Hydrogen technology

Consistent market leadership
Hydrogen is our core expertise

Hydrogen, either in its pure form or as a component of syngas, is the most widely used industrial gas in the refining, chemical and petrochemical industries, and the market demand is growing continuously.

Since pioneering the steam reforming process in the early 1960s, TechnipFMC has enhanced our hydrogen technology and plant designs through continuous improvement, product development and technology advancement programs. This commitment has resulted in commercially proven solutions.

Our hydrogen plants have demonstrated the highest reliability and efficiency in the industry. With a consistent worldwide market leadership, we have provided our proprietary steam reforming technology in more than 270 plants worldwide. This represents a global market share of more than 35 percent. Our reference list includes several of the world’s largest steam reformers for hydrogen-syngas applications.

We offer clients world-class project management and execution with single-point responsibility from concept to commercial production, including startup, operator training, plant optimization, troubleshooting and maintenance support.

Bulgaria – 83,400 Nm³/h Hydrogen

The Netherlands – 135,000 Nm³/h Hydrogen
Our process designs

TechnipFMC’s hydrogen plants have proven reliability and onstream availability of more than 99 percent (excluding turnaround and forced outage). Our proprietary steam reformer design is compact with high thermal efficiency and low carbon emissions per unit of syngas. The cost-effective design, especially for larger capacities, can be modularized and customized for each application.

Our tailored solutions have led to many industry “firsts” and we understand the need for flexibility in the scope of work and forms of contract.

**Feedstock flexibility**
Many of today's refinery hydrogen plants use multiple feedstocks ranging from refinery off gases (ROG) and natural gas to LPG and naphtha. To provide required feedstocks flexibility, TechnipFMC applies adiabatic pre-reforming in plant design. Advanced control configurations allow on-line changeover of feedstocks with minimal impact on production.

**Key differentiators and continuous improvement**
TechnipFMC offers commercially proven solutions:

- Enhanced energy efficiency flow sheets with optimized reforming severity, optional pre-reforming, conforming level of shift conversion and advanced heat integration
- Value engineering solutions for lowest unit cost of hydrogen
- Recuperative reforming with our TechnipFMC Parallel Reformer (TPR®), allowing up to 30 percent additional reformed gas using process heat
- Specific design and execution philosophy for smaller hydrogen plants
- Gas turbine combined cycle and exhaust integration for steam power synergy and reliable captive power
- Advanced modularization for faster, cost-effective execution
- High purity export steam based on high-pressure stripping of condensate, segregated or “dual-steam” systems or feed saturation concepts

**Main process steps in a hydrogen plant**

- Hydrocarbon feed
- Process steam
- Hydrogen recycle
- Hydrogen product
- Product purification
- Purge gas

Feed purification
Pre-reforming (optional)
Reforming
Shift Conversion

4 Hydrogen technology
Our plants are designed to meet the highest HSE and quality standards

Our foremost focus is safety, without compromise, from process concept and design to installation, operation and maintenance. Extensive HAZOP reviews, safety studies, CFD simulations and critical design analyses are conducted to ensure safety of personnel and equipment as part of our commitment to embed safety integrally in our designs.

We use the best available technology for environmental performance and compliance. Our solutions are designed to minimize NOx emissions from the steam reformer furnace and reuse spent process condensate. We have the expertise to design plants for the lowest energy consumption and to provide CO$_2$ capture facilities if required.

Our competences in managing construction activities lead to optimized designs in accordance with safety, operation and maintenance requirements. A constructability program with an integrated database of applicable procedures and project feedback reports is available to provide project management teams with construction tools and methodology.

Pulse, our Health, Safety, Environment and Security culture and engagement program, and Impact Quality, our quality leadership program, help us drive a culture of prevention, accountability and continuous improvement across our global operations.

France – 97,000 Nm$^3$/h Hydrogen
Over-the-fence hydrogen supply

Advantages of over-the-fence hydrogen supply:

- Cost of delivered hydrogen is optimized (opex & capex).
- Extensive operational feedback drives design enhancements.
- Air Products provides the initial capital investment for the hydrogen plant based on their “own, operate and maintain” model under long-term contract.
- Any risk of project execution, plant efficiency and on-stream performance lies with the supplier (alliance), not with the end-user.
- Leading-edge reliability of hydrogen generation and/or supply is further facilitated by multi-plant, multi-customer pipeline networks and/or back-up franchise provisions.

Global alliance with Air Products

Since 1992, TechnipFMC and Air Products have cooperated in an alliance to supply outsourced “over-the-fence” hydrogen to the global refining industry. TechnipFMC provides the design and construction expertise for steam reformers and Air Products provides the gas separation technology. Both companies bring effective operational and engineering knowledge into the design for high reliability and efficiency. TechnipFMC offers a large reference base and Air Products an extensive operating network.

The alliance is responsible for more than 35 hydrogen plants supplying more than 2,600 MMSCFD (2,900,000 Nm$^3$/h) of hydrogen. Air Products and TechnipFMC are fully committed to hydrogen as their worldwide core business applying the highest HSE standards.
Innovative solutions and clean technologies

Oil refiners often look for more hydrogen to process heavier and sour crudes and/or maximize the middle-distillate pool while meeting stricter clean fuels requirements.

Our proprietary Hydrogen Network Design Tool (HyNDT™) optimizes refinery hydrogen networks for performance, cost efficiency, operational flexibility and HSE targets by balancing the production and consumption of hydrogen.

The advanced Large Scale Vortex (LSV®) burner, with its innovative flame stabilizer and unique fuel premix injection system, offers ultra-low NOx emissions.

TPR® is our proven, proprietary convective recuperative heat exchange reformer for retrofits or new plants. It is designed to optimize high-grade heat cycle and increase reforming capacity without additional firing.

Our proprietary Dual Chamber Process Gas Boiler enhances cost effectiveness and improves energy efficiency through extended heat recovery. Its design includes two chambers separated by an intermediate compartment with an external bypass assembly to control the exit temperature.

China – 100,000 Nm³/h Hydrogen + Syngas
Sustainability drives our innovation focus

Hydrogen, an energy carrier that can be generated by traditional or renewable sources, is projected to play a major role in the future sustainable clean energy landscape.

As the market leader in supply of hydrogen plants, TechnipFMC is committed to further developing this sustainability principle as it drives our innovation focus targeting environmental, economic and social benefits.

**Innovation**
- Mega steam reformer with steam power synergy and CO₂ capture
- Proprietary equipment (TechnipFMC’s steam methane reformer (SMR), TPR, LSV burners, advanced process gas boiler)
- More than a dozen industry “firsts” (largest plants, multiple-feed flexibility, power cogeneration and carbon management)

**Benefits**
- For 30 years, TechnipFMC’s technology developments have improved energy efficiency of hydrogen plants by more than 10 percent, reducing emissions and operating costs.
- Optimization of the hydrogen network in refineries has resulted in more effective use of hydrocarbon resources.
- For steam power integration, gas turbine exhaust can be used as combustion air for SMR burners, improving a refinery’s energy efficiency and carbon footprint.
- We have solutions for carbon capture readiness in future hydrogen plants, targeting more than a two-thirds reduction in CO₂ release from the hydrogen plant.
- Technology advancements have reduced operating and capital expenditures, resulting in up to 15 percent lower “unit cost of hydrogen.” At the same time, on-stream reliability has been enhanced to 99 percent or more.
- Hydrogen as a carbon-free energy vector carries a potential role in the clean fuels and sustainable energy pathways, ensuring a cleaner environment and better quality of life.
Key References

(1 MMSCFD = 1,110 Nm³/h)

- 344,500 Nm³/h hydrogen and syngas plant for Petronas, Malaysia, under construction (2018); one of the world largest facilities (with three trains)
- 238,000 Nm³/h hydrogen plant for Rosneft, Tuapse, Russia, under construction (2018); largest single-train plant in the world
- 182,000 Nm³/h hydrogen plant for Air Products, Kochi, India; 2017; gas turbine integrated facility with cryogenic installation for co-production of syngas
- 155 MMSCFD hydrogen for Air Products, Louisiana, USA; 2014; largest single-train plant for over-the-fence hydrogen supply
- 100,000 Nm³/h hydrogen and 28,000 Nm³/h syngas plant for Air Products, Chengdu, China; 2013; one of the largest HyCO facilities based on steam reforming
- 104,000 Nm³/h hydrogen plant for Indian Oil Corp., Haldia, India; 2009; among the largest plants with pre-reforming, LT shift and dual-steam system
- 110 MMSCFD hydrogen plant for GS Caltex, South Korea; 2007; largest naphtha (and LPG) direct reforming-based plant
- 115 MMSCFD hydrogen plant for Air Products (Port Arthur-II), Texas, USA; 2006; largest gas turbine (exhaust) integration with 100 MW cogeneration
- 200 MMSCFD hydrogen plant for Syncrude, Ft. McMurray, Canada; 2005; largest operating single-train plant with 75 MW cogeneration
- 106,000 Nm³/h hydrogen recovery plant + 21 t/h C₂ co-producing for PKN, Poland; 1998; one of the largest ROG recovery plants with PSA and cold box hybrid
- 111,000 Nm³/h hydrogen plant for PKN, Poland; 1997; largest plant with multiple feed flexibility (NG, LPG, naphtha and mixture)
- 35 MMSCFD hydrogen plant for Air Products, California, USA; 1993; first plant under the TechnipFMC/Air Products alliance
- 69,500 Nm³/h hydrogen plant for Total, Vlissingen, The Netherlands; 1985; one of the first large modern plants for hydrocracker application; expanded to 80,000 Nm³/h; 2002