

Where energies make tomorrow ●

Hydrogen

Global leader delivering a full suite of hydrogen solutions through unrivaled technology and seamless project execution

T.EN

**TECHNIP
ENERGIES**



The hydrogen industry's market leader

Our positioning across the H₂ value chain

With more than 55 years of expertise and leadership in the production of hydrogen, our full scope of services ranges from process and front-end design packages, through detailed engineering and supply, to full turnkey EPC projects, and ultimately asset management services.

We maintain our leadership position thanks to our team of experienced professionals, continuous improvement and dedicated research and development programs.

We provide a wide array of solutions and technologies to arrive at the lowest levelized cost of hydrogen (LCOH). Our

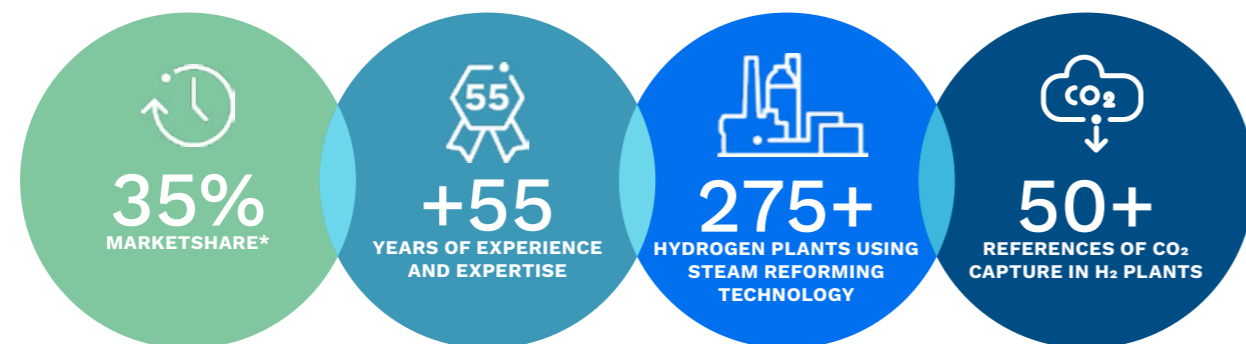
references include several of the world's largest single-train hydrogen/syngas applications, and our reference fleet is rapidly evolving to address the mandate to raise efficiency and reduce carbon emissions in support of the energy transition.

Our designs fully integrate with surrounding production facilities, both exploiting opportunities to utilize advantaged feedstock (including valuable off-gas and carbon-neutral feeds) and the coproduction of value products, such as steam, synthesis gas, power and even CO₂.

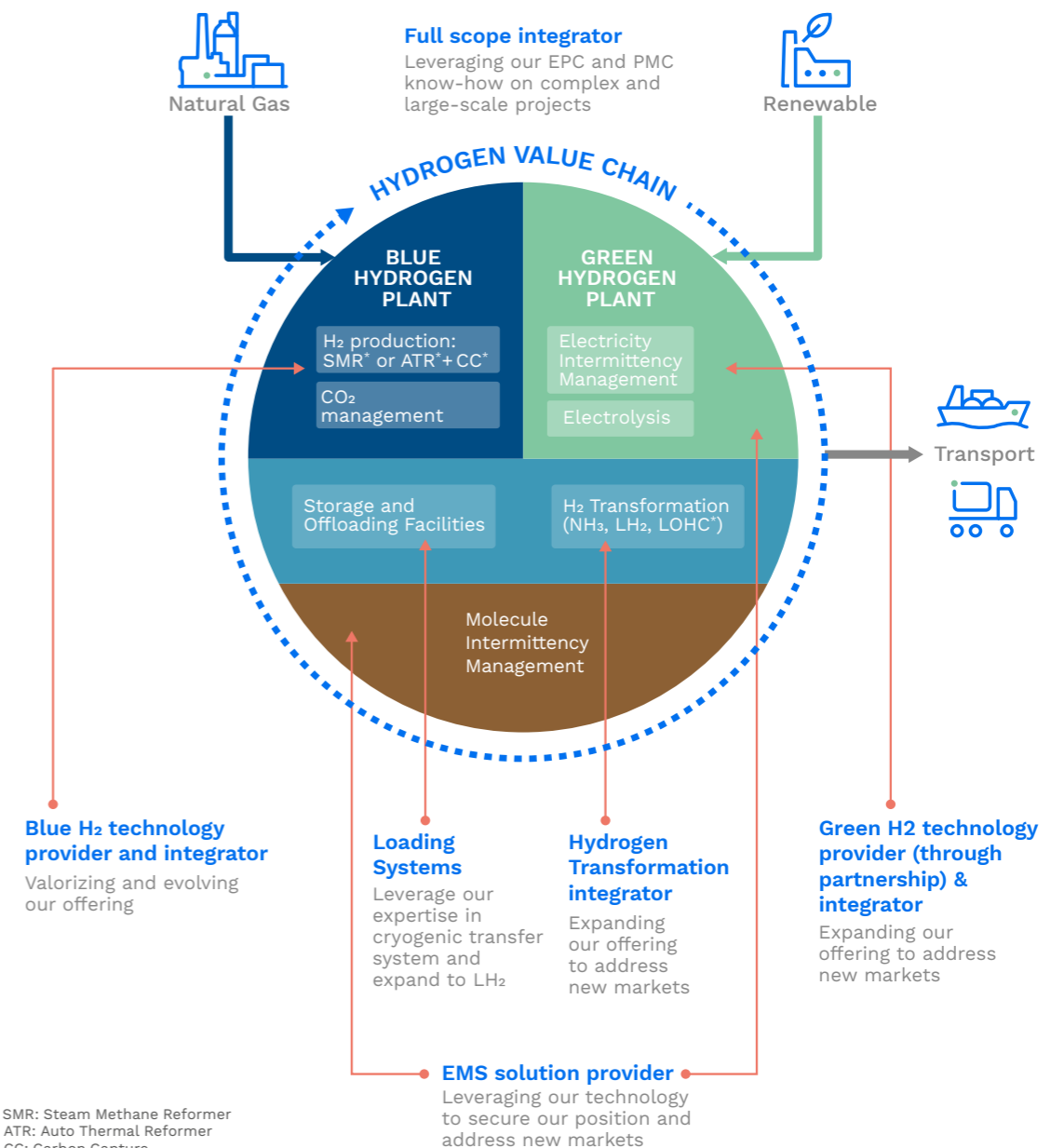
In addition to serving the traditional hydrogen business, Technip Energies' hydrogen

technology is evolving to further support the decarbonization of numerous industries, such as refining, ammonia/fertilizers, steel, cement, power, olefins and LNG, as well as further supporting clean energy carriers.

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Delivering plants with the highest levels of reliability and efficiency in the industry”.



* In pure H₂ production (excluding H₂ for ammonia)



* SMR: Steam Methane Reformer
ATR: Auto Thermal Reformer
CC: Carbon Capture
LOHC: Liquid Organic Hydrogen Carrier

Accelerating the energy transition through innovation and advanced technology

Clean hydrogen is our business. With a track record of leading edge hydrogen solutions, we are well-positioned to support the evolving needs of the energy transition.

Extensive experience in low-carbon (blue) hydrogen

“Blue” hydrogen, with substantially reduced CO₂ emissions, is produced through minimization of the primary footprint and deliberate capture of the co-produced CO₂. Technip Energies is a pioneer in this rapidly expanding market and a global leader in low-carbon hydrogen solutions through:

- Portfolio of enhanced reforming technologies
- Company-developed recuperative reforming technologies: Technip Parallel Reformer “TPR®” and Enhanced Annular Reforming Tube for Hydrogen “EARTH®”
- In-house combustion and burner technology, and experience utilizing a wide range of fuels (heavy to carbon-free)
- 50+ hydrogen/syngas references already utilizing CO₂ capture solutions.

Valorizing opportunity & green feeds

Certain feedstock, such as bio-based gas, present viable opportunities for conversion to low cost and/or low-carbon hydrogen. With broad experience processing difficult feedstock under a variety of conditions, Technip Energies is well-positioned to valorize such opportunities to produce clean, low-cost hydrogen. In many situations, hydrogen production with negative CO₂ emissions (net carbon sink) may also be realized.

We offer an expanded pathway to hydrogen production, incorporating steam-, oxidative- and CO₂-assisted reforming into our portfolio. Our low-carbon portfolio is based on a large number of flight-proven building blocks to serve any industrial application.

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We are committed to improving energy efficiency and reducing the carbon footprint of our clients’ new or existing hydrogen plants.

Technip Energies’ hydrogen plants have proven reliability and demonstrated onstream availability of more than 99% (excluding planned downtime and external forced outage). Our proprietary designs provide compact solutions with high overall energy efficiency and minimize environmental impacts and carbon emissions.

Technip Energies’ offers proven hydrogen technology and tailored solutions for cost optimal, high-efficiency and reliable production to meet the needs of industry and accelerate the energy transition.

BlueH₂TM by T.EN 2

Technip Energies offers a full suite of decarbonized and affordable solutions for hydrogen production.

Main features:

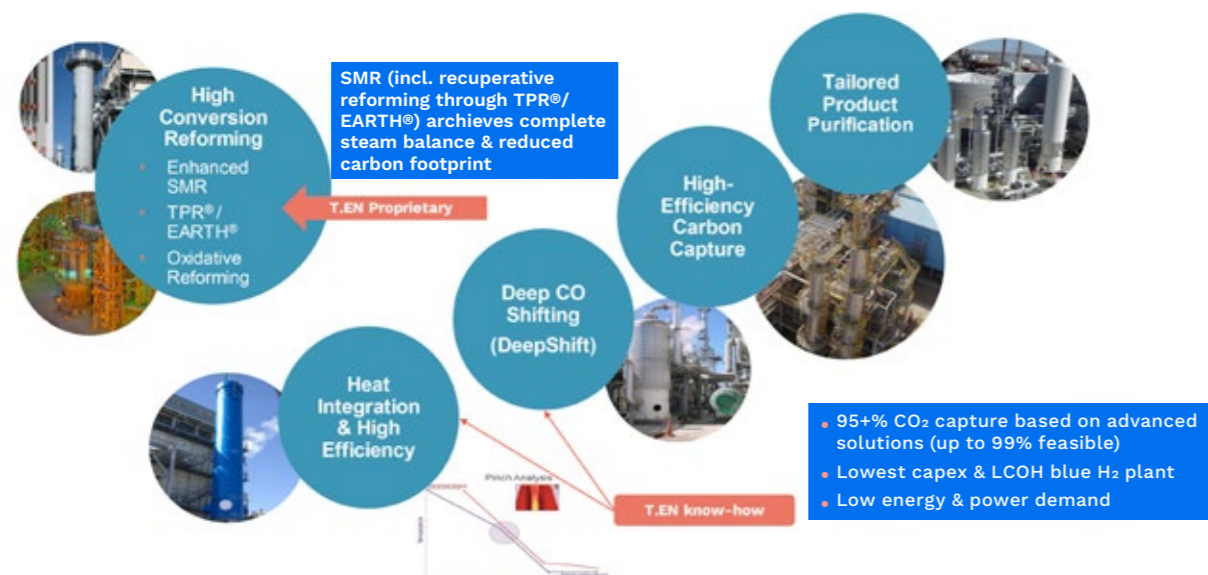
- Up to a 99% reduction in the carbon footprint compared to the traditional hydrogen process – from ~10 down to 0.1 kilogram CO₂ per kilogram H₂, while maintaining flexibility to be tailored to each individual application.
- Maximum hydrogen yield, minimum energy demand (fuel + power), and highly-efficient carbon avoidance

and carbon capture utilization and storage (CCUS) techniques, to arrive at the lowest cost of (blue) hydrogen “LCOH”.

- Comprised of “flight proven”, company developed and owned technologies and equipment, available to customers today.
- Optional integration of highly efficient, low-carbon cogeneration of power.

In addition to targeting traditional low-carbon hydrogen production applications, such as refining and ammonia manufacturing, BlueH₂ by T.ENTM has been developed to further support the decarbonization of numerous industries, such as steel, cement, power, olefins and LNG as well as facilitating clean energy carriers.

Building blocks for low-carbon solutions



REFERENCE BASE:

- > 50 H₂ with carbon capture
- > 30 H₂ with deep CO shift
- > 14 H₂ with recuperative reforming



Air Products Gulf Coast HyCO

HYCO PLANT WITH CO₂ CAPTURE

- **Multi-Product Plant:** Hydrogen, CO & CO₂
- **Startup:** 2017
- **Location:** Baytown, Texas



Hydrogen with carbon capture and CO plus syngas cogeneration

- **Contract:** EPC (Plant 1) / BDEP (Plant 2) for hydrogen + CO plant including CO₂ capture
- **Startup:** 2006 (Plant 1) / 2010 (Plant 2)
- **Location:** Nanjing, China



KEY FIGURES

- Capacity:
- ~ 140,000 Nm³/h Hydrogen
 - ~ 22,000 Nm³/h CO
 - ~ 500 TPD CO₂ Capture

KEY FIGURES

- Capacity:
- Plant 1 – 21,000 Nm³/h H₂; 25,000 Nm³/h H₂+CO & 5,000 Nm³/h CO.
 - Plant 2 – 59,000 Nm³/h H₂; 16,000 Nm³/h H₂+CO & 25,000 Nm³/h CO
 - CO₂ capture rate (for reutilization) : 800 TPD

Robust components, including proprietary technologies and innovations

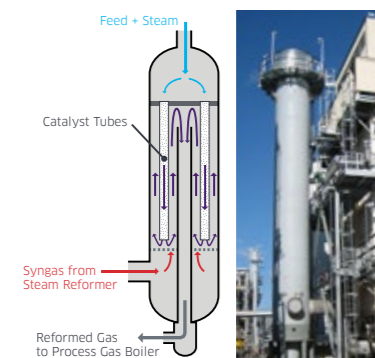
Reforming

Steam reforming is the predominant technology for cost-effective hydrogen production, widely adopted for its flexibility and simplicity. In addition, high energy efficiency is achieved through the use of our innovative technologies and case-specific optimization of heat recovery design.

To arrive at lowest-cost hydrogen, we incorporate:

- Pre-reforming,
- Heat recuperative reforming: TPR® and EARTH®
- Oxygen-based reforming
- CO₂ co-reforming as needed into the main feed conversion block.

TPR® parallel reformer



The Technip Energies' Parallel Reformer TPR® is our proven convective recuperative reformer, also suitable for retrofits. It is designed to optimize the high-grade heat utilization and increase reforming capacity without additional firing, thus resulting in lower CO₂ emissions by up to 20%.

EARTH® recuperative reformer catalyst tubes



The Enhanced Annular Reforming Tube for Hydrogen "EARTH®" is our newest (heat) recuperative reforming technology. It is a drop-in insert for reformer tubes consisting of a structured reforming catalyst and concentric internal tubes, also suitable for retrofits.

It allows the reformer to operate up to 20% higher capacity and up to 10% lower CO₂ footprint.

Water-gas shift

We have wide experience in deployment of the various styles and temperature levels of water-gas shift reactors (multi-step, adiabatic, isothermal etc.).

CO₂ capture

We have applied carbon capture (and use) in more than 50 of our plants, either to produce CO₂ as a byproduct gas, or to adapt H₂/CO ratios for syngas applications. Hydrogen plants with overall CO₂ capture rates up to 99% are achievable utilizing pre-combustion process capture with Technip Energies technology and solutions.

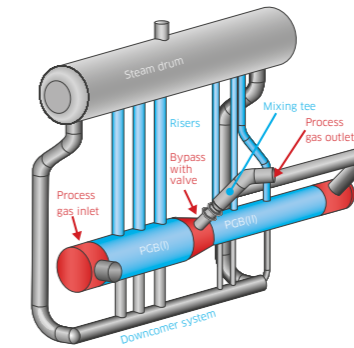
We have experience with a variety of CO₂ capture technologies, including the BASF OASE White process, in collaboration with BASF under a framework license.

LSV® ultra low-NOx burner



The advanced Large Scale Vortex (LSV®) burner, with its innovative flame stabilizer and unique fuel premix system, offers ultra-low NO_x emissions. Our burner design capabilities are further enhanced via our own burner test and manufacturing facilities, where we recently and successfully tested the LSV® burner with 100% hydrogen firing

Process gas boiler



Our company developed process gas boiler includes a two chamber design for enhanced overall heat transfer, and an external bypass assembly to ease both operational and maintenance requirements.

Steam generation and process condensate recovery

Technip Energies tailors the quantity and quality of steam for export to neighboring steam networks, including the option for zero export and full independence of the ISBL steam/condensate system.

Product purification

PSA, ColdBox, Methanator, and/or Membrane: Depending on the applications and product requirements, the product purification block is adapted to needs.



Carbon-free (green) hydrogen

Technip Energies is ideally positioned to provide fully renewable (“green”) hydrogen in the current and future energy landscape, due to our extensive expertise in hydrogen technology, seamless project execution capabilities and established presence in the market.

Offering carbon-free H2 solutions, an alternative energy powering industry transition

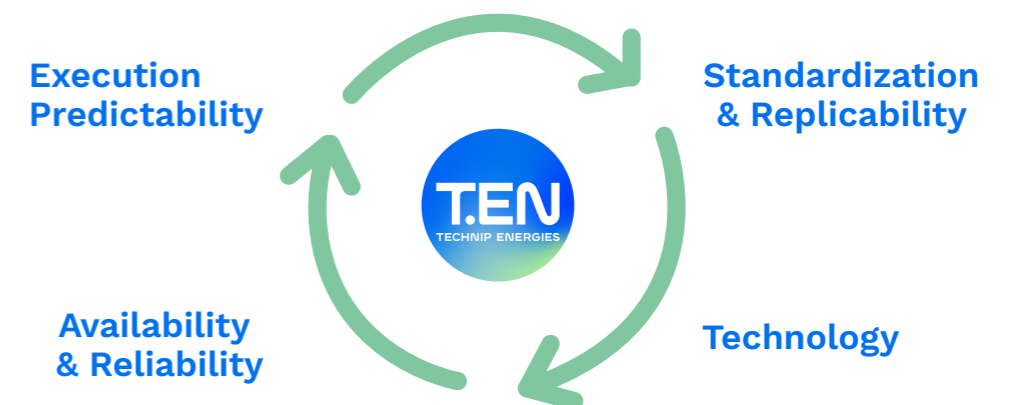
Enabling onshore and offshore large-scale green-hydrogen projects

- Global leader in hydrogen market with proven and extensive experience, expertise and technologies
- Wide range of services: from consultancy and EPC services to technology development and turnkey delivery
- Development of an energy management system (EMS) to provide full architecture integration from renewable production to hydrogen monetization (downstream process or hydrogen transportation).
- Formulating project economics with partners and customers to enable large scale projects
- Strategic investment and technology partnership (non-exclusive) with **McPhy**



Optimized Total Cost of Ownership (TCO) and Levelized Cost of Hydrogen (LCOH):

- Designed to scale, Technip Energies provides modular and affordable green hydrogen solutions to medium and large scale industrial clients. Whether it is green hydrogen for refining, petrochemicals, power generation, steel manufacturing or ammonia production, we provide single-point systems and project integration services.
 - Off-the-shelf Basic Design and Engineering Packages (BDEP) tailored to client needs.
 - Robust supply chain and quality surveillance.
 - Digital by design
 - Turnkey solutions
 - Operation and maintenance services
- Through our global footprint and already established presence in the green hydrogen market, we are intimately involved in the development of state-of-the-art hydrogen generation units operating at high efficiency and availability with fast response times adapted to fluctuating renewable power sources.



Full range of services from BDEP to EPC

Technip Energies offers a cost-competitive full range of project services, from concept development through turn-key delivery, including startup, training, optimization, and asset support.

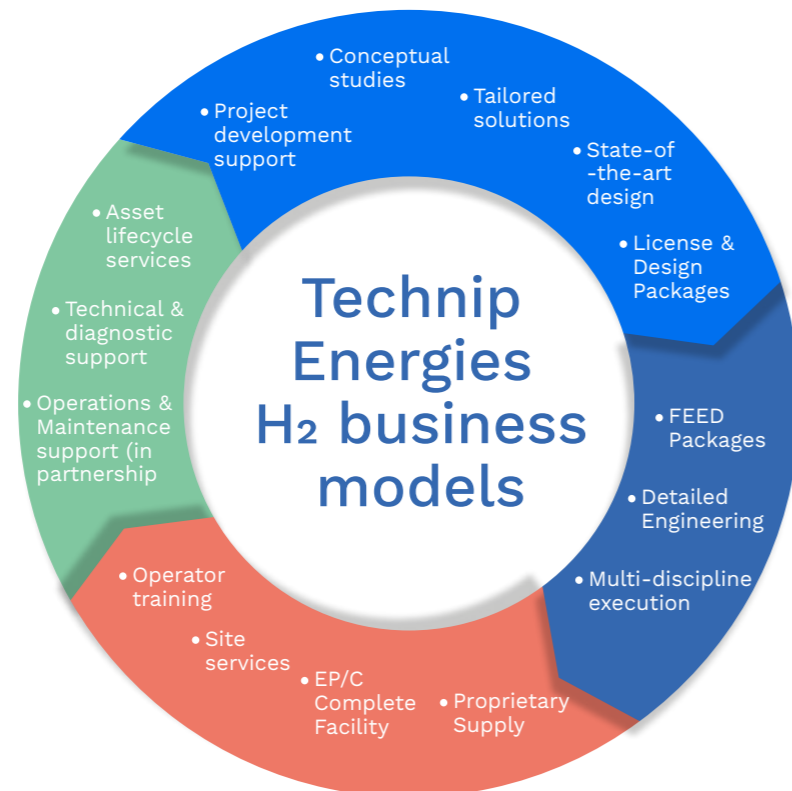


Hydrogen gas supply

Through our sale-of-gas partner Air Products, we provide our technology and solutions for highly reliable hydrogen supply under long-term gas contracts.



We work with our clients from the earliest stages of their project development, providing a full scope of services from feasibility studies and design/FEED packages to complete EPC projects involving engineering, procurement, construction and ultimate start-up of the facilities.



GLOBAL ALLIANCE WITH AIR PRODUCTS

- Since 1992, Technip Energies and Air Products have combined forces to supply “over-the-fence” hydrogen to global industry.
- The alliance is responsible for more than 40 hydrogen plants with a global design capacity of more than 3.3 million Nm³/h (3 billion standard cubic feet per day) of hydrogen. Air Products and Technip Energies are committed to applying the highest reliability, availability and HSE standards.



Project references

THE NETHERLANDS

- Startup: 1985/2002
- Client: Total
- Location: Vlissingen
- Scope: One of the first large modern plants for hydrocracker application /69,500 Nm³/h, expanded to 80,000 Nm³/h in 2002

UK

- Startup: under execution
- Client: Esso Petroleum
- Location: Fawley
- Scope: Process Design Package, Reformer & PSA

FRANCE

- Startup: 1998/2011
- Client: Total
- Location: Le Havre, France
- Scope: Hydrogen Plant of 96,000 Nm³/h revamped with TPR® to 117,000 Nm³/h

CANADA

- Startup: 2005
- Client: Syncrude
- Location: Ft. McMurray
- Scope: Largest operating single-train plant with 75 MW cogeneration/200 MMSCFD

USA

- Startup: 2006
- Client: Air Products
- Location: Texas
- Scope: Large gas turbine (exhaust) integration with 100 MW cogeneration/115 MMSCFD

USA

- Startup: 2014
- Client: Air Products
- Location: Louisiana
- Scope: Largest single-train plant for over-the-fence hydrogen supply/155 MMSCFD

SPAIN

- Startup: Under execution
- Client: Repsol
- Location: Spain
- Scope: ~ 21,000 Nm³/h hydrogen plant using T.EN innovative EARTH® reformer technology

- Startup: Under execution
- Client: MIDOR
- Scope: Complete plant 57,000 Nm³/h

- Startup: Under execution
- Client: ANOPC
- Scope: Complete plant 82,000 Nm³/h

EGYPT

INDIA

- Startup: Under construction
- Client: HPCL
- Location: Visakhapatnam
- Scope: Two hydrogen trains of 160,000 Nm³/h each, the largest hydrogen generation plant in India/ with power generation (12.9 MW) and zero net export steam

INDIA

- Startup: 2009, revamped in 2020 for +20% capacity
- Client: Indian Oil Corp.
- Location: Haldia
- Scope: Among the largest plants with pre-reforming, HT+ LT shift and segregated-steam system/104,000 Nm³/h revamped with TPR® 124,000 Nm³/h

POLAND

RUSSIA

- Startup: 1998
- Client: PKN Orlen
- Scope: One of the largest ROG recovery plants with PSA and cold box hybrid/106,000 Nm³/h + 21 t/h C₂₊ co-product to petrochemicals, utilizing over 20 H₂ rich streams from the Complex

RUSSIA

- Startup: 1997(Plant 1), 2012 (Plant 2)
- Client: PKN Orlen
- Scope: Plant with multiple feed flexibility (NG, LPG, naphtha and mixture)/111,000 Nm³/h (Plant 1), 55,000 Nm³/h (Plant 2)

SOUTH KOREA

- Startup: Under construction
- Client: Rosneft
- Location: Tuapse
- Scope: Largest single-train plant in the world/ 238,000 Nm³/h

CHINA

- Startup: 2007
- Client: GS Caltex
- Scope: Largest naphtha (and LPG) direct reforming based plant/110 MMSCFD

CHINA

- Startup: 2011
- Client: Air Products
- Location: Chengdu
- Scope: One of the largest HyCO facilities based on steam reforming/100,000 Nm³/h hydrogen and 28,000 Nm³/h syngas including pre-combustion CO₂ capture

INDIA

MALAYSIA

- Startup: 2020
- Client: Petronas
- Location: Malaysia
- Scope: One of the world largest facilities including 3 trains/344,500 Nm³/h and 14,500 Nm³/h of Syngas including pre-combustion CO₂ capture

SINGAPORE

- Startup: Under execution
- Client: Neste
- Scope: Complete plant 40,000 Nm³/h

INDIA

- Startup: 2017
- Client: Air Products
- Location: Kochi
- Scope: Gas turbine integrated facility with cryogenic installation for co-production of syngas /2 trains of 91,000 Nm³/h + 18,000 Nm³/h Syngas

KTPA: kilo tonnes per annum
 Nm³/h: Normal metre cubed per hour
 MMSCFD: Million standard cubic feet per day
 1MMSCFD = ~ 1.117 k Nm³/h



Narik Basmajian
VP Hydrogen Product Line
France: +33 1 8567 4171
UAE: +971 2 697 1118
narik.basmajian@technipenergies.com

THE NETHERLANDS

Zain Abdin
Vice President Sales
+31 79 3293 625
zainul.abdin@technipenergies.com

USA

Vinay Khurana
Vice President Sales
+1 909 376 8142
vinay.khurana@technipenergies.com

technipenergies.com