Henry Liu
Honeywell UOP China VP & GM

REFINERY OF THE FUTURE

TO LEAD GLOBAL MARKET TRANSITION

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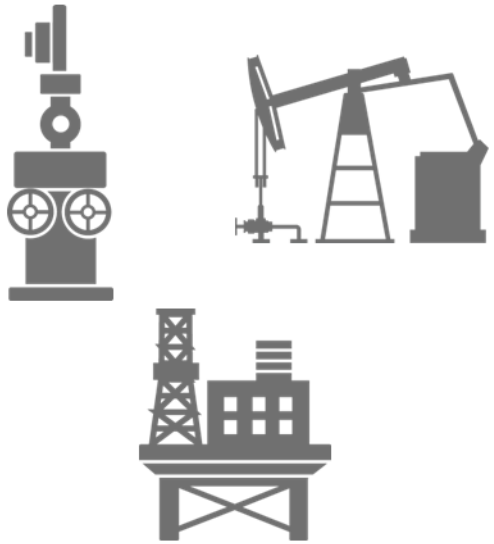
Honeywell UOP Positioning in Energy Supply Chain

Upstream

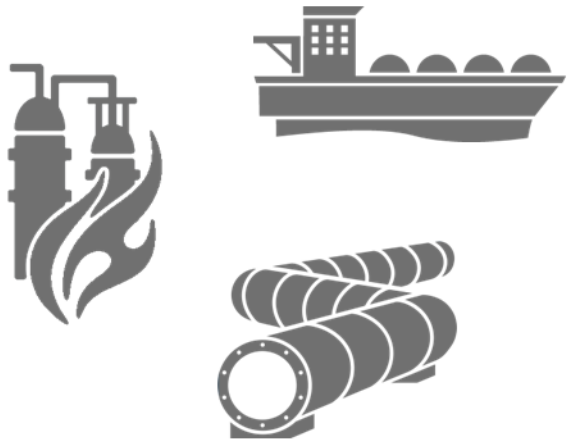
Exploring, drilling and producing crude oil and natural gas



Technology and Materials for Wellhead Treating and Sulfur and Liquids Recovery

Midstream

Processing, storage and transportation



Technology and Materials for Natural Gas Processing and Production of Petrochemical Feeds

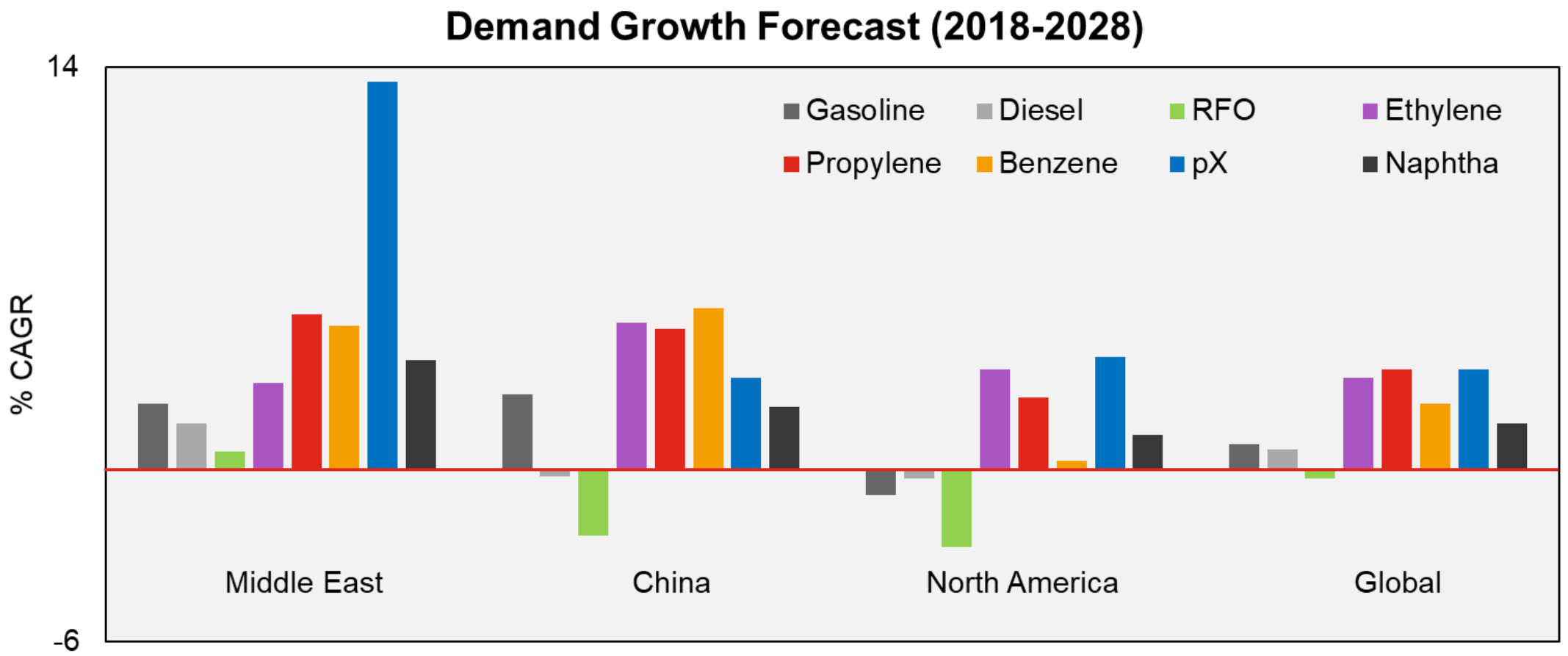
Downstream

Refining oil, gas, and biomass into fuels and chemicals

Process Technology, Equipment, Materials, Services and Connected Plant

31 out of **36** refining technologies in use today were developed by **UOP**

Global Product Demand Shifting from Fuels to Petrochemicals



Source: IHS Markit

Opportunities globally to shift from fuels to petrochemicals

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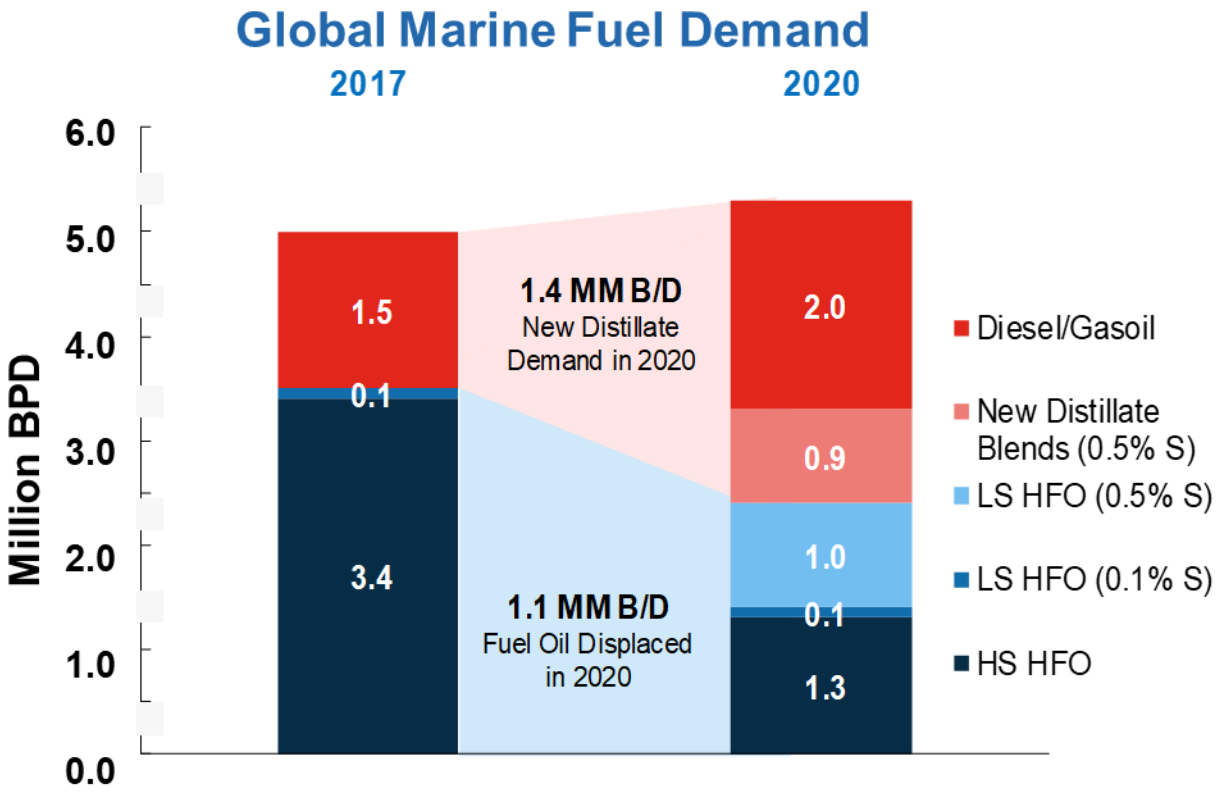
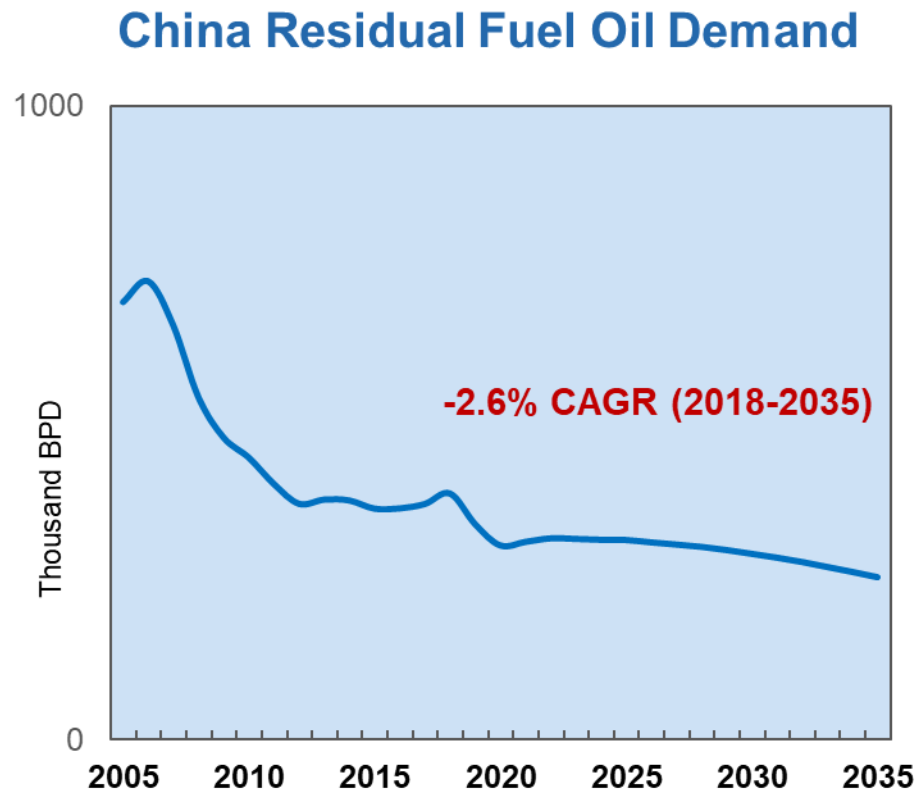
Declining Fuel Oil Demand Drives Interest in Bottom-of-Barrel Conversion





Source: IHS Markit

Fuels Oil Demand to Decline; Upgrade to Diesel or petrochemical?

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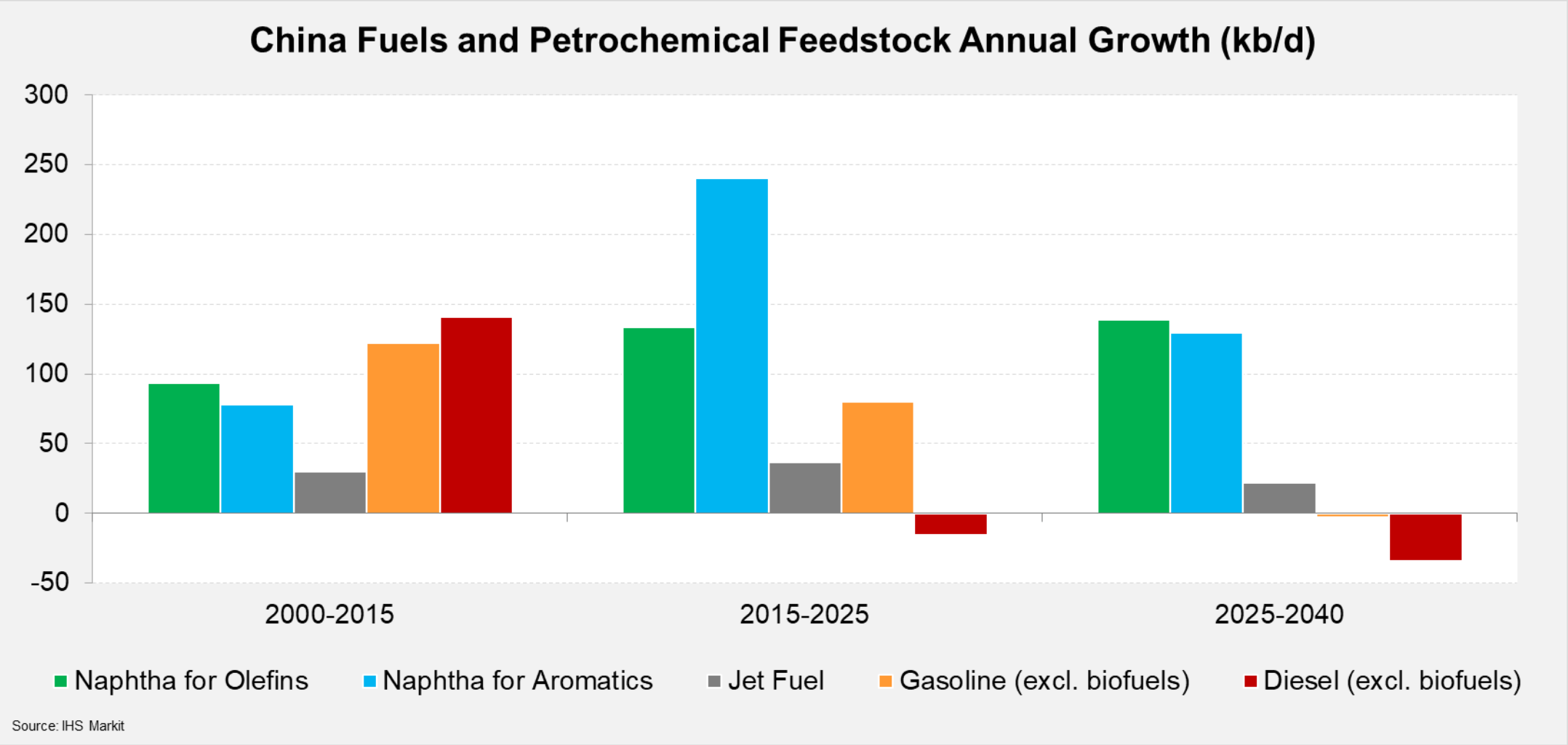
China Refinery Transformation



Refinery is Transforming from Oil Products to Petrochemicals

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Traditional Export Markets Investing in Local Production

Large-scale refinery, petrochemical complex planned off eastern coast of Chin

IHS Headline Analysis

The $15-billion complex is to be built in Zhoushan with a 400,000-bbl/day refinery and a 1.4-million mt/year ethylene plant.

Nanshan Group to build 60MMTA R&P Complex in China's Yantai

Nanshan Group will lead the Yantai-based Yulong refining and chemical project, the largest refining and chemical project in Shandong. Based on the government-set ratio of new refining capacity to old capacity to be removed, which stands at 1: 1.25, the province will re
25 million mt/yr

CHINA INDEPENDENT OIL REFINERS SET UP $5 BILLION JOINT VENTURE: EXECUTIVE

BEIJING (Reuters) - A group of six Chinese independent oil refiners set up a 33 billion yuan ($5 billion) joint venture to compete with state-owned giants and the rise of private chemical giants,

Construction of Huge Petrochemical Plant Begins in Dalian

By Zhang Xiaomin(chinadaily.com.cn)

A refining-chemical integration project began construction on Wednesday near the world's biggest purified terephthalic acid (PTA) production base at Dalian Changxing Island Economic Zone

China Shenghong Petrochem R&P project to cost CNY71.4B

Source: ICIS News

The complex, which will be owned by its subsidiary called Shenghong Refining and Chemical (Lianyugang) Co, will include a 16m tonnes/year (320,000 bbl/day) refinery, 1.1m tonne/year of ethylene and 2.8m tonne/year of para-xylene capacities, according to a company document.

China's state planner approves new oil refinery in Hebei province

NDRC approved a refinery project owned by private company Risun. The new refinery, near the port of Caofeidian in Hebei province, which is located in northeastern China, can process 15 million tonnes of crude per year, the Hebei NDRC said. That is about 300,000 barrels per day.

Tongkun plans $7-billion PX/PTA complex

Aug 27 -- Zhejiang Tongkun Holding Group (Tongxiang, China) signed an agreement in August with the municipal government of Qinzhou, China, for an investment of 51 bi renminbi ($7.1 billion) to build an integrate petrochemical complex that will have a par xylene (p-xylene) capacity of 2.8 million me tons/year (MMt/y) and a purified terephtha acid (PTA) capacity of 5 MMt/y on the Beibu Gulf at Qinzhou.

Construction kicks off for new refinery in Guangdong

By Zheng Xin | chinadaily.com.cn

Construction of the 20 MMTA refinery, 1.2 MMTA steam ethylene cracking complex plant and one 2600 KMTA PX complex , in southern China by CNPC and Venezuela's PDVSA, kicked off .

Invest in Fuels for Local Demand – Extend into PetChem for Higher Returns

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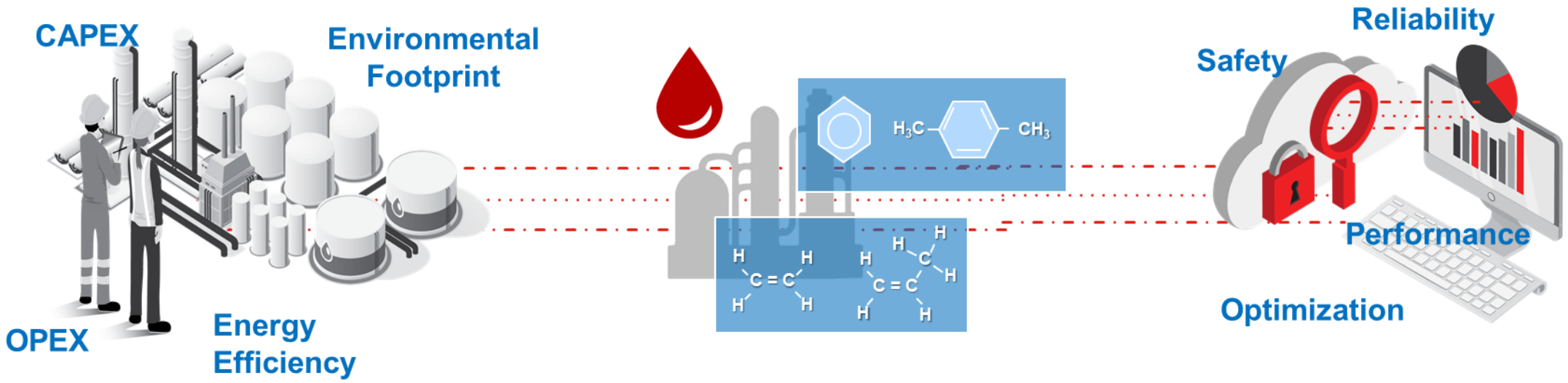
China is Leading the Trend……

Integration

Crude Oil to Chemicals

Connected



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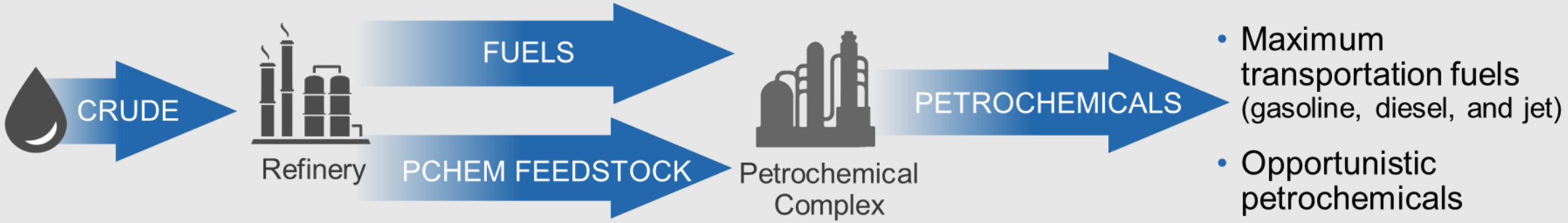
The Refinery of the Future

Traditional Crude Processing: Refining



- Maximum transportation fuels (gasoline, diesel, and jet)
- Opportunistic petrochemicals

Refining & Petrochemical Integration

Crude to Chemicals Through Integration for Existing Refineries

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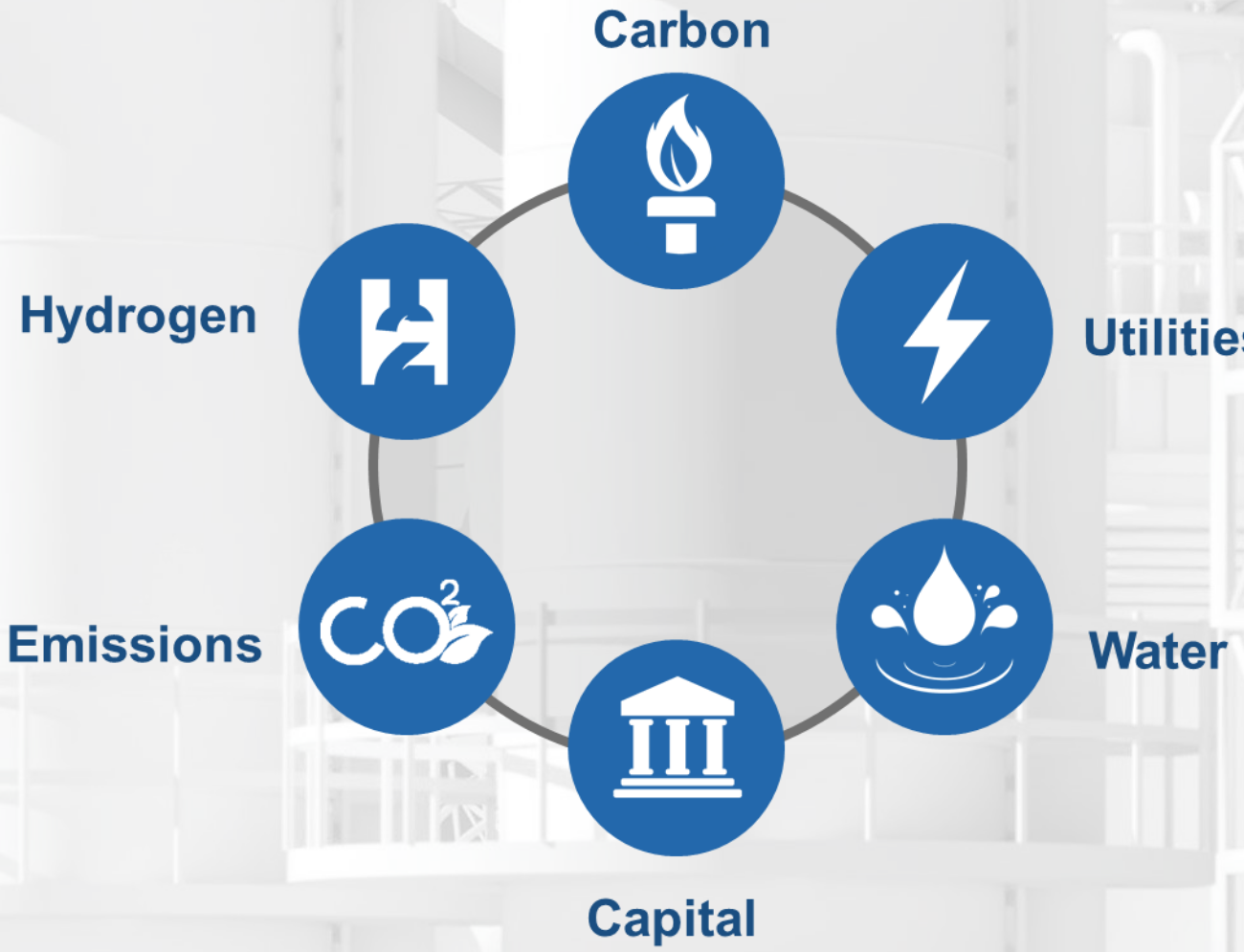
6-Efficiency Metrics for Business Alignment



- **Carbon** – Maximizing value from each barrel of crude
- **Hydrogen** – A configuration that balances the H2 produced from feed that minimizes on-purpose H2 requirements
- **Utilities** - Lowest energy cost per ton of product produced
- **Emissions** - Lower emission footprint than the NBA for the entire process portfolio
- **Water** - Minimize net water consumption regardless of source
- **Capital** - Capital efficiency as measure by
  1. Internal Rate of Return (IRR)
  2. Debt Coverage Ratio (DCR)

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The Refinery of the Future Is…

FLEXIBLE

To meet rapidly changing product markets

- Greater flexibility at lower cost
- Minimum residual products
- Changing fuel specs

INTEGRATED WITH PETROCHEMICALS

To achieve higher margins and value

- Molecule management to produce fuels or base petrochemicals
- Capture further value

CONNECTED

Achieves best operating performance every day

- Real-time business advisor
- Maintains an engaged, skilled and enabled workforce

Adaptable to Future Market Needs and Maximizing Value from Every Molecule

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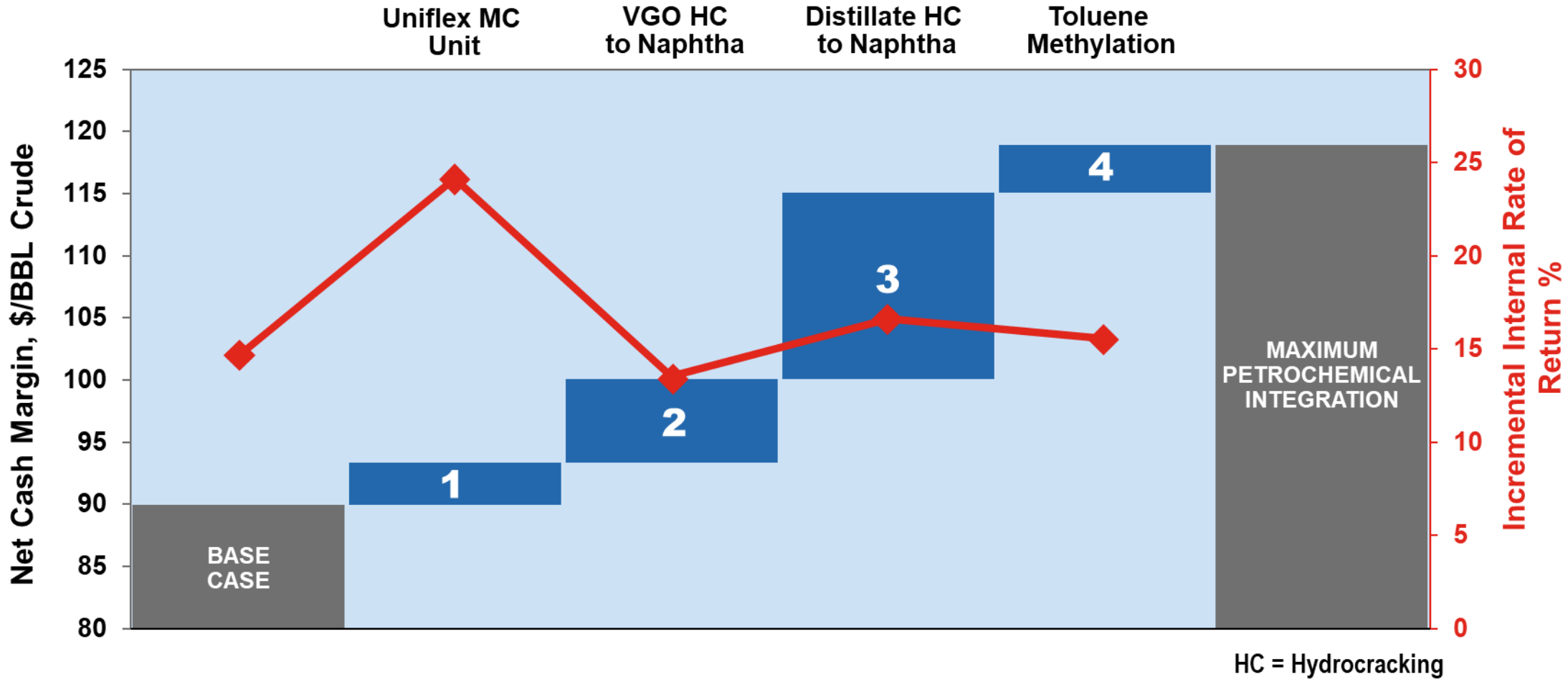
Stepwise Investment Plan to Unlock Value Through Integration



Opportunity to Increase Net Cash Margin by Up to $30/BBL

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Honeywell Connected Plant

Avoid Unplanned Downtime

Process issues

Equipment failures

Optimize Process Performance

Manage changing conditions

Performance vs expected

Manage Human Capital Challenges

Right skills

Sustaining expertise

Reduce Energy and Emissions

Emission standards

Energy reduction

Connecting: Assets, People, and Processes

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Conclusions

Petro-chemicals integration is becoming the standard for new world-scale refinery investments

A **future** where some refineries will produce only petrochemicals is possible

Molecule management, optimized configuration and advanced technologies are **critical for maximizing value**

Existing assets will be re-tasked to produce higher levels of olefins and aromatics

New **technology innovation** will focus on process intensification, bottoms upgrading, and **getting more from less**

The Refinery of the Future is a Reality Now

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