GT GreenbergTraurig & DEEP.KBB & ABEL

Hydrogen: Infrastructure and Storage Projects

June 10, 2021

Agenda

1. Introduction
2. Presentation: Large-Scale Underground Storage as the First Hydrogen Infrastructure? (by **Gas Storage Denmark**)
3. Presentation: Hydrogen Transport and Storage (by **Snam**)
4. Panel Discussion

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GAS STORAGE DENMARK

LARGE-SCALE UNDERGROUND STORAGE AS THE FIRST HYDROGEN INFRASTRUCTURE?

GT WEBINAR: HYDROGEN INFRASTRUCTURE AND STORAGE PROJECTS

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•agenda

- About Gas Storage Denmark
- An example of GSD's contributions for the green transition
- Outlook: Scaling through continues value chain optimization

About Gas Storage Denmark

We own and operate Denmark's 2 underground gas storage facilities:

- 7 salt caverns in northern Jutland. In operation since 1987.
- The aquifer storage facility in central Zealand. In operation since 1995.
- Total capacity of 900 mil. m^3
- 45 employees

GAS STORAGE DENMARK

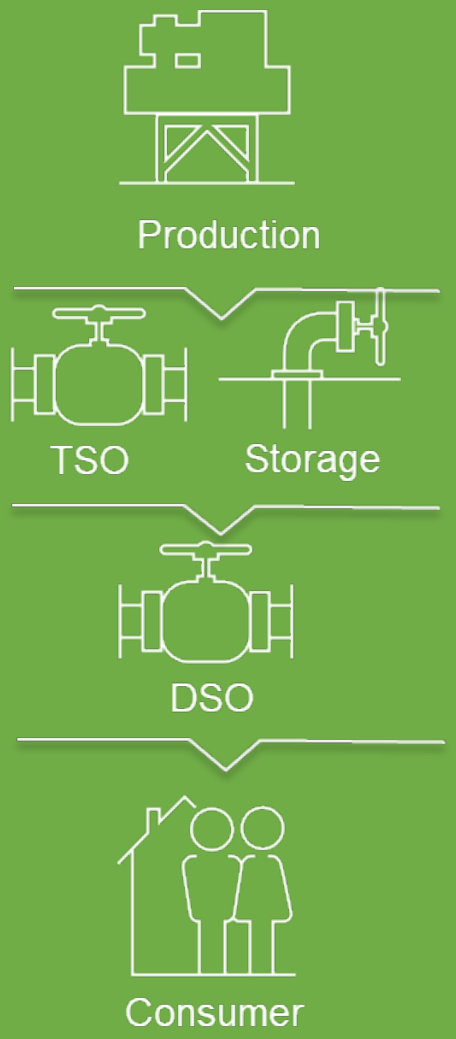
Infrastructure with a purpose

- Not a commercial company
  - We are *state owned*
  - We operate *critical infrastructure*
  - *Our target is a Green, Affordable and Secure energy supply*

But we act in a commercial framework

- We operate on *marked conditions*
- We optimize our *customers' value creation*
- We aim for *company profit* as the foundation of a *sustainable business*

FROM SINGLE TO MULTI COMMODITY BUSINESS



GAS STORAGE DENMARK

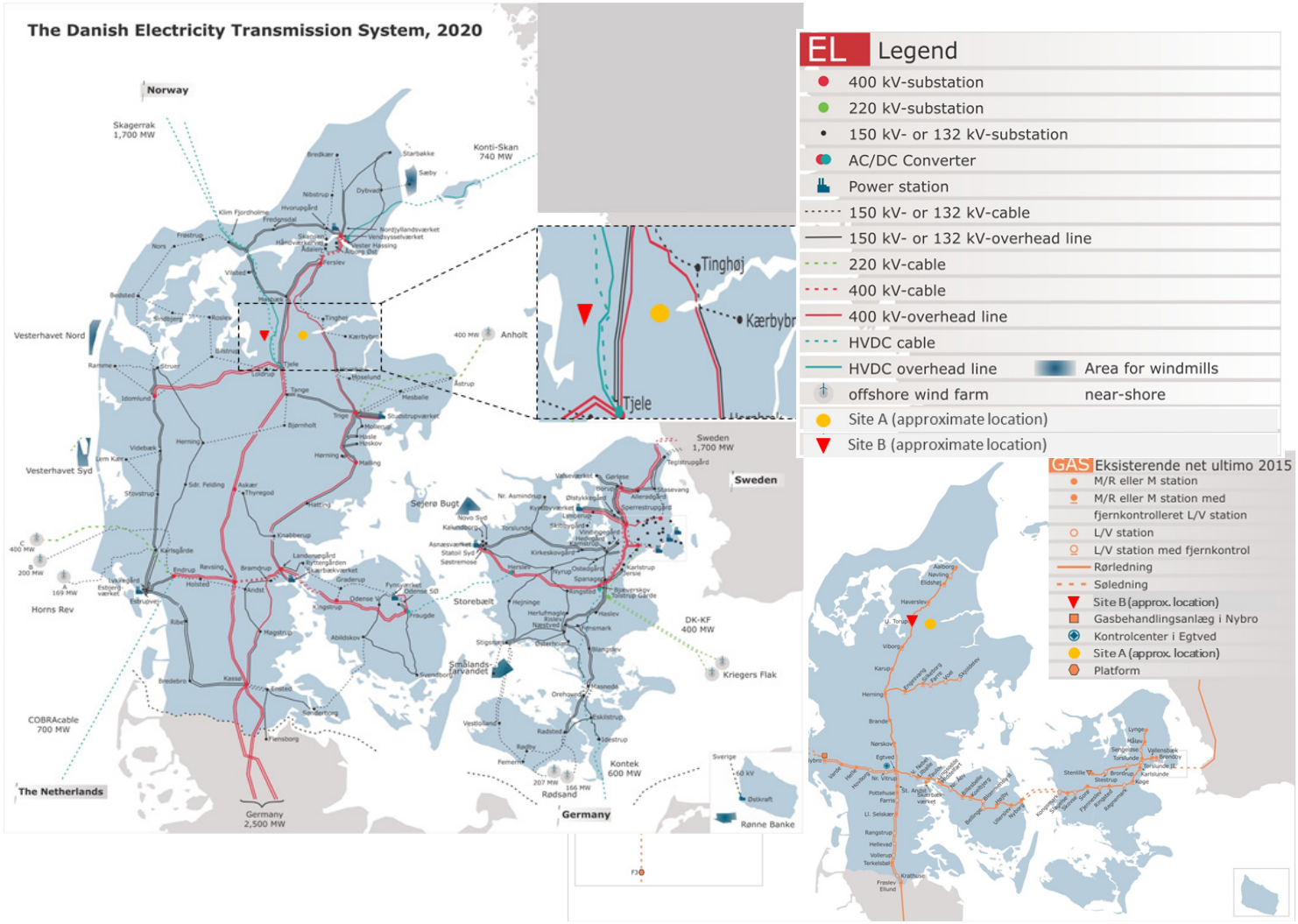
A PART OF ENERGINET

AS HYDROGEN STORAGE WILL HAVE SOCIETAL VALUE, LOCATION WILL BE KEY TO BROAD SECTOR INTEGRATION

GSD GAS STORAGE DENMARK

- Strategic position in the area between Hobro and Viborg will not only allow to create value for the Danish society, but also on European level:

- Very good integration to electric grids
- In vicinity of potential H2 customers
- In vicinity of biogas production
- In vicinity of wind farms
- In vicinity of district heating customers



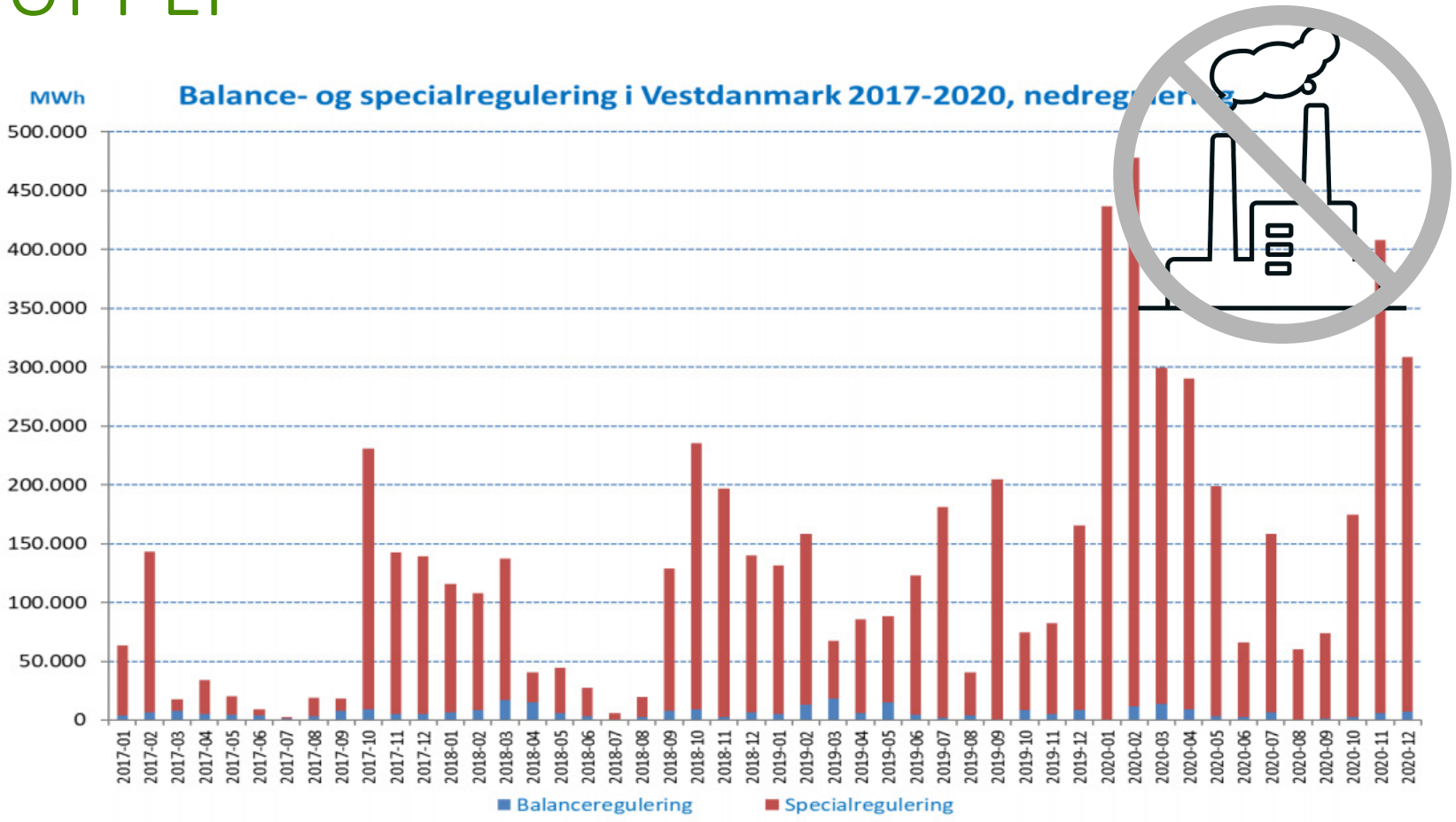
GREEN
HYDROGEN HUB
DENMARK

AN EXAMPLE OF GAS STORAGE DENMARK'S CONTRIBUTIONS FOR THE GREEN TRANSITION

HIGHER USE OF RENEWABLE ENERGY REQUIRES HIGHER AVAILABILITY OF SECURITY OF SUPPLY

GREEN HYDROGEN HUB DENMARK

- In December 2019 the danish parliament **voted in favour of 70% reduction in GHG** (Green House Gasses) by 2030.
- Changing over to more renewable-based energy production, **supply must be flexible to maintain sufficient supply**.
- With this society gets even more **dependent on security of supply**.



GREEN HYDROGEN HUB DENMARK IS BEING DEVELOPED THROUGH PRIVATE-PUBLIC CO-CREATION PARTNERSHIPS

GREEN HYDROGEN HUB DENMARK

GSD GAS STORAGE DENMARK

We cannot do this on our own

Hen and the egg dilemma: hydrogen production requires customers and customers require production.

Infrastructure needs to have many customers in order to be economically viable.

A shared business model approach

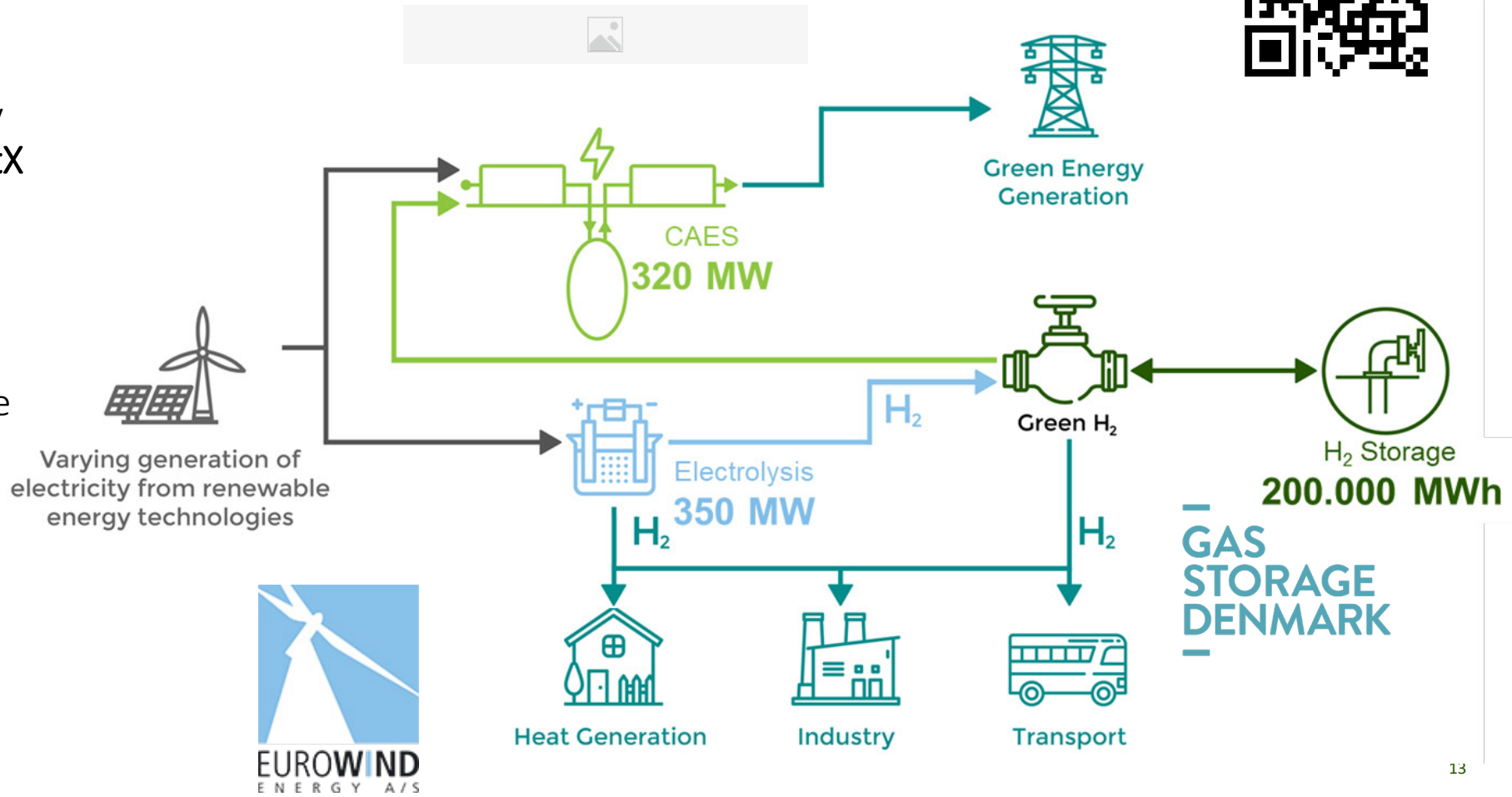
We are looking at the added value across the whole value chain, before we look into the value creation of each entity.

The purpose of this is to reduce risk across the entire value chain.

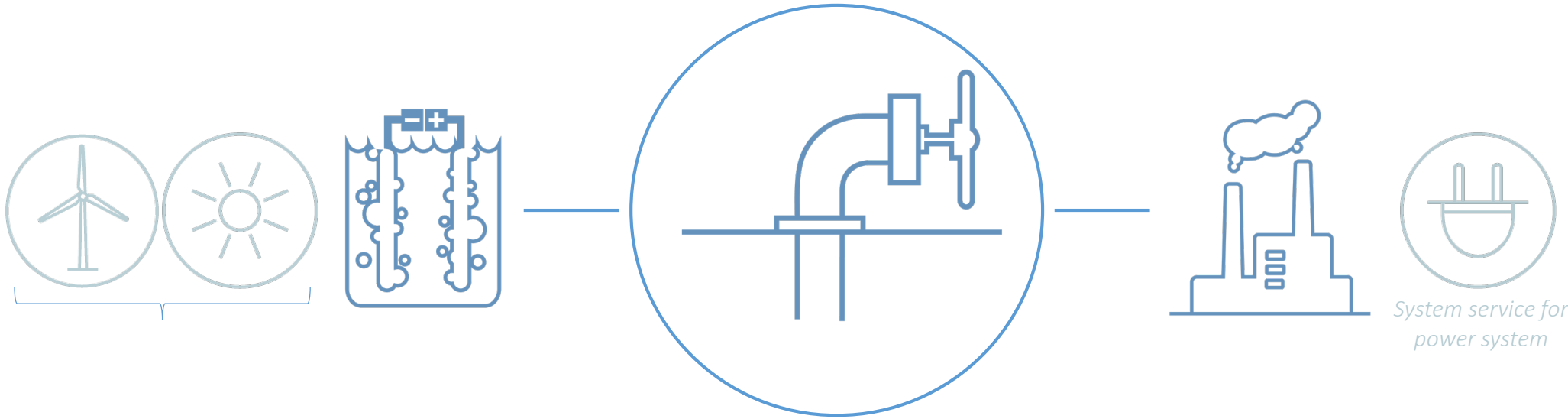
GHH ENABLES THE SIMULTANEOUS CONSTRUCTION OF AN END-TO-END GREEN HYDROGEN VALUE CHAIN

- Green Hydrogen Hub Denmark (GHH) is a **PtP project** with one of the key objectives to enable the **PtX industry**

- The vision of GHH is to create **the world's first co-located scheme** to combine **large-scale electrolysis**, **hydrogen storage** and hydrogen-fueled **Compressed Air Energy Storage** (CAES)



FOUR TYPES OF SERVICES AND COSTUMERS



Sceurity of demand
Price risk mitigation:

- Renewable energy produceres

Sceurity of Supply of Green Hydrogen

- Industries
- RED-II e-fuel

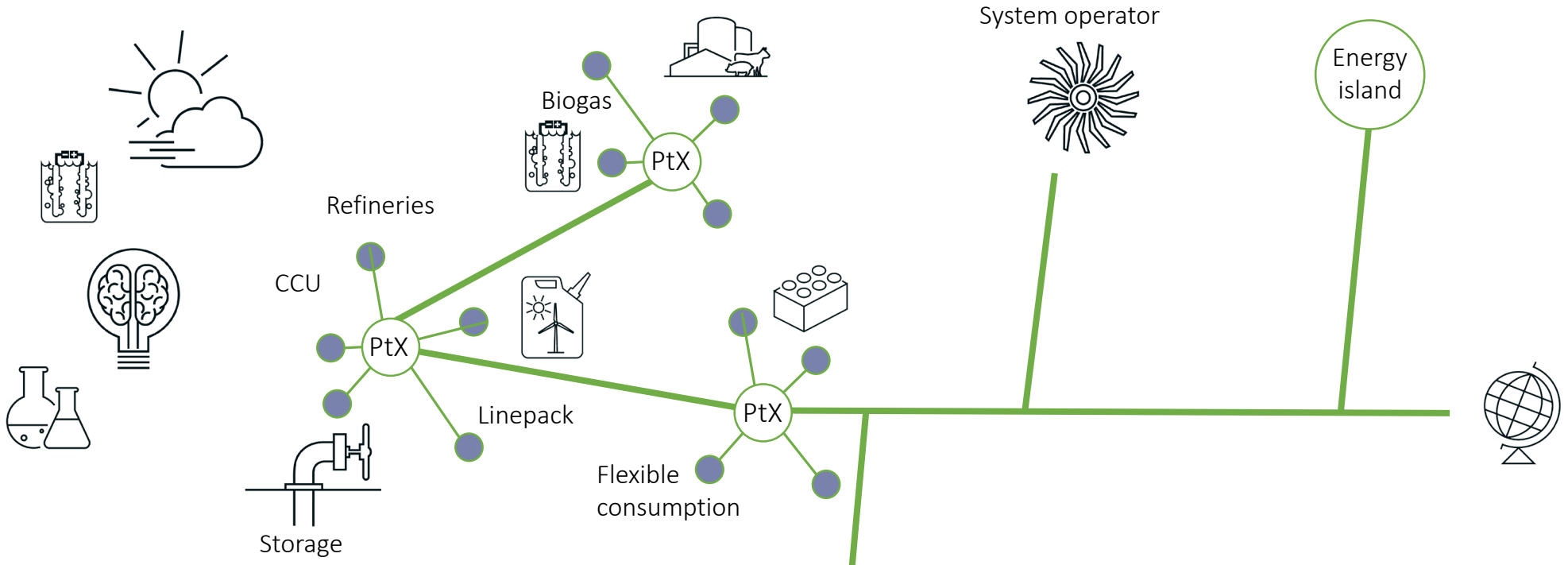
Real-time green power

- Accountability / Additionality driven demand

Asset backed trading

OUTLOOK: SCALING THROUGH CONTINUES VALUE CHAIN OPTIMIZATION

POSSIBLE ROLL-OUT OF HYDROGEN INFRASTRUCTURE



DEMO PROJECTS | CLUSTER/ POINT-TO-POINT | CONNECTIONS | GROWING NETWORK | EXPORT

SNAM
H2 WEBINAR GREEBERG TRAURIG
JUNE 2021

Overview

About Snam

Snam is One of the Main Global Energy Infrastructure Companies

Key figures

€ 22.6 bn RAB + affiliates ('19)	**€ 28 bn** Enterprise Value	**1.1%** Debt cost
€ 1.093 m Net Profit Adj ('19)	**~ € 15 bn** Market Cap	**BBB+** Rating

30.3% CDP Reti

69.7% Free float
~80K investors

International associates

Trans Austria Gasleitung · TERĒGA · Trans Adriatic Pipeline · GAS CONNECT AUSTRIA · Interconnector · DESFA · albgaz · Snam Beijing Gas & Energy Services · ADNOC

Natural gas[1]

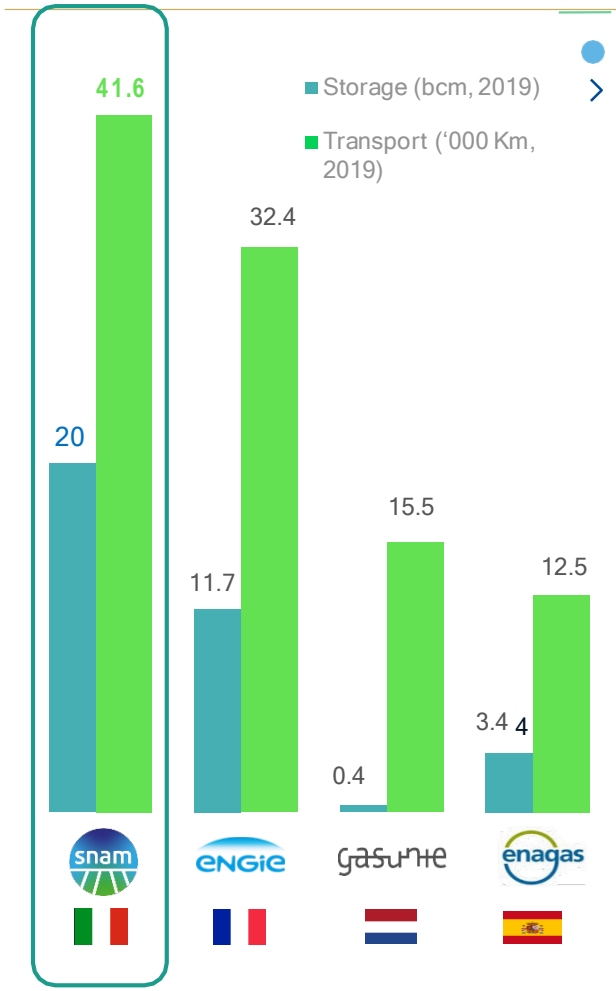
~41,700 km	~20 bcm capacity	~20 bcm/y capacity
Transport	Storage	Regasification

New companies for energy transition

- BU Hydrogen
- Snam4 Mobility
- Snam4 Environment
- Snam4 Efficiency
- ARBOLIA

[1]Italy and international associates

Largest Natural Gas Infrastructure in Europe and Second Largest Worldwide



3/3 Our regasification terminals in Italy

2012

Interconnector

235 km bi-directional submarine pipeline connecting UK and Belgium

2013

Teréga

Transmission (~5,000 km network) and storage (2.8 BCM capacity) player in south-west of France

2014

TAG

Pipeline (~1,140 km) bringing Russian gas in Italy through Austria

2015

TAP

Last section of the Southern Corridor bringing Azeri gas to Europe Pipeline (878 km) connecting Greece and Italy

2016

GCA

Transport and distribution network (564 + 322 Km) in Austria connecting Germany, Hungary, Slovenia and Slovakia

2018

DESFA

Acquisition by Snam, Enagas, Fluxys of a 66% stake of Desfa, the Greek gas infrastructure operator

2020

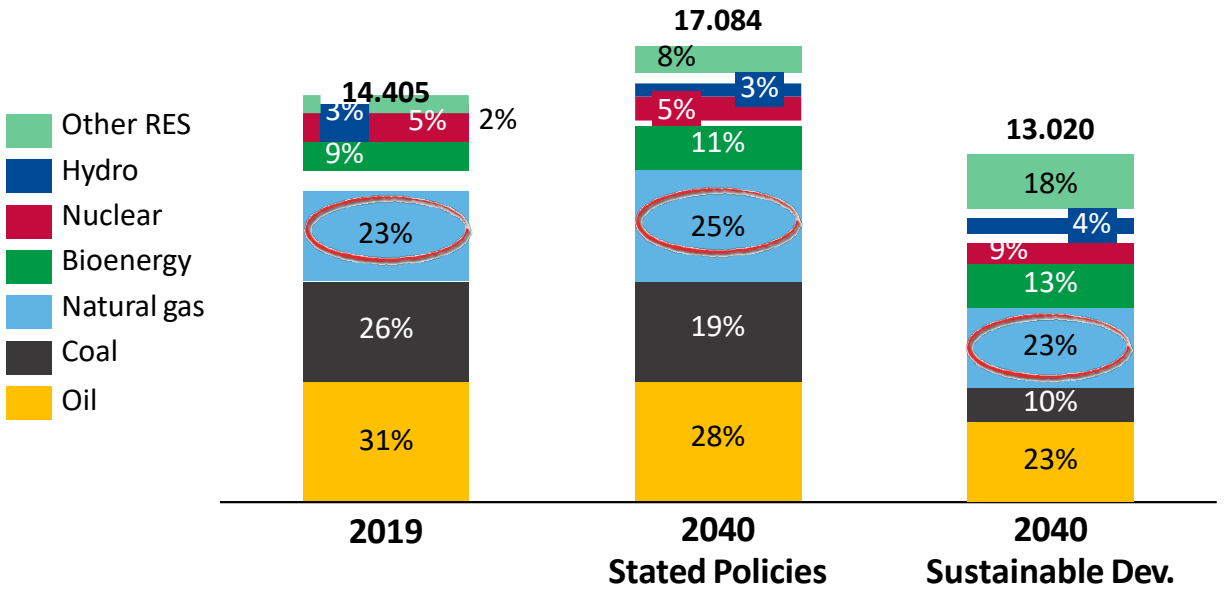
ADNOC

Sole Industrial player in the 49% stake of ADNOC Gas Pipelines, a company controlled by ADNOC with an enterprise value of $ 20.7 bn

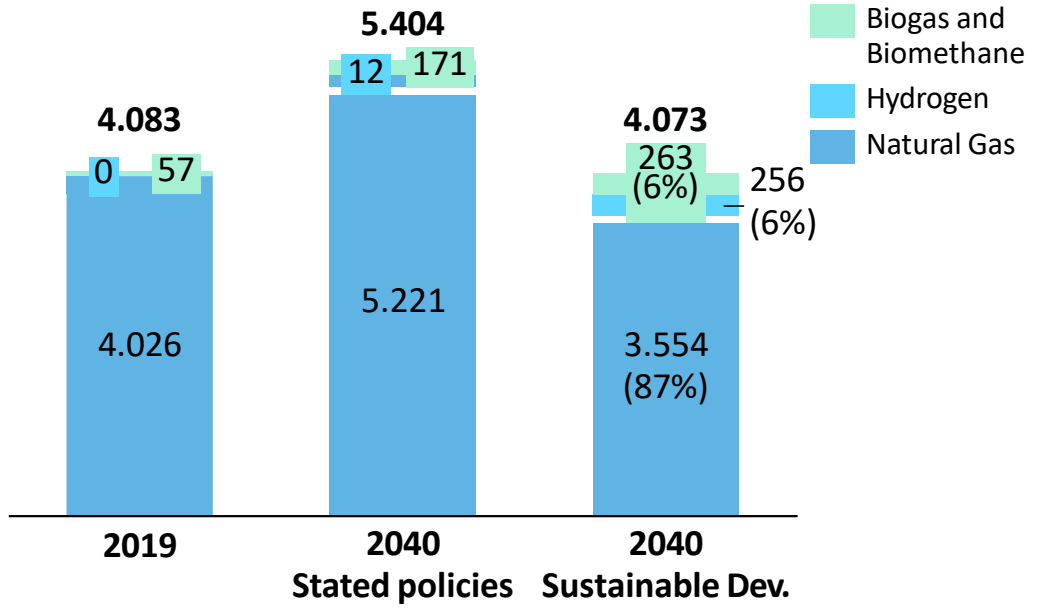
NOTE:
Data referred to Snam and its subsidiaries (Teréga, TAP, IUK, TAG, Desfa). Countries are France, Austria, Belgium, UK, Greece, Italy.
Snam owns 100% of Panigaglia LNG terminal, 7.3% of Adriatic LNG and 49.07% of OLT Offshore LNG Toscana S.p.A.

The Role of Natural Gas and Hydrogen in the Future Energy Mix

Global primary energy demand[1] (*Mmtoe*)



Global natural and low-carbon gases demand[1] (*Bcm*)

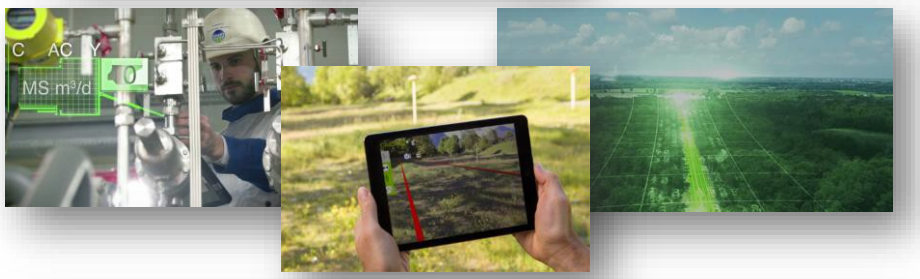


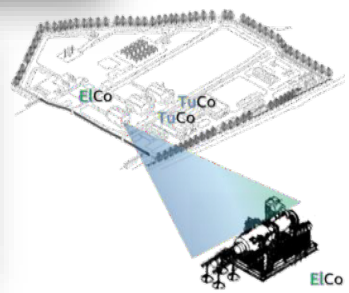
Strong future role for gas infrastructures

1. World Energy Outlook 2020

The Future Role of Gases will Require Infrastructure Upgrades To …

Enable H2 ramp up (also in blending)	• Know your network km by km, item by item • Understand the "as is" potential • Analyse the gaps vs XX% of blending • Define your roadmap of upgrades • Evaluate upgrade investment required
Digitalize the asset	• Smart Gas … a single digital platform to operate and manage the asset from E&C to daily operation • We are continuously investing in digitalization, AI and ML to improve operational efficiency, safety, and network availability
Enhance the ability to assess and maintain its integrity	• Our leak detection platform (PIMOS) is based on neural network AI to identify leakages within 150 mt of accuracy • Our Cathodic protection platform Pegaso monitor in real time >3400 clusters of network to extend assets life • Developing remote sensing of infrastructure to prevent external interference damages
Reduce the emission	• Optimize compressor station efficiency thru combination of electric and gas driven compressors • Enable sector coupling of GAS & Electricity • Foster the development of renewable energy to enable Hydrogen production





NG and H2 Transportation

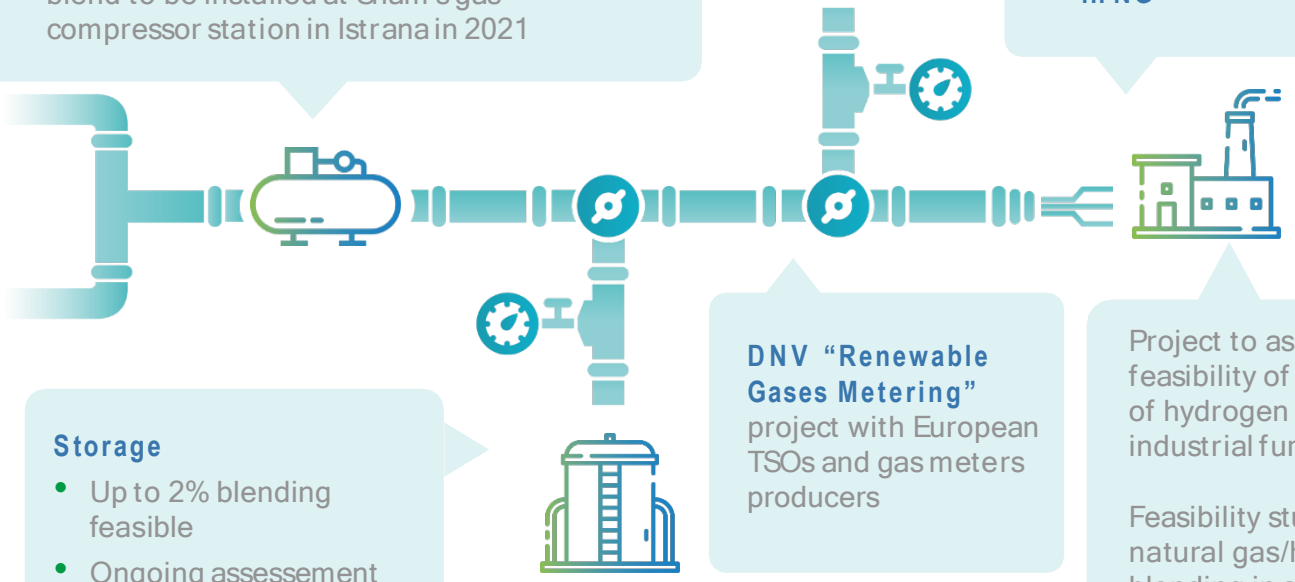
Transition to Hydrogen … H2-Readiness along the Infrastructure Value Chain

ITALIAN INFRASTRUCTURE

Compression stations:

- Definition of standards for H2NG mix to fuel compressors and turbines
- New "hybrid" compressor turbine tested with Baker Hughes, suitable for up to 10% H2 blend to be installed at Snam's gas compressor station in Istrana in 2021

Development of the first H2 network for a cluster of industrial users supplied with **mixtures of up to 10% green H2 in NG**



Pipelines

- 70% of pipes hydrogen ready)
- Procurement standards for H2 ready pipelines

Storage

- Up to 2% blending feasible
- Ongoing assessement for higher percentage
- CO2 storage potential
- (under analysis)

DNV "Renewable Gases Metering" project with European TSOs and gas meters producers

Project to assess the feasibility of using high % of hydrogen in steel mill industrial furnaces **(RINA)**

Feasibility study on natural gas/hydrogen blending in steel thermal treatment, to be developed through European/national funding

Working for a «Hy-ready» network

Sector collaboration

H2 Gas Asset Readiness (H2GAR) cooperation between EU TSOs.
6 working groups on pipelines, compressor stations, separation systems, metering, safety and underground storage

European H2 Backbone plan - done in collaboration with 11 EU gas infrastructure companies - for a dedicated hydrogen transport infrastructure

Snam H2 Testing with End Users …

End User	H2 blending	When	Description
Pasta factory	5%	April 2019	• **Injection** campaign of a **hydrogen-natural gas blend** (H2NG) in a portion of the **Snam grid** (Contursi Terme) • It has been verified the **regular working** of: ✓ Snam **Reduction plant** (piping and instrumentation) ✓ **Pre-heating section** (gas boilers)
Water bottling	 10%	December 2019	
Steel forging	30%	May 2021	• July 2020 Snam launched a project w/ Rina to assess the **performance of industrial burners** with H_2NG mixtures • Burners have been **tested** at Rina combustion station with a **30%** H_2 in volume with **no need of hardware modifications** • Testing has **been successfully replicated in the industrial plant** of Forgiatura A. Vienna, part of Giva Group, a worldwide leader in production of ingots, forgings & valves

Snam “H2 Readiness” Service Helps Global Players to Assess their Infrastructure and Optimize Investments Needed to get Hydrogen Flow-Through

Transportation network - H2 Readiness: Pipelines - Standards

Standards

- SNAM internal standards **("GASD")** come from the implementation of the **ISO, EN, UNI *.**
- Design and construction of all SNAM pipelines and plants are based on these standards including company's know-how.
- **Pipelines internal standards** "hydrogen ready" are based on the ASME B31.12' "Hydrogen Piping and Pipeline" standard.
- GASD remain unchanged for H2NG mixtures up to H2 10% in volume. Once this limit has been exceeded, new GASD must be followed. The standards regulate design and construction phases of new gas pipelines.

*SNAM regularly participates in the UNI, EN and ISO working groups by actively participating in the drafting and definition of industry standards.

10

Gas turbines and Compressors – H2 Readiness

GAS TURBINES

For H2 percentages **up to 5%** by volume, there are **no hardware modifications** to be done on SNAM gas turbines. **In principle,** the **suppliers have extended** the H2 **limit up to 10%** in H2NG fuel blend.

SNAM is planning Factory and On-Field tests for appropriate verifications and validations. The H2 percentages are meant to be variables within the defined limits.

For H2 Above 10% , hardware modifications are required, while for percentages **higher than 20%** it is necessary **to purchase specific machines** in order to operate with this H2 percentage.

GAS COMPRESSORS

There are **neither performance nor integrity problems for percentages of H2** by volume **up to 5%.** This limit shall be considered conservative.

With the **exception of some specific operating points,** to be verified case by case, the **value can be extended approximately up to 10%.**

Above 10% and generally **up to 20% of H2,** it is necessary to **rebundle the compressor. Above 20%** it is necessary to **replace the machine.**

12

	Scope of the Study		Scope of the Study
A	MATERIAL & WELDING	E	LDS – LEAK DETECTION SYSTEM
B	COMPRESSORS, TURBINES, COOLERS & PRESSURE EQUIPMENT	F	SAFETY
C	CONTROL VALVES & ACTUATORS, BALL, GATE, PLUV VALVES, CHECK VALVES	G	PIPELINE HYDRAULIC PERFORMANCE AND CONTROL
D	METERING – GAS CHROMATOGRAPHS & FLOW METERS	H	APPLICABLE STANDARDS FOR PIPELINE SYSTEM
		I	EMISSIONS

NG and H2 Storage

Storage

The **largest European gas storage player** with **9** operating **fields** in Italy

Main figures (2019)

Headquarters
San Donato Milanese (registered office)
Crema (operating office)

Storage concessions
9 (5 in Lombardy, 3 in Emilia-Romagna and 1 in Abruzzo)

Clients
~ 88 (shippers)

Technical investments
€112 m

Operating profits
€337 m

Gas moved
~ 19.3 bcm

Total storage capacity available
~ 16.9 bcm

H2 Storage Readiness for Italian Depleted UGSs - Project Objectives

Foreword

Current scientific literature doesn't provide all the needed elements to deem H2 storage into depleted reservoir as a viable safe technology

For this reason has developed a programme involving research institutes and academic entities multidisciplinary studies on the physical, chemical and microbiological aspects associated to the storage of CH4 + H2 mixture.

This program will allow to create the technical basis for the definition of the pilot project on one of Snam assets

Politecnico di Torino
ISTITUTO ITALIANO DI TECNOLOGIA
Politecnico di Torino SEASTAR
CO_2 Circle Lab

Areas of analysis

- ✓ Diffusivity tests Test on cap-rock
- ✓ Reservoir rock characterization pre-post exposure to gaseous mixture at different H2 percentage
- ✓ Microbiological study on bacterial typology and characteristic of the reservoir
- ✓ Fluido-dynamic and numerical modelization at reservoir level
- ✓ Design and construction of a multi-parametric reactor to run test at reservoir conditions
- ✓ Analysis of cements, steels, elastomers and joint when exposed to gaseous mixture at different H2 percentage

H2 Storage Readiness for Italian Depleted UGSs - Project Phases

Phase 1

April 2021

- Test result on cements 10% - 50% - 100%
- Preliminary microbiological study - Bacterial mass type and characteristics
- Test result at 2% - 10% - 20% of site specific H2
  - effects on **reservoir rock**,
  - diffusivity **test on cap rock (2% - 10%)**
  - **hydrogen - methane interaction**

- Equation of state calibration
- **Numerical simulation** of reservoir on possible Pilot and specific storage field
- **Preliminary results** on elastomers and joints
- Design and construction of **multi-parameter reactor for high H2% tests**

Phase 2

December 2021

- Final microbiological study - **Bacterical mass type and characteristics**
- Test result at% higher of H2 site specific (to be defined on the basis of the results of Phase 1, e.g. 50% 100%)
  - effects on **reservoir rock,**
  - **diffusivity test on cap rock**
  - **hydrogen - methane interaction**

- Characterization of **hydrogen solubility in formation water**
- Test on **elastomers**

Please note: the activities take into consideration tests carried out in the multireactor system

Phase 3

July 2022

- Reactivity characterization of hydrogen reservoir rocks
- **Threshold pressure** characterization of cover rock
- Test result and gas **flow modeling** at the microscale
- Microbial activity modeling in the reservoir and bacterial evolution at reservoir condition

- Strength test result on steels

Please note: the activities take into consideration tests carried out in the multireactor system

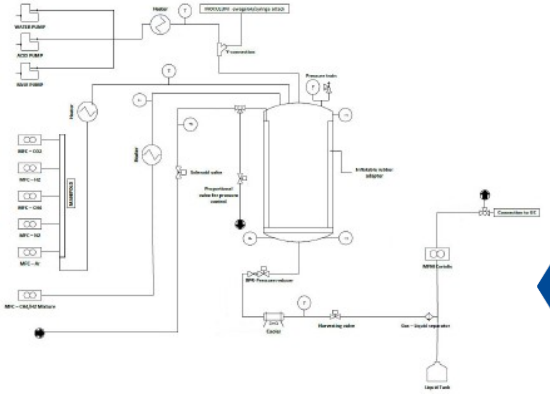
Multi-Parametric Reactors

Design e construction of a multi-reactor for experimental tests execution

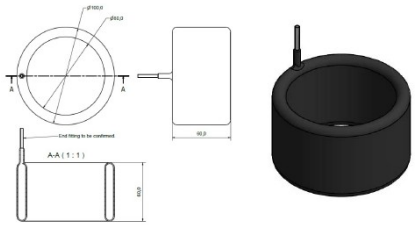
Multi-parametric reactor which allows to execute test at reservoir conditions and monitoring all the input parameters for the multidisciplinary studies.
It is a NON standard device designed on Snam specs and needs aimed at evaluating effects and ideal conditions for storage of H2 mixture up to 100% h2 in depleted underground reservoirs.

The reactor has been designed to work in **multi-sensorial mode** (both biological measurements on micro-organism and physic-chemical reaction on gaseous/liquid component) with synthetic and real samples, and with different porous structure.

A **seamless pressure and temperature control system** has been implemented for the full device (reactors and feeding lines) allowing to reproduce real reservoir condition always guaranteeing safe condition for the operator.



Specs
- Temperature Range : **20 -150°C**
- Pressure range: **1 to 200 bar**
- 3 lines for pressure gas
- 3 lines for pressure fluids
- Polymeric adaptable samples lodging system suitable for flow no flow tests



SNAM GLOBAL SOLUTIONS

Natural gas value chain

Energy transition + H_2

The Global Solutions value proposition

Covering the whole gas value chain with a unique end-to-end approach

ADVISORY & TRAINING

Managing the challenges rising from market development and the energy transition

- Capacity building
- Access code support and tariffs set up
- Commercial set up
- Consultancy on H_2 readiness, biomethane plants and fuelling stations for CNG

TECHNICAL SERVICES AND DIGITAL TRASFORMATION

Tailored process building and design to achieve reliability, operational improvement and cost efficiency

- Assessment and gap analysis
- O&M reengineering for optimization
- Engineering services
- Hybrid cloud transformation and software applications
- Digital journey (e.g. smart infrastructures, AI & IoT for gas infrastructures and processes)

ASSET DESIGN AND MANAGEMENT

Actionable knowledge and a solid partner from engineering to operation of the assets of complex transport, storage and regasification infrastructures

- BOOT
- EPC(M)
- Full O&M execution and services on complex infrastructures
- Project management

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