HYDROGEN

FLEXIBLUE®

HYDROGEN

ROX

Casale & Technip Energies' Recuperative and Oxidative Reforming for large-scale low-carbon Hydrogen plants

T.EN TECHNIP ENERGIES

CASALE

We are a global partner in the chemical industry, offering **integrated technologies, engineering, contracting and construction solutions** for over a century.

Our mission

Contribute to shape a new sustainable planet with our plants for the production of fertilizer, methanol, hydrogen, melamine and derivatives, and help our customers creating value respecting the environment.

We are a global company front leader in the energy transition: a key player in the sustainable transformation of the chemical and energy industry, from a social, economic and environmental point of view.

Our values

INNOVATION PEOPLE CARE **PROFESSIONAL EXCELLENCE** QUALITY **SAFETY** ETHIC **SUSTAINABILITY**

Casale and Technip Energies: a long term partnership

Technip Energies and Casale have a long relationship, going back to the 1980s, with numerous achievements in the syngas and hydrogen fields. A new partnership is formed to jointly license oxidative reforming-based technologies. As part of this collaboration, Technip Energies and Casale are co-licensors of the technology and Process Design Packages (PDP's), the associated proprietary equipment, or entire plants on an EPC basis. Technip Energies and Casale together bring unique strengths for improved low-carbon hydrogen project performance.

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Casale and Technip Energies provide a solution for low-carbon hydrogen production at mid to large scale. ROX combines Recuperative and Oxidative Reforming technologies to optimize hydrogen production, which allow to achieve up to 99% carbon capture rate.
The scheme is extremely flexible and it can be customized to meet specific Client's needs for steam and power as well as be easily integrated in any downstream unit.

Capacity

- Best suited up to **600.000 Nm³/hr** in a single train

Performances

- Natural gas consumption:
  < 14 MJ/Nm³ H_2 on Low Heat Value (LHV) basis
- Net energy (Natural Gas + El. Power) efficiency: **> 70-80%+**

Benefits

- Low energy consumption
- Reduced NG specific consumption
- Reduced CAPEX and OPEX
- The steam production can be optimized from nil to maximum export.
  The excess steam can be utilized for power production
- Single train arrangement, up to very high capacities
- Compact and simple lay-out
- Auto-Thermal Reforming (ATR) is used for synthesis gas generation
- Lowest Levelized Cost of Hydrogen (LCOH)

Enviromental Impact

Carbon capture higher than 99%
Total emissions to atmosphere:
- less than 0.1 kg CO_2 / kg H_2
- less than 140 mg/Nm³ of NOx or even lower than 50 mg/Nm³ installing an SCR in the fired heater's convection section.

Casale and Technip Energies technical assets

- Design of ATR Fired Heater
- ATR reactor and burner
- Axial-Radial® Pre-Reformer
- High temperature Axial-Radial® water gas shift converter
- Low temperature Axial-Radial® water gas shift converter
- Technip Parallel Reformer (TPR®)
- Technip Large Scale Vortex (LSV®) burners

PROCESS OUTLINE

The ROX process represents a groundbreaking advancement in the production of low-carbon hydrogen, synergizing Casale and Technip's cutting-edge technologies. At its core, the process integrates Casale's pre-reforming and Casale's O_2-blown ATR with Technip's Parallel Reformer® (TPR®), which effectively leverages the heat of the ATR effluent to generate more syngas.

Operating at high pressure with a low Steam-to-Carbon ratio (S/C), this unique, multireforming approach delivers exceptional outcomes, when compared to a standard, pure ATR-based configuration, including enhanced efficiency, reduced environmental impact, and substantial cost savings. More in particular:

- reduced size of ATR
- reduced O_2 demand translating in 10%+ size reduction of the Air Separation Unit (ASU)
- 5% less natural gas specific consumption
- minimized fired duty for process purposes, which results in lower CO_2 emissions, contributing to a more sustainable operation
- reduced natural gas usage: lower methane slip translates to decreased reliance on natural gas feedstock, thereby reducing carbon usage.
- > 30% waste heat boilers' size reduction and consequent reduced "fatal" steam generation
- reduced plot area required, with significant savings in both bulk material and erection costs
- reduced CAPEX and OPEX

Factors such as S/C ratios, effluent temperature, and oxygen ratios are adjusted to minimize methane slip, leading to notable benefits:

- reduced natural gas usage: lower methane slip translates to decreased reliance on natural gas feedstock, thereby reducing carbon usage
- lower carbon emissions: by mitigating methane slip, the process yields lower overall carbon emissions.

Furthermore, taking a small portion of the produced hydrogen as fuel for the Large Scale Vortex® (LSV) burners instead of natural gas significantly diminishes the carbon footprint by up to 99%, underscoring the process's environmental stewardship.

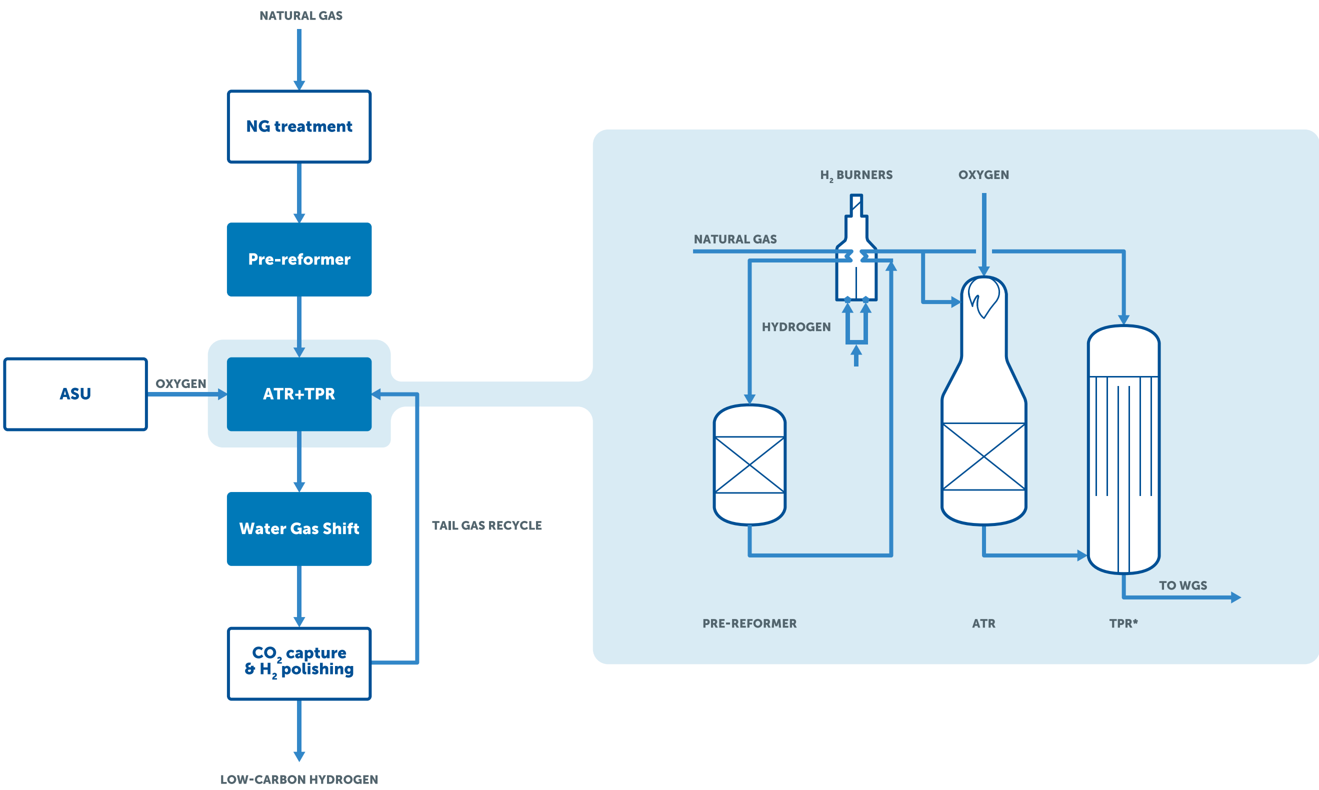
The main steps of the ROX process:

The feed natural gas undergoes desulfurization before entering the Casale Axial-Radial® pre-reformer. The effluent gas is then split as follows:

- one stream goes to the O_2-blown ATR
- the other stream undergoes reforming in the TPR®, with its heat supplied by the hot effluent stream from the ATR.

The resulting gas is treated in the Casale Axial-Radial® water gas shift section, where the CO present in the gas is converted to hydrogen.

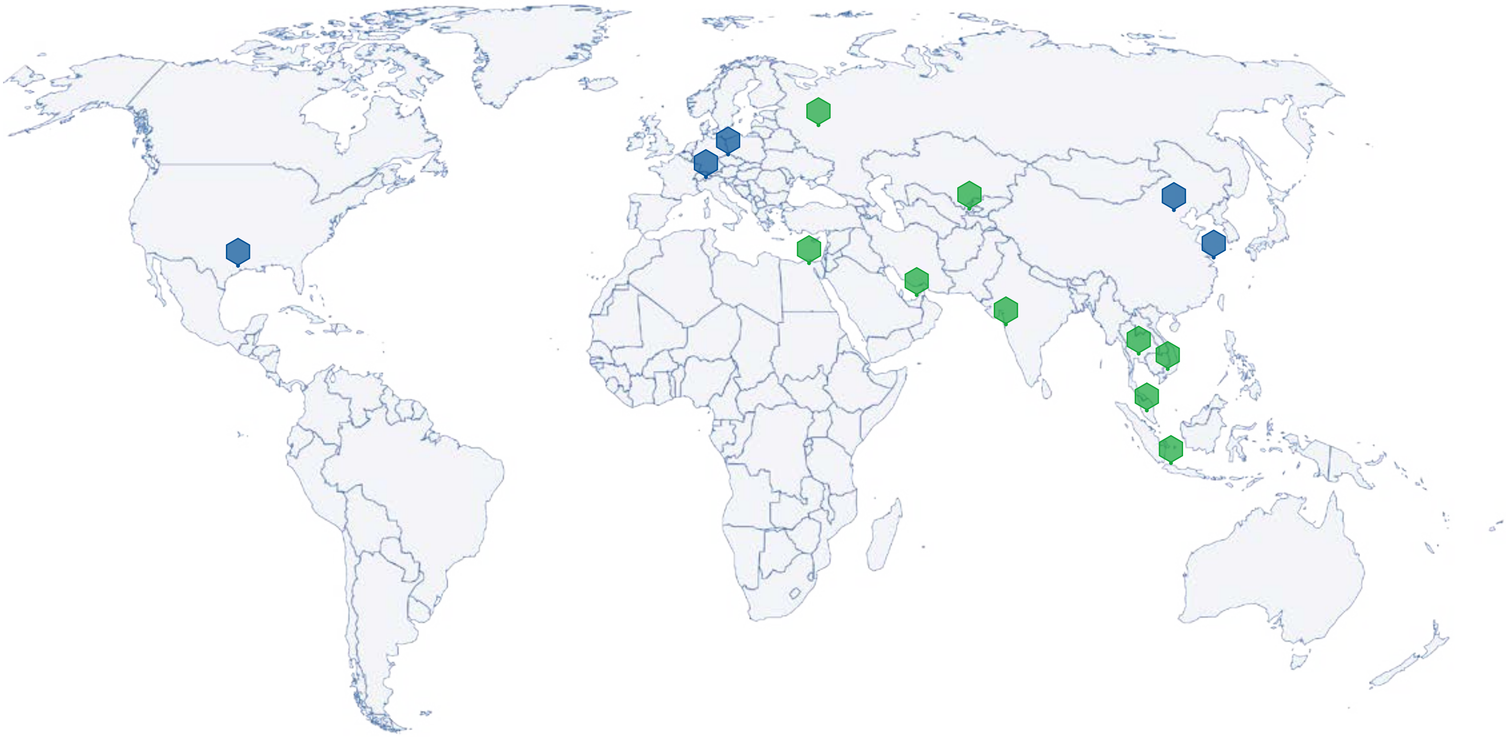
Afterwards, all CO_2 in the gas stream is extracted and recovered for either definitive sequestration or alternative applications. Final purification of the hydrogen is then accomplished using an appropriate unit, guaranteeing the production of high-purity, low-carbon hydrogen suitable for a wide range of applications.



Flow diagram of ROX low-carbon hydrogen process

PLANTS FOR
A NEW PLANET.
SINCE 1921.

Casale in the world



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