

ENGINEER INVESTMENTS TO ENSURE LONG-TERM PROFITABILITY

The Refinery of the Future is based on
analysis of six critical efficiencies

The Honeywell Refinery of the Future employs the UOP E6 methodology to calculate the efficiency of every resource in a potential configuration. Honeywell UOP can help define a step-wise investment strategy to capture growth and engineer the most profitable enterprise possible.



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GLOBAL DEMAND FOR PETROCHEMICALS IS OUTPACING DEMAND FOR FUEL

Gross domestic product around the world is growing by an average of 4 percent annually, driven primarily by economic growth in emerging economies. Hundreds of millions of people are generating new demand for products made from petrochemicals, including plastics used in billions of consumer products, protective food packaging, medical supplies, communications equipment, and other items.

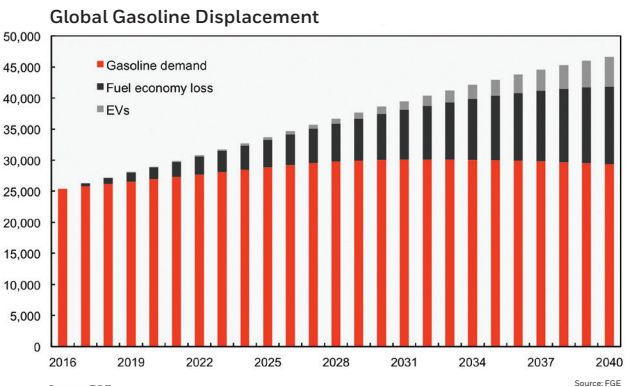
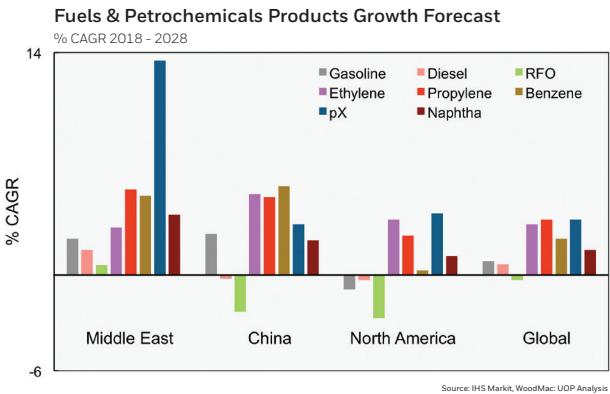
The production capacity currently in place cannot meet the growing demand for petrochemicals. But there is a path to reconfigure refineries in

a stepwise fashion over a period of years to meet that demand, ensure maximum profitability at every stage, and become the Refinery of the Future.

The Refinery of the Future is not a standard configuration or collection of technologies, but a capital investment strategy for capturing growth to ensure a refiner is the most economically efficient and profitable enterprise possible. It's a prescription that is unique to each refinery, accounting for changing market conditions, available feedstocks, new technology, regulatory constraints,

and competition, with the goal of sustainable long-term profitability.

While demand for fuels will continue to rise in emerging economies, global demand for motor fuels will peak somewhere around 2035. In addition, countries that historically have imported fuels now are building their own refineries, using the most advanced technologies available. Export-oriented refiners currently supplying those markets will soon run up against new domestic competitors who could even emerge as regional competitors.



Export-dependent refiners must find alternatives to fuels production, or they may be forced to close. The most logical course for most of these refiners is to invest in petrochemicals production because it allows them to escape a rapidly closing market, and pivot to products with far better margins and growing demand.

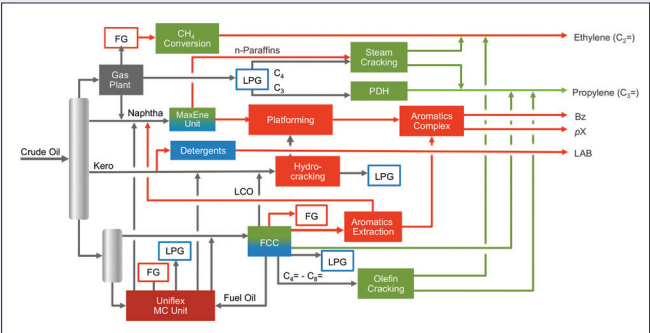
REFINERY OF THE FUTURE: A VIEW TO ZERO FUELS PRODUCTION

This change toward more integrated complexes already has begun. As recently as five years ago, roughly 15 percent of new CCR Platforming™ units were designed for petrochemicals production. Today, that number has risen to nearly 70 percent. New integrated complexes in the Middle East, Southeast Asia and China –

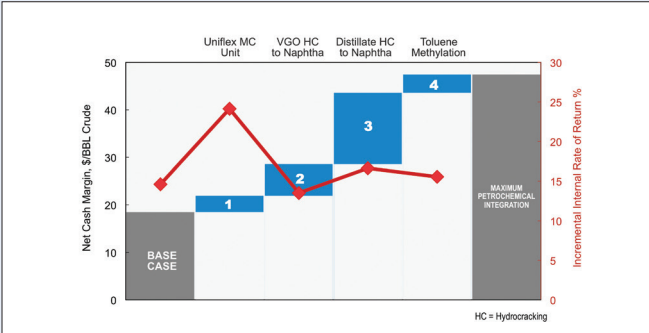
where GDP growth is highest – are being designed to convert as much as two-thirds of their feedstock into petrochemicals. No two complexes will have the same solution, route or timeline. But all will begin with an evaluation of the customer's goals and current technology assets. We must gauge how well a customer is prepared

to compete in petrochemicals, how quickly they will need to move to maintain a competitive advantage, and how they can make the best use of the assets they have today. This helps determine whether a customer should pursue a staged series of investments, or a faster and more comprehensive transformation.

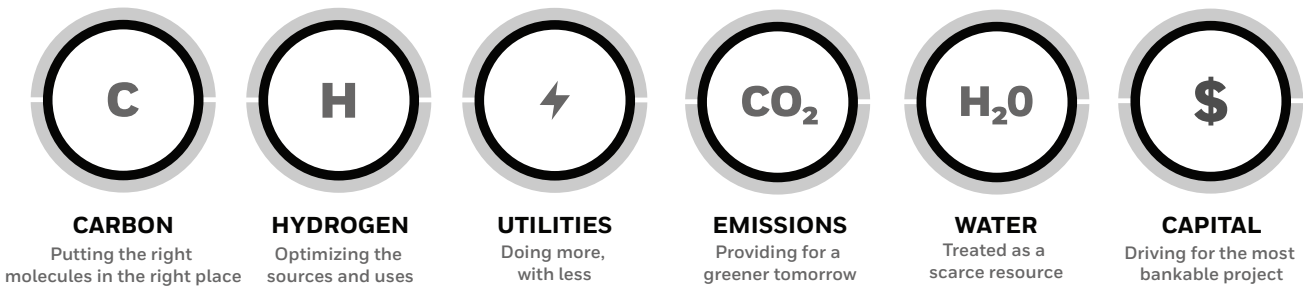
Petrochemicals Integration Model



Stepwise Investment Plan to Unlock Value through Integration



UOP E6 METHODOLOGY: ANALYZE THE EFFICIENCY OF SIX KEY ELEMENTS



The framework for this analysis allows us to evaluate efficiencies and grade tradeoffs that may be necessary when pursuing a course of action. There are six fundamental criteria, each quantifying the efficiency of carbon, hydrogen, waste, utilities, water, and capital.

Carbon is the heart of every hydrocarbon molecule, and therefore, almost every fuel and petrochemical compound. We measure carbon efficiency as a function of converting the molecules into their products as efficiently as possible by doing the least amount to change them or rearrange them.

Because hydrogen is essential to many conversion processes, we measure hydrogen efficiency in terms of how sparingly it can be used to effect changes in the molecules to get the desired slate of products. Carbon and hydrogen efficiency can be improved by eliminating intermediate conversion steps

through more effective processes. Accordingly, we can determine utilities efficiency to ensure we make the best use of energy to convert feedstocks into the highest possible net value of products.

As the world becomes more conscious of pollution and climate change, greater focus is placed on emissions. Carbon taxes have been considered but have failed to gain broad acceptance. Instead, some institutional investors have begun to move cash away from firms lacking plans to lower their emissions. The goal of emissions efficiency is to do more with less and maximize conversion of crude into more valuable products with the lowest net emissions footprint.

Water must always be treated as a scarce resource, so we measure water efficiency not as a utility, but in a way that minimizes the use of fresh water across an entire facility.



PROCESS INTENSIFICATION

The refinery of today typically is divided into traditional blocks, beginning with heavy oil conversion and moving in stages to treating the lightest products. By excluding fuels production, these plants look completely different.

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Framed by UOP E6, plant configuration and investment criteria change dramatically from the traditional approach. Molecule management can be viewed in terms of which

intermediate processes can be eliminated. By their nature, these simpler processes will require less steel and a smaller physical footprint.

Through this process intensification, the facility can do more with less, improving productivity and efficiency, and increasing returns on invested capital.

CONNECTED PLANT

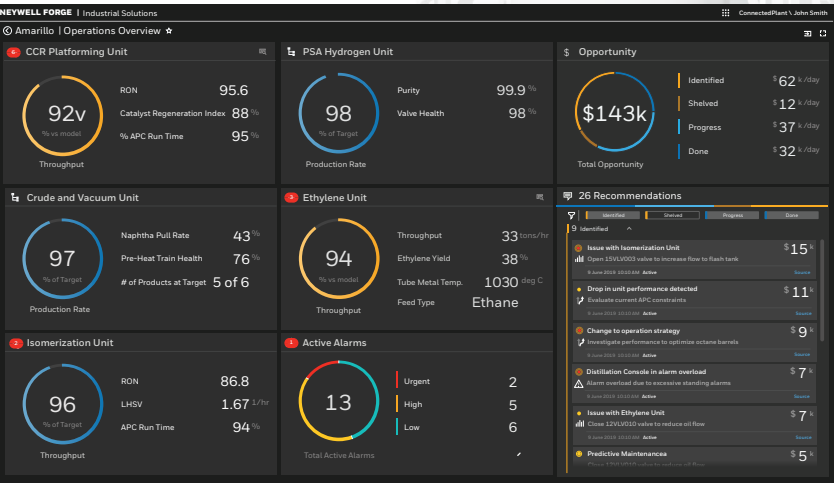
The success or failure of a program to expand into petrochemicals also could be determined by something beyond the technical interfaces, integration of molecule movement, and balancing of feedstocks. Refineries will begin to encounter more complex and consequential operational decisions in an environment where nearly half of the skilled operations personnel are within five years of retirement.

At the very moment their skill and experience are most needed, many of the people who provide it will not be available. But this sudden loss of operational knowledge can be bridged with new connected plant technology.

The Refinery of the Future must be digitally enabled. In these integrated complexes, actual operational data is compared to

data from a digital twin to identify how the plant's performance deviates from its optimal condition, provide recommendations to determine the precise cause of that underperformance, and correct it. The most effective connected plant systems are based on the specific process technology used, employing operational data from the entire installed base of those technologies.

Honeywell Forge Industrial Solutions – Operations Overview



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For More Information

To schedule a call or an onsite meeting to review your operation and needs, contact us at 847-391-2000. Visit us at [Bit.ly/ROTF-HEFC](https://bit.ly/ROTF-HEFC) or scan the QR code.



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