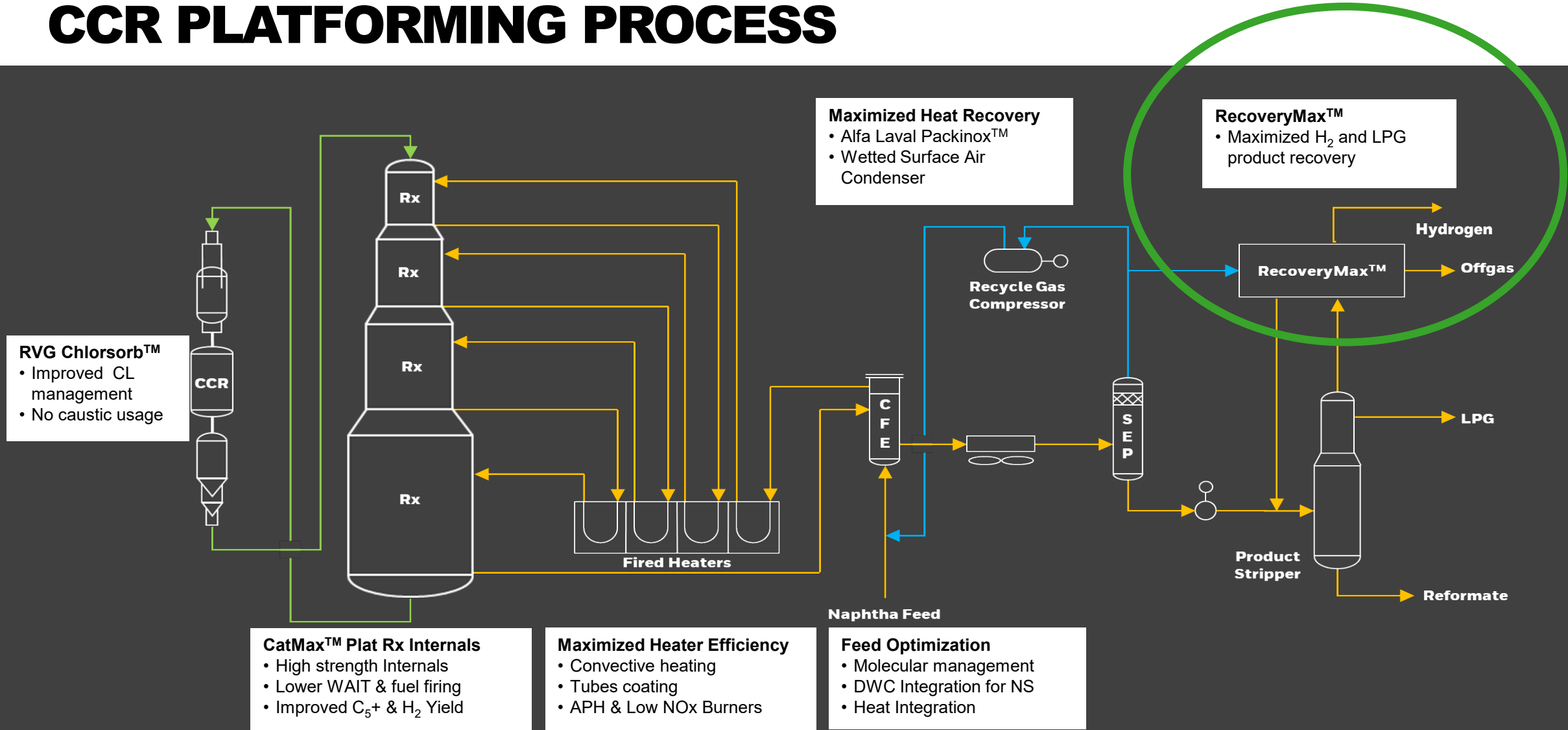
Leverage internal resources, local engineering firms & technology licensors

NAPHTHA COMPLEX CO₂ EMISSIONS



Product recovery, fired heaters and compression are key contributors for CO₂ emissions

CCR PLATFORMING PROCESS



RECOVERYMAX

WHAT IS RECOVERYMAX?

- An energy efficient system to recover high value products from Platforming gases
- **Plays pivotal role for refinery H₂ balance**
- Modular supply revamp option (integrated or independent)
- 12 references, 2 of those delivered as a Modular solution

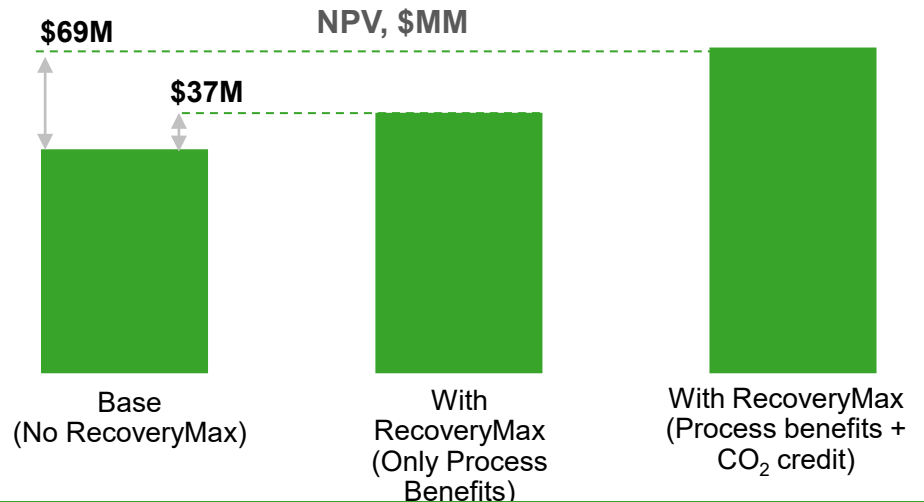
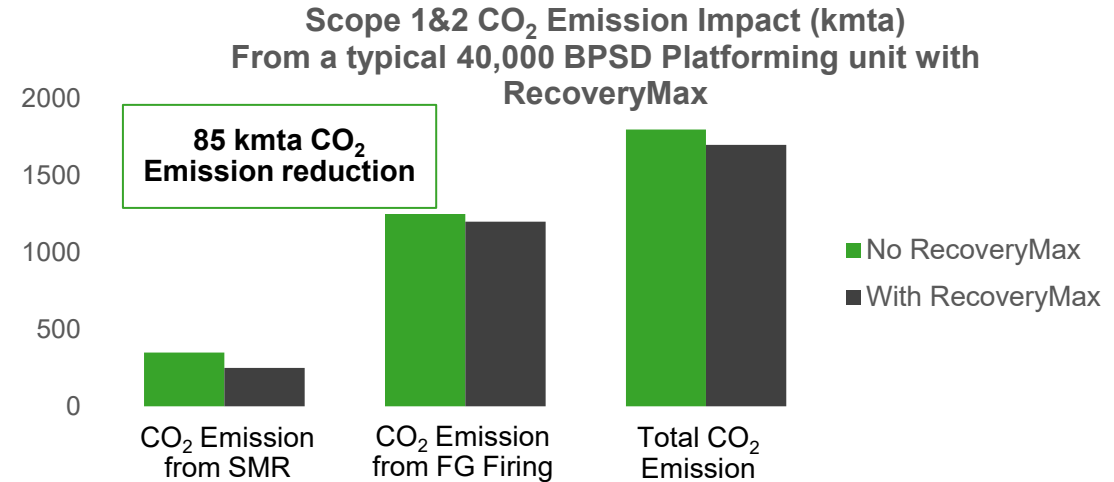
ECONOMIC AND EMISSION REDUCTION VALUE

Enables higher economic return

- ~10% higher H₂ recovery
- ~30% higher LPG recovery
- ~0.5% higher reformate production

A cost-effective choice for CO₂ emission reduction¹

- Improve H₂ supply from low-emission source and reduce need of SMR H₂
- Improve refinery fuel gas quality by enhanced C₃/C₄ recovery

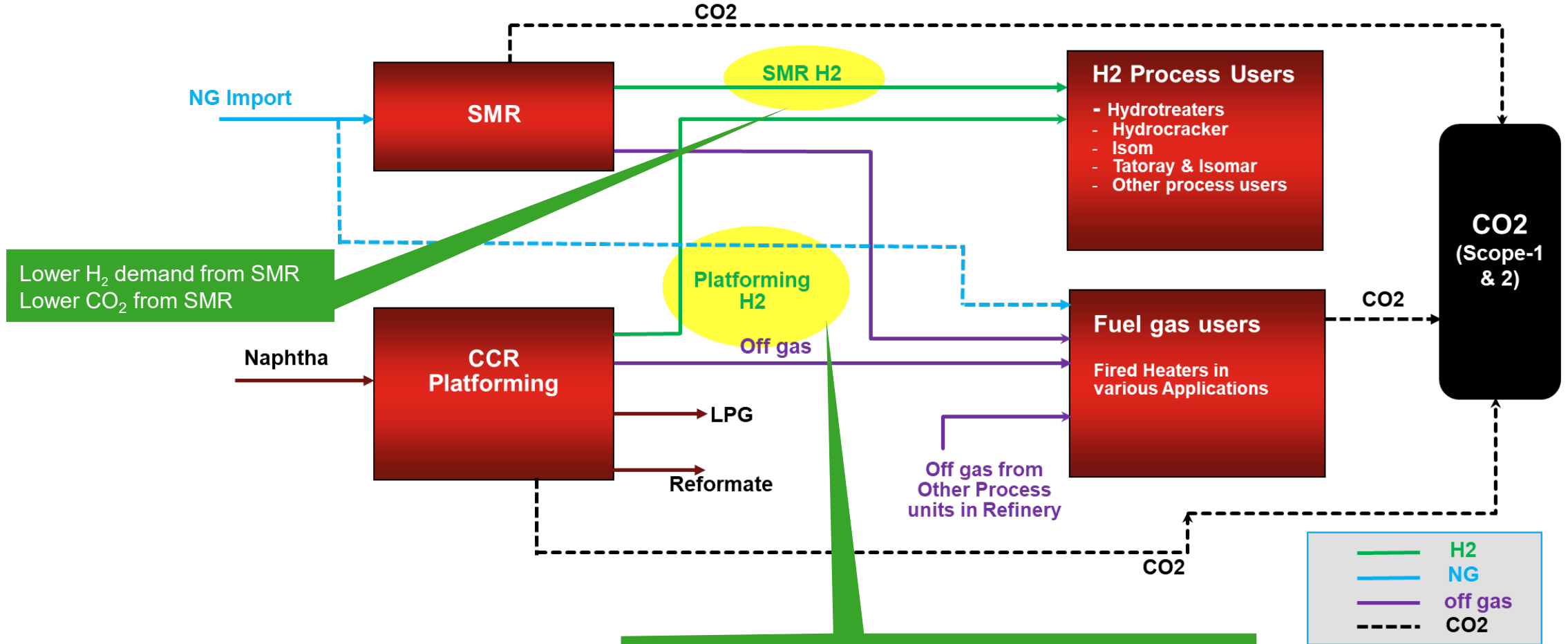


RecoveryMax Reduces Scope 1 & 2 Emissions while improving profitability

Notes:
¹ Scope 1 & Scope 2 CO₂ emission. Assumed \$50/mt CO₂ credit
² For NPV assessment standard SEA price set is considered
³ 85kmta CO₂ reduction is based on UOP internal calculation for a typical refinery H₂ and fuel gas balance where SMR is being fed by NG and is a primary H₂ source to meet refinery process requirements

RECOVERYMAX - HOW DOES IT WORK?

Refinery H₂ and Fuel Gas Balance



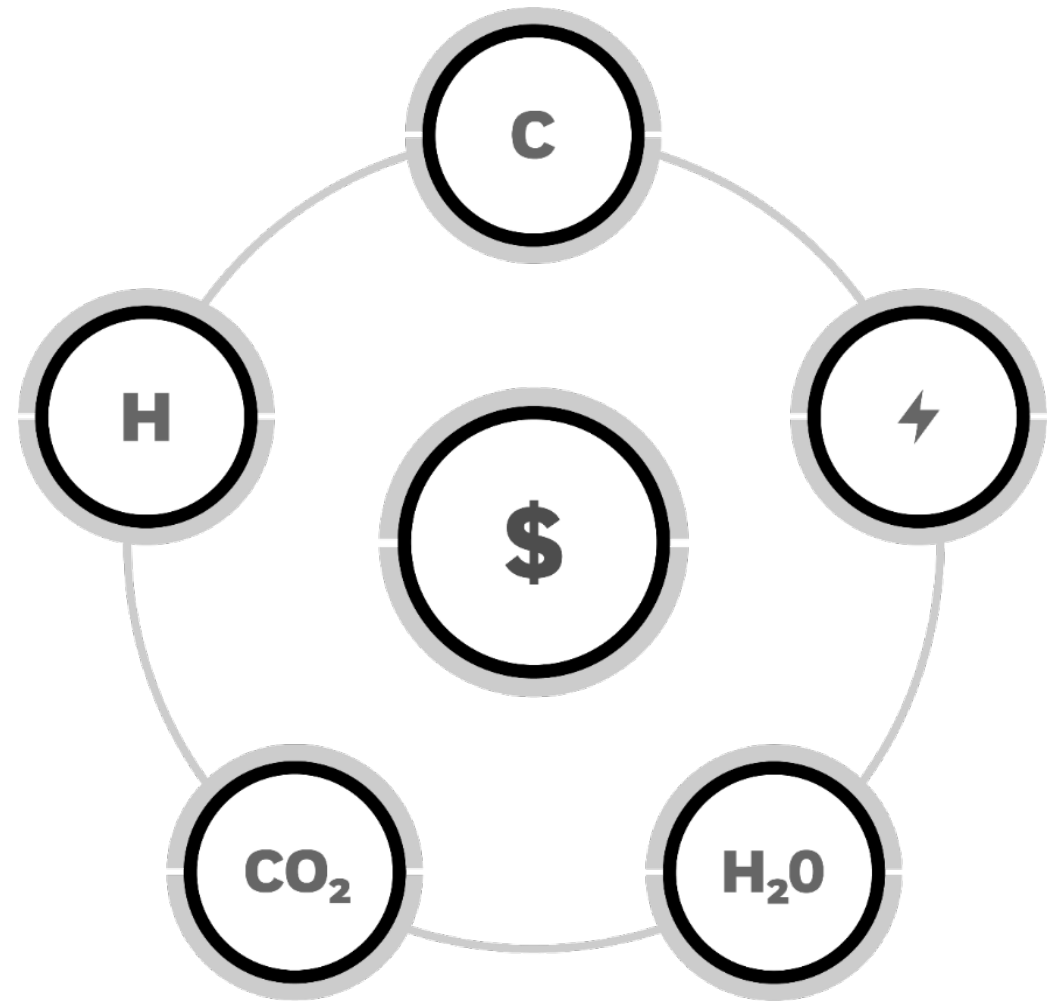
RecoveryMax Enables:

- Additional H₂ supply from low emission source
- Off gas clean-up to reduce CO₂ emission from fired heaters

UOP E6 – NPV SUMMARY

RECOVERY MAX

- C
\$7 MM additional product value from LPG and Reformate
- H
\$43 MM additional production of hydrogen
- ⚡
(\$5) MM additional power consumption and utility
- CO₂
\$32 MM NPV from CO₂ avoidance at \$50/mt (~85 kmta)
- H₂O
\$0.0 MM no shift in water usage
- \$
\$69 MM total NPV improvement (includes initial capital investment)



Not recovering products in your off-gas is equivalent to burning \$13 MM/y!

WHY A MODULAR SOLUTION FOR RECOVERY MAX?

REDUCED RISK

- UOP Fixed Price & Schedule
- Superior quality via shop fabrication & UOP inspection
- Effective labor
- Avoid cost overruns and change orders
- On-time start-up

SHORTER SCHEDULE

- UOP basic/ detailed design, fabrication, & site services
- Parallel path design, procurement, fabrication & site
- Extensive UOP Modular and PSA experience

SMOOTHER EXECUTION

- One-stop shop
- Fewer disruptions to operations
- Less site construction & congestion
- Improved safety and security
- Less waste & material loss

UOP offers independent RecoveryMax Modular option that does not require revamp of existing unit

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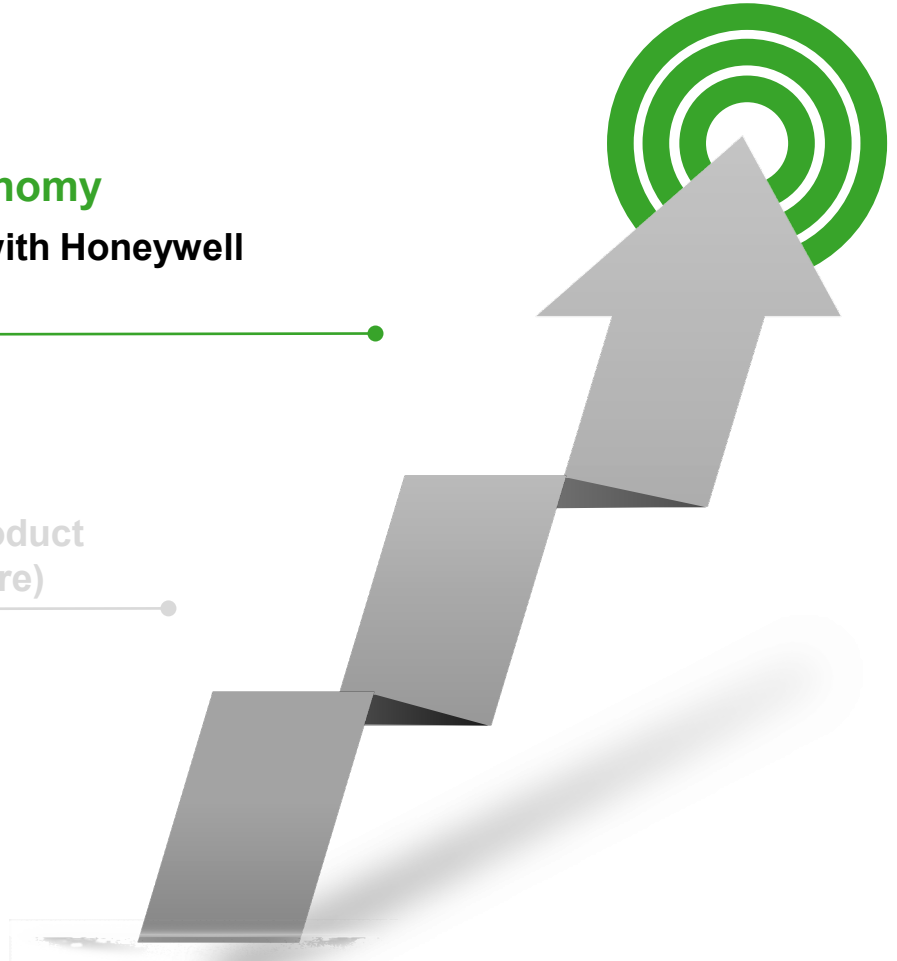


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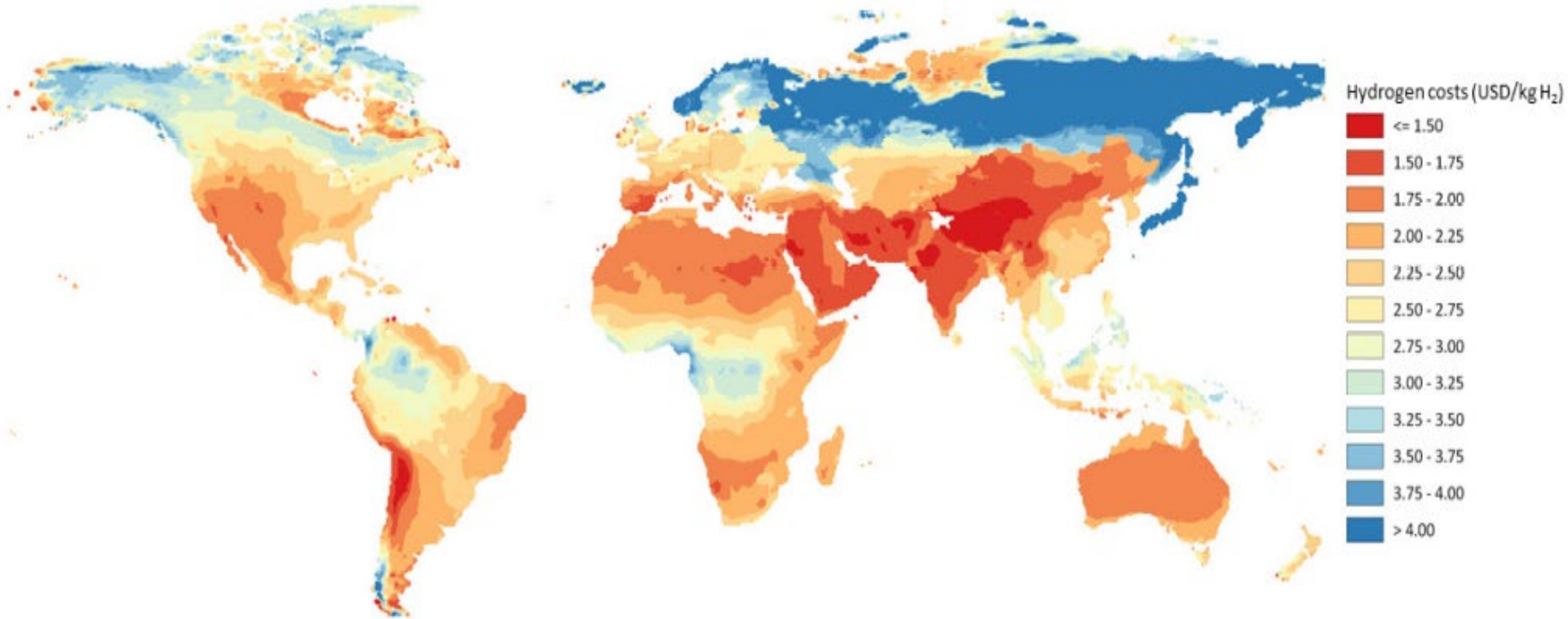
100+ UOP Platforming units in North America



GREEN HYDROGEN

GENERATION COST

Hydrogen production cost from hybrid solar PV and wind systems in 2030



Long Distance H₂ transport Drivers:

- Supply and demand gap between the regions
- Difference in cost of production of H₂ due to limitations in renewable resources

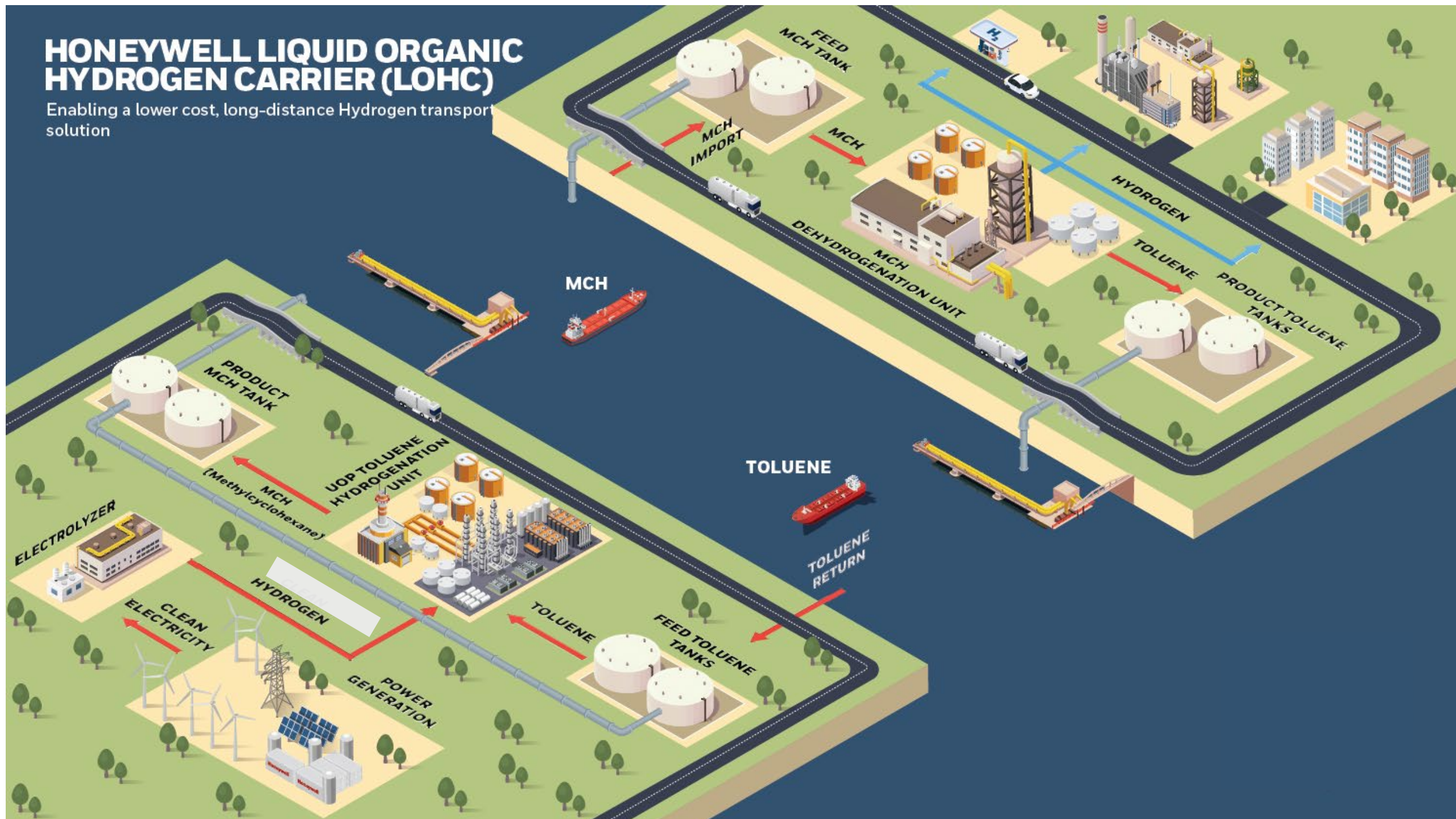
Notes: This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area. For each location, production were derived by optimizing the mix of solar PV, onshore wind and electrolyser capacities, resulting in the lowest costs and including the option to curtail electricity generation.

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Sources: Based on hourly wind data from [Copernicus Climate Change Services](#) and hourly solar data from [Renewables.ninja](#).

HONEYWELL LIQUID ORGANIC HYDROGEN CARRIER (LOHC)

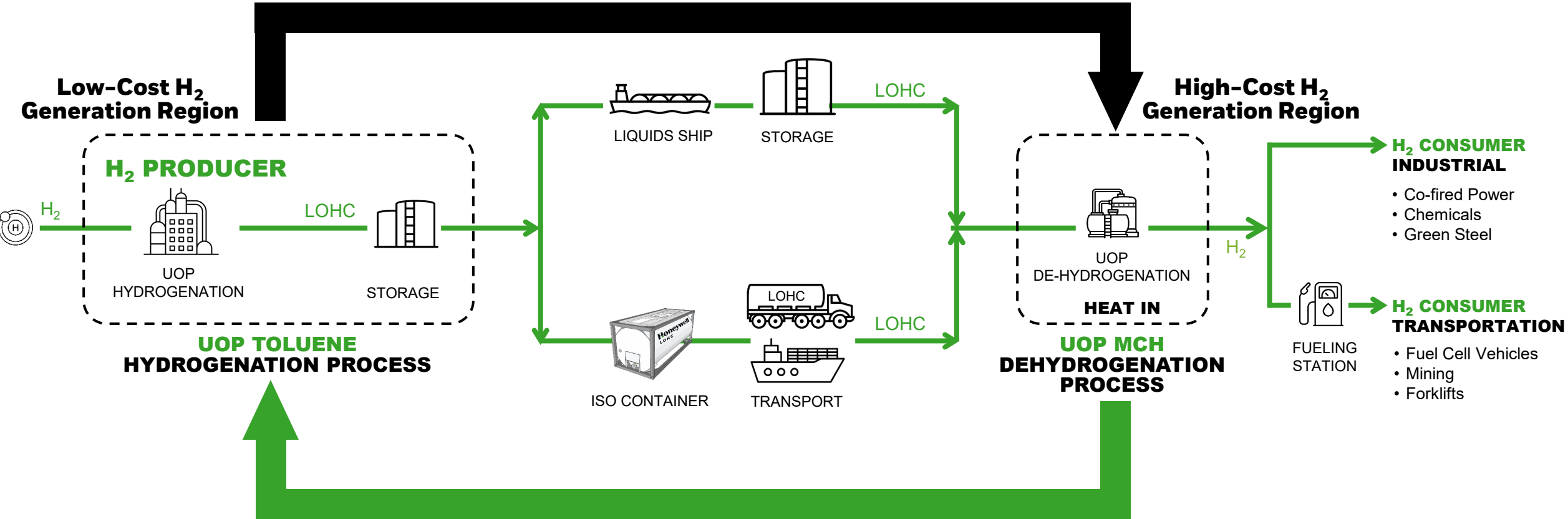
Enabling a lower cost, long-distance Hydrogen transport solution



HONEYWELL LOHC SOLUTIONS

COMMERCIALLY PROVEN TECHNOLOGY AND CATALYTIC SOLUTION

MCH



UOP HYDROGENATION
 45+ commercial reference units on similar technology for Benzene/Aromatics processing

TOLUENE

UOP DE-HYDROGENATION
 1000+ commercial reference units on similar technology for Heavy Naphtha processing

THANK YOU