Use and Optimization of Hydrogen at Oil Refineries

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Definitions & cautionary note

Reserves: Our use of the term "reserves" in this presentation means SEC proved oil and gas reserves.
Resources: Our use of the term "resources" in this presentation includes quantities of oil and gas not yet classified as SEC proved oil and gas reserves. Resources are consistent with the Society of Petroleum Engineers (SPE) 2P + 2C definitions.
Discovered and prospective resources: Our use of the term "discovered and prospective resources" are consistent with SPE 2P + 2C + 2U definitions.
Organic: Our use of the term Organic includes SEC proved oil and gas reserves excluding changes resulting from acquisitions, divestments and year-average pricing impact.
Shales: Our use of the term 'shales' refers to tight, shale and coal bed methane oil and gas acreage.
Underlying operating cost is defined as operating cost less identified items. A reconciliation can be found in the quarterly results announcement.

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Agenda

Refinery Configurations and H_2 Demand

H_2 Sources

H_2 System Management

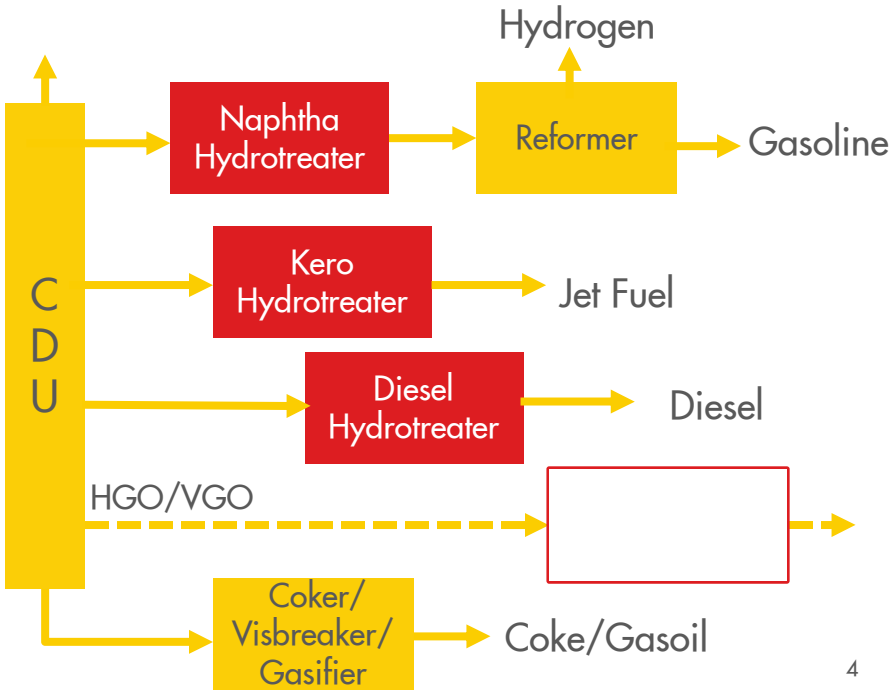
Steam Methane Reformer as the Industry Standard

H2@Scale – Framing the Opportunity

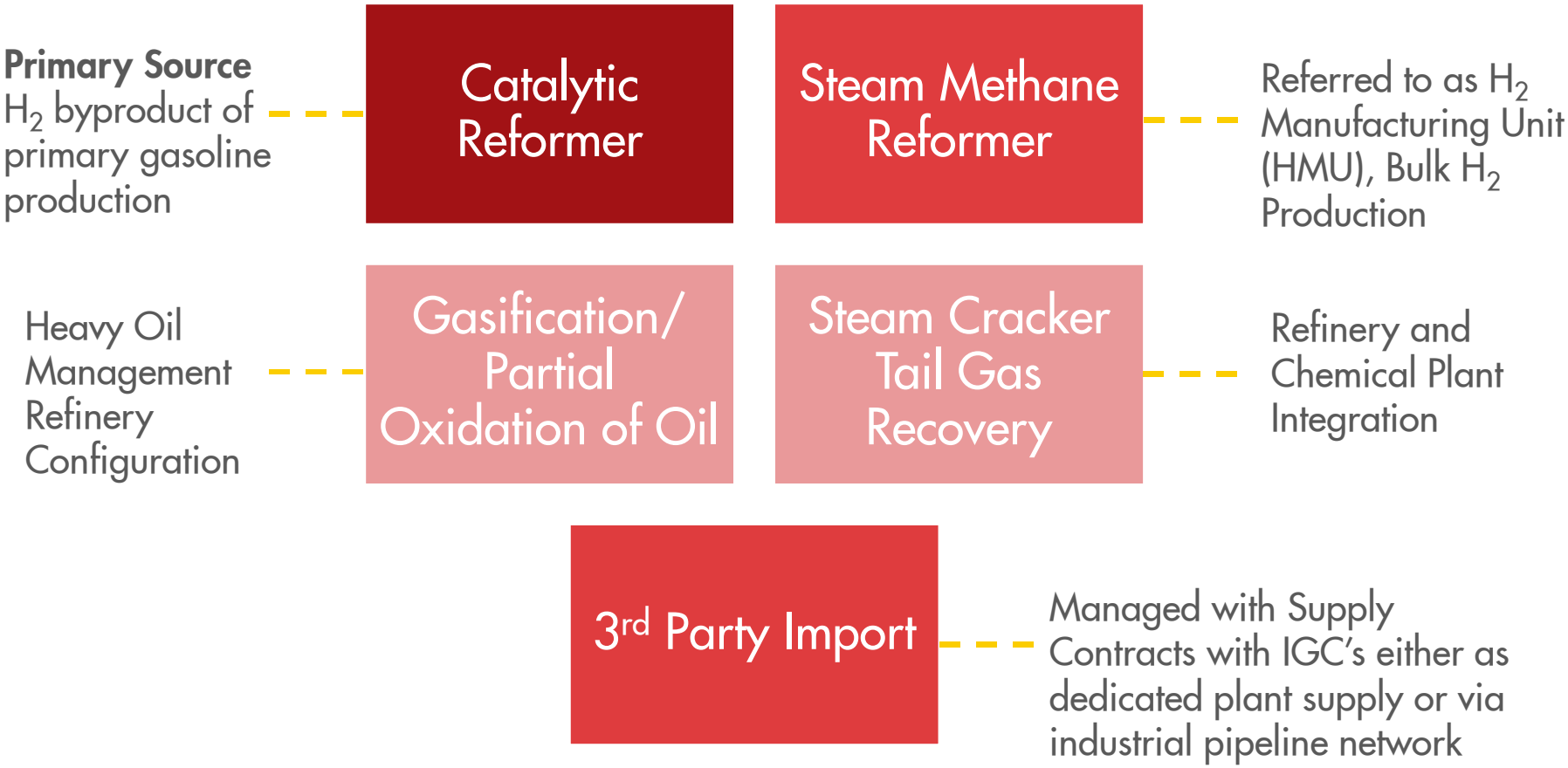
Refinery Technology Development Goals

Refinery Configurations Dictate H_2 Demand

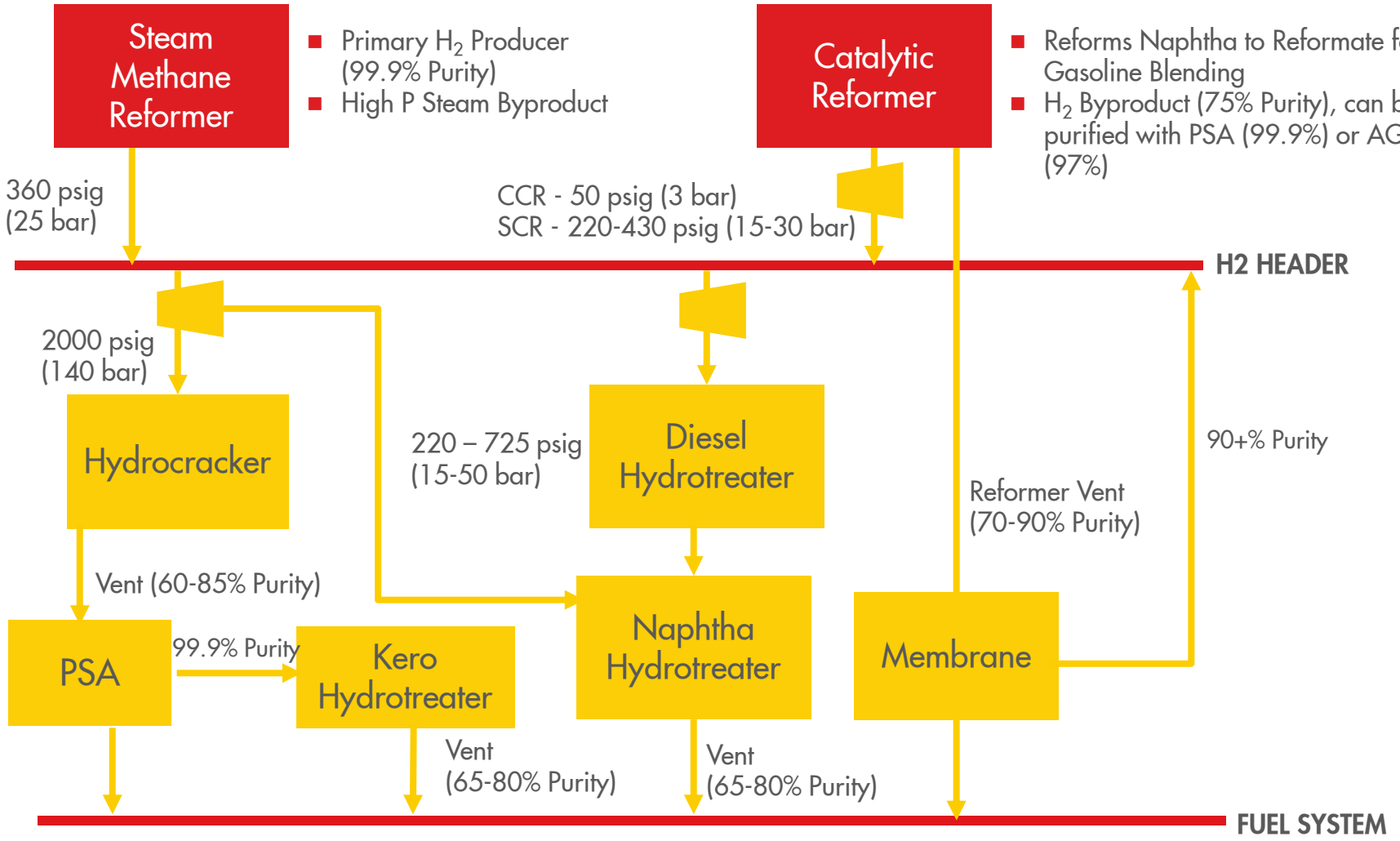
- Simple → Complex Refineries
  - Existing infrastructure investment and modifications are site specific
- Role of Hydrogen – Hydroprocessing
  - Hydrotreating - to remove impurities (sulfur), hydrogenate aromatics and olefins
  - Hydrocracking – Break larger molecules into smaller, higher value molecules
- Hydrogen demand
  - Depends on configuration and feedstock quality (sulfur content)



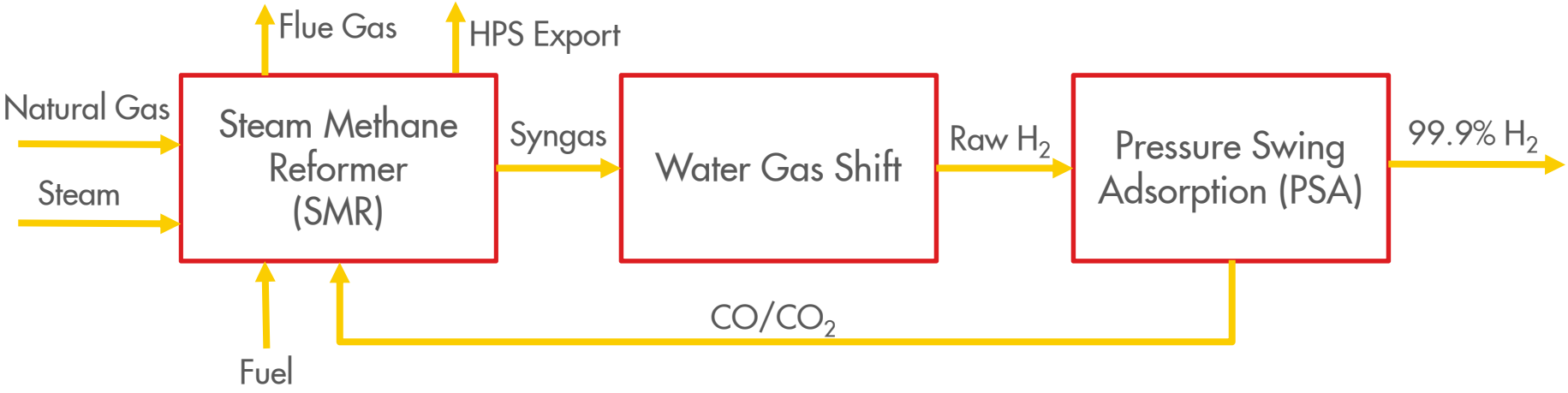
Utilize Internal H_2 Production, then Import



Hydrogen System Management - Optimization



Steam Methane Reforming – The Industry Standard



Low Cost
- High efficiency, turn-key installation

High Purity
- Integrated PSA Technology offers very high purity

Steam Export
- High pressure steam export for integration with refinery

Reliability
- Steady operation, 3rd party supply network

Framing the Opportunity

H2@Scale Opportunity
Replace SMR based H_2 volumes at refineries. This can potentially include H_2 firing of assets.

Competitiveness
Understanding green hydrogen technology competitiveness and timing with SMR + CCS.

Timing for Investment
Market headed towards tighter sulfur specifications, resulting in increased hydrogen demand. Replacing an aging infrastructure

The Near Term CO_2 Challenge
Driving towards decarbonisation within existing infrastructure through targeting energy efficiency, pre-combustion, and post-combustion capture opportunities.

Collaboration
Partnering with H_2 suppliers to optimize cost for refineries helping maintain refinery margins.

Refinery Technology Development Goals

What does a mature hydrogen economy look like for the refinery?

- Manage H_2 purity and cost within the system
  - (Refinery vs. Mobility vs. Other end use)
- Maintain scale, integration, reliability and purity based on SMR standard
- Maximize potential new, integration opportunities i.e. electricity, steam, etc.

Questions and Answers