AMMONIA

FLEXIGREEN®

AMMONIA

MIX-N

Casale's solution to decarbonise existing Ammonia plants through the integration of Green Hydrogen

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 value

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

AMMONIA

MIX-N

MIX-N, part of the FLEXIGREEN® range of sustainable products, is Casale concept specifically devised to enable the integration of any existing plant with green hydrogen supply.
The MIX-N concept stands out for its simple and reliable arrangement.
It operates the plant front-end under near steady conditions, while the synthesis loop load flexibly fluctuates in response to the variability of renewable energy supply.
This approach avoids any cyclic operation, ensuring a wide range of production adaptability.

Feedstock

- **Natural Gas and green hydrogen from renewables**

Enviromental Impact

Reduced CO_2 emission: In a similar way as the NG consumption also the CO_2 emission reduction is inversely proportional to the extent of green H_2 hybridization.

Performances

- Lower energy consumption. As a general rule, the Natural Gas consumption is inversely proportional to the extent of hybridization, that is, for each percentage of green H_2 in the total H_2 fed to the plant, the NG specific consumption reduces by approximately by 1%
- The electrical energy consumption is increased on account of the increased demand for green H_2 production
- Significant production turn-down: **10-110%** in plant back-end

Benefits

- Possibility to adopt a stepwise approach up to full hybridization in order to improve project economics, e.g. taking advantage of increasing levels of CO_2 taxation
- Reduced modifications to existing plant
- Low LCOA

Casale technical assets

- Loop's dynamic analysis and Casale's proprietary solution for dynamic loop control
- Axial-Radial® ammonia converter revamping

PROCESS OUTLINE

Each MIXGREEN retrofit calls for bespoke solutions, depending on project-specific factors, such as the required extent of hybridization (i.e., how much of the NG feed is to be replaced by green H_2), the original plant licensor technology, the nature of hydrogen supply (i.e., whether steady or erratic), whether a production increase is also required as well as the current status and integrity of the existing equipment.
Casale, drawing upon its extensive and proven experience in revamping any kind of plant of any original licensor - is the ideal partner to devise and implement the best hybridization solution.
Typically, the green H_2 (i.e. generated electrolytically from renewable energy) is injected at the suction of the syngas compressor, even if other locations would also be also possible (e.g., upstream of the methanator or directly inside the synthesis loop)

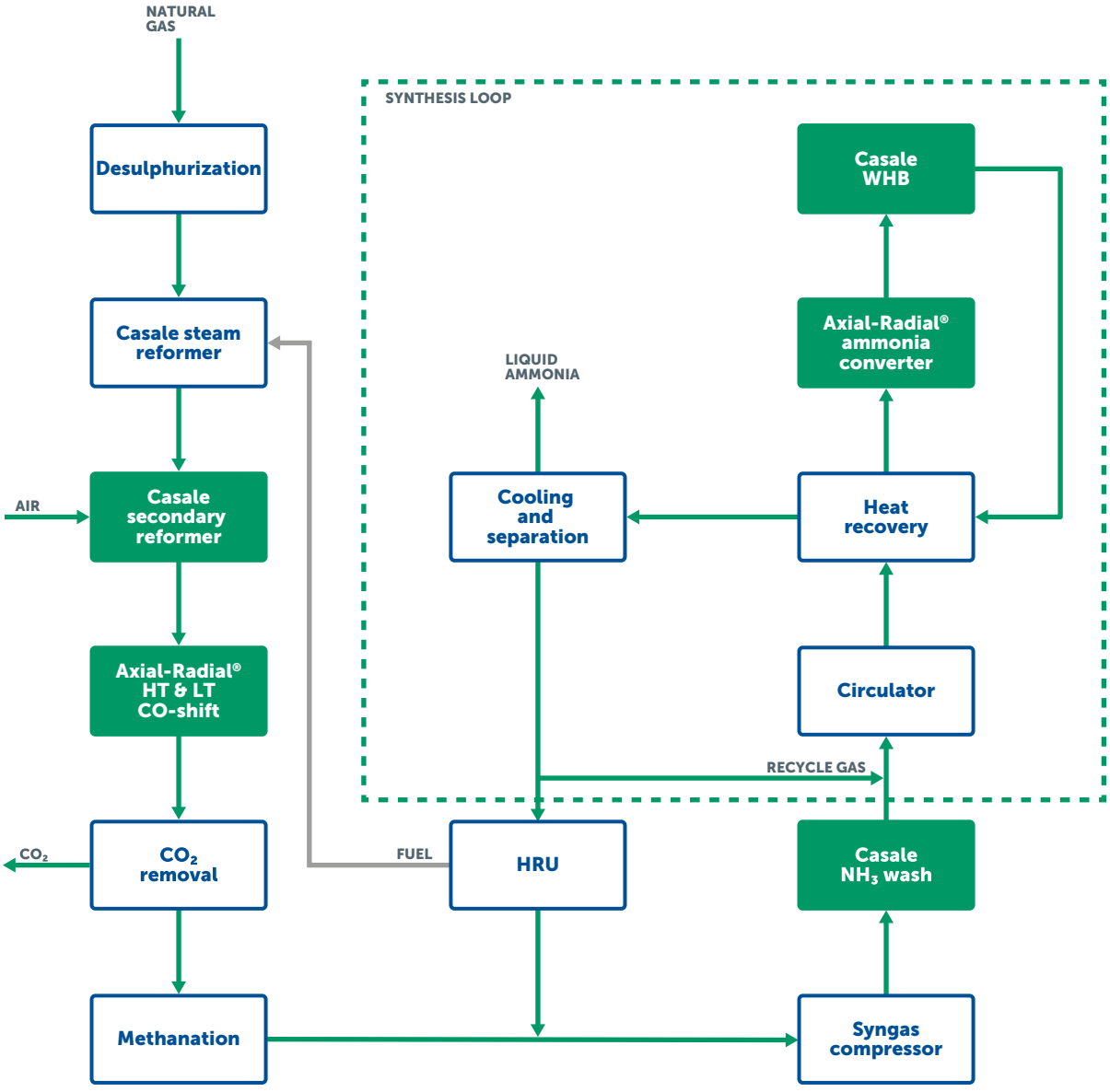
The corresponding nitrogen required by ammonia synthesis can be supplied either by increasing the air flow through the existing air compressor or, especially in case of erratic renewable energy supply, it can be generated in a criogenic air separation unit or a PSA.

For a low degree of hybridization (say, green hydrogen being less than 5-10% of the total hydrogen fed to the ammonia synthesis), it is reasonably expected that no (or just minor) modifications are necessary to the existing ammonia plant, regardless of the nature of green hydrogen supply (steady or erratic).

On the other hand, the plant front end - depending on the degree of hybridization - could require modifications particularly, to the reforming section.

Avoiding continuous adjustments of the front-end load in response to the variable renewable power supply is crucial. Such continuous changes could, in fact, lead expensive equipment upgrades in order to ensure mechanical integrity, given the cyclic operation of the system, which can trigger fatigue-related issues. To address this concern, a "stepped" strategy is adopted for modifying the front-end load. This entails selecting the front-end load, for example, on a weekly or bi-weekly basis, to prevent constant adjustments of the operating parameters.
Conversely, the synthesis loop would be operated in a continuous and flexible manner, adjusting the operating parameters consistently, by means of the Casale's proprietary control philosophy also adopted for green ammonia plants that allows production variations in the range 10-110% and according to quick ramp-up and ramp-down parameters (3%/min).

The use of a hydrogen storage is in general not mandatory, but it can be evaluated in case of high hybridization rates, if it is beneficial for the project economics.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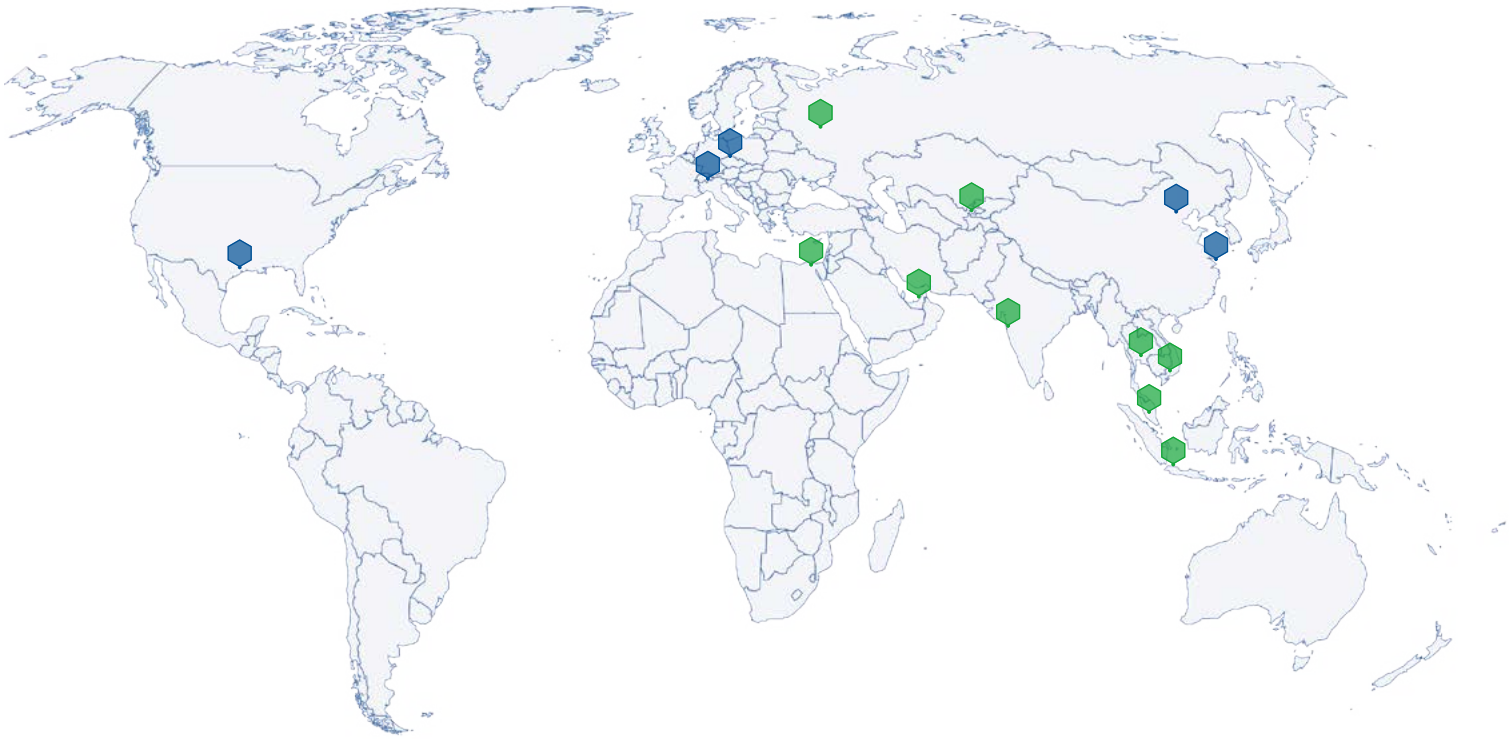
Casale in the world



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