



energia per ispirare il mondo

# Pathways towards Hydrogen

16th Dec 2022

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# Snam is a leading company in the gas infrastructures



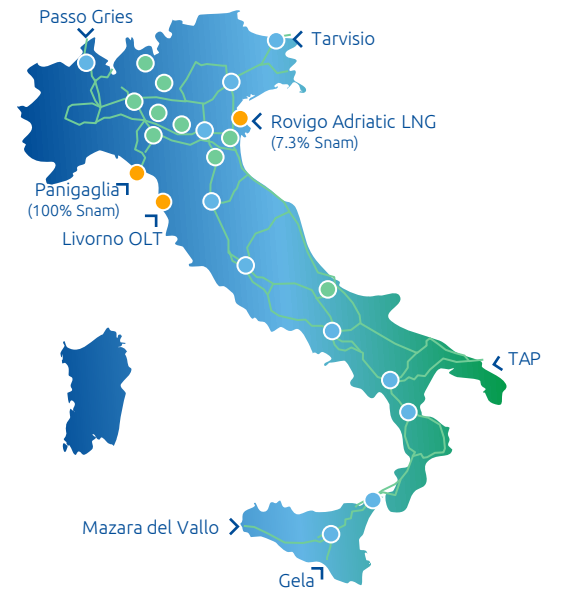
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- National transport grid
- Compressor stations
- > Entry points
- Storage sites
- Rigassification Terminals

~ 33.000 km

17 bcm storage capacity (16% mercato UE)

✓ Test 10% di blending H2 (Contursi, Salerno)



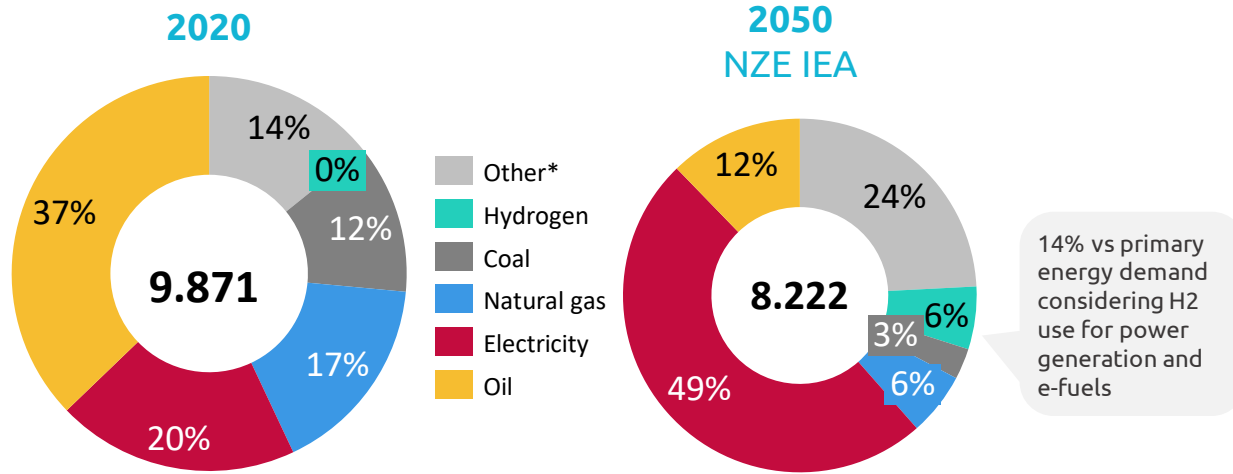
## New business for energy transition

- Value Chain H2
- Asset readiness
- Energy efficiency Platform (Renovit) with CDP
- Sustainable Mobility
- Biomethane infrastructures
- Other decarbonization Projects

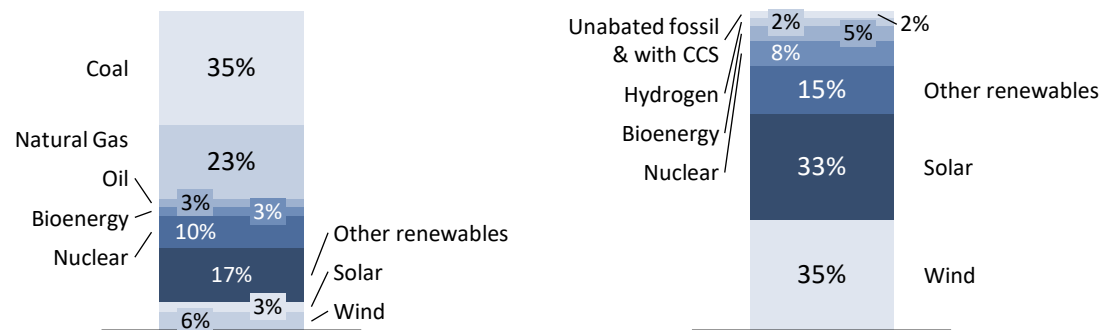


# Our end point: net zero

## Global final energy demand by fuel, Mtoe



## Global power mix



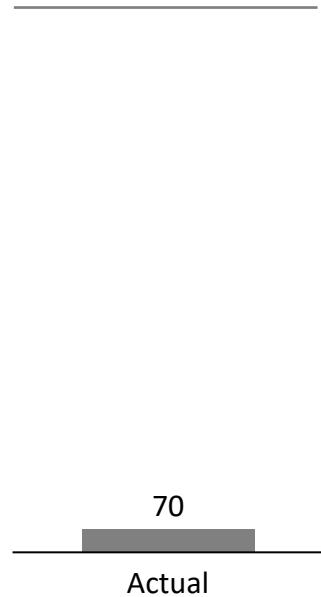
## Key trends related to Net Zero scenarios

- Electrification of final demand increasing** from 20% today up to 50% in 2050
- Primary energy consumption per capita decreasing by ~20% by 2050 due to **Energy efficiency enhancement**
- Growing penetration of RES** with wind and solar having ~70% share in the power mix @2050 and increasing need for the flexibility the energy system
- Importance of green gases and especially Hydrogen and its derivatives** (NH3, e-fuel) as key energy vectors to ensure full decarbonization and **sector coupling**
- CCS emerging as necessary technology** to achieve net-zero – 6-12 Gt per year will be required by 2050 (10 - 20% of current GHG emissions)

# Focus H2: scenarios see a share of around 15%

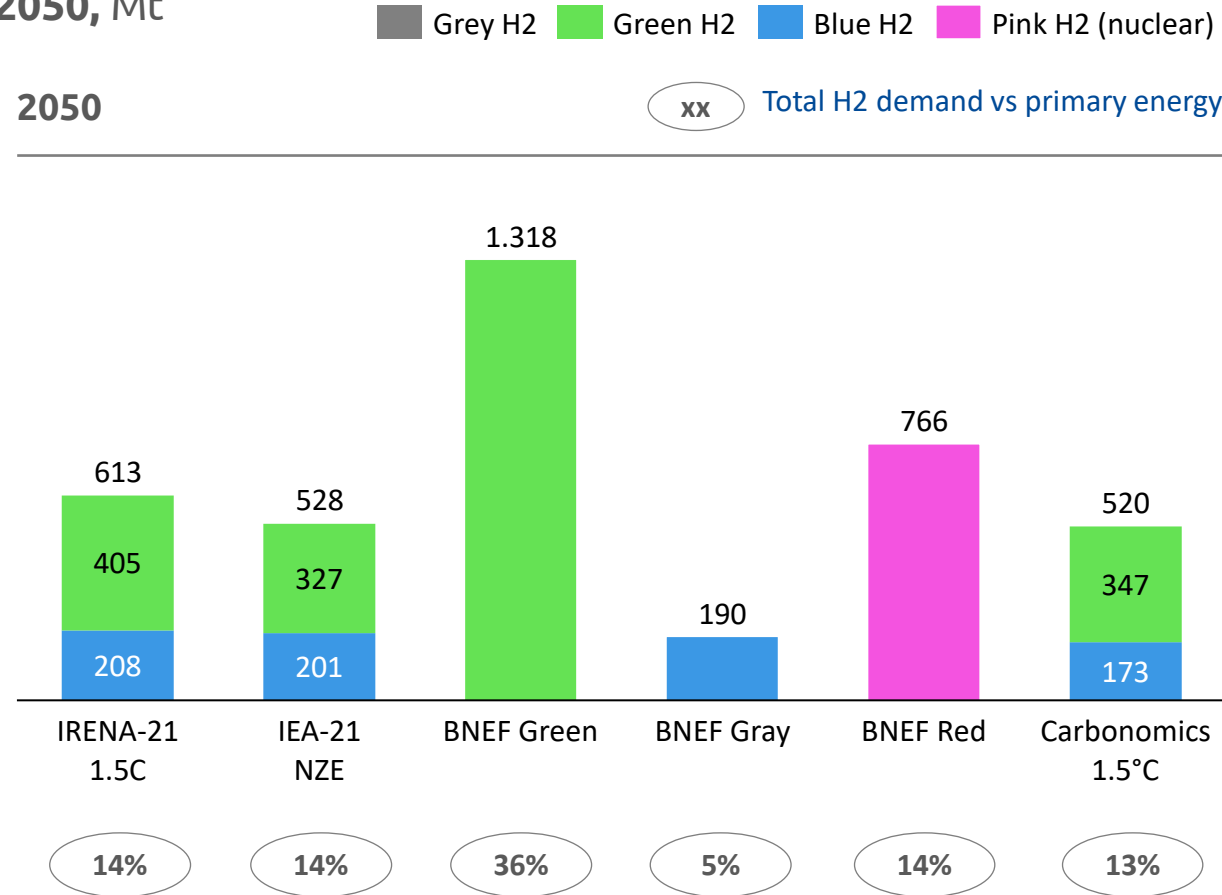
## Hydrogen demand in 2050, Mt

2020



2%

2050



## Key takeaways

- All scenarios recognize a role for hydrogen in the long term, with different rate of penetration and timing of H2 development
- Most scenarios see a relevant role of blue hydrogen in the next decade and also in the long run – 1/3 of total hydrogen
- In the long term hydrogen demand could reach around 15% of total primary energy demand



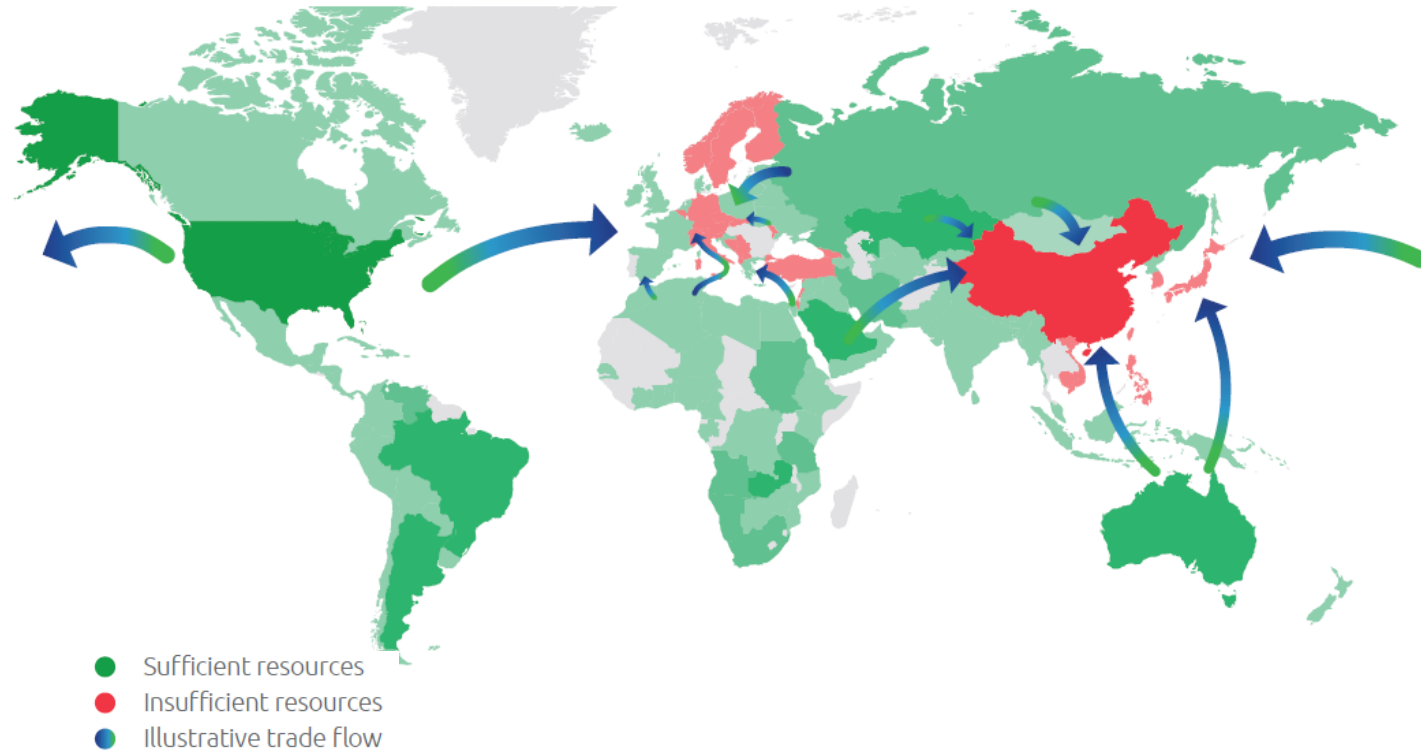
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Source: Snam team elaboration of IRENA, IEA, ETC, BP and BNEF data

# Where will clean energy come from? The key role of Africa for RES production



Indicative H2 trade flows based on the demand and green H2 production capacities of each state



# Hydrogen: the new decarbonised energy carrier

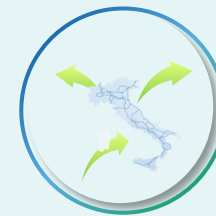
**Hydrogen** to contribute to:



**Integrate highly variable energy sources** (solar and wind) into the energy system

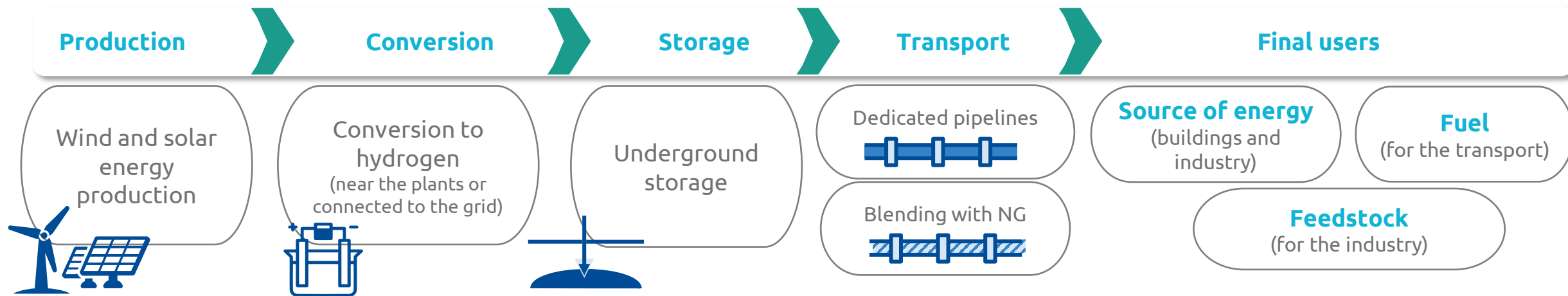


**Decarbonising** hard-to-abate sectors

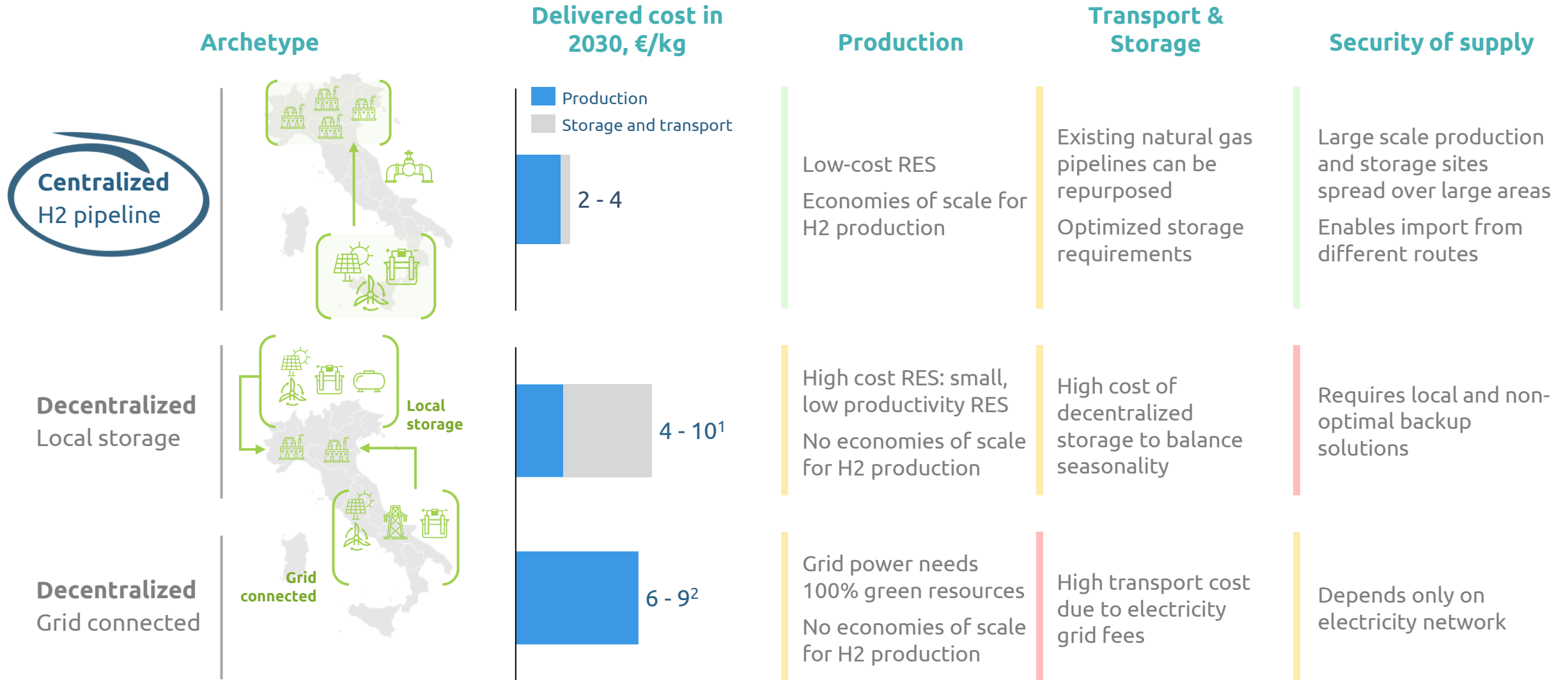


**Making Italy the European hydrogen hub**

## A supply chain to decarbonise energy consumption



# The most efficient H2 market for Italy



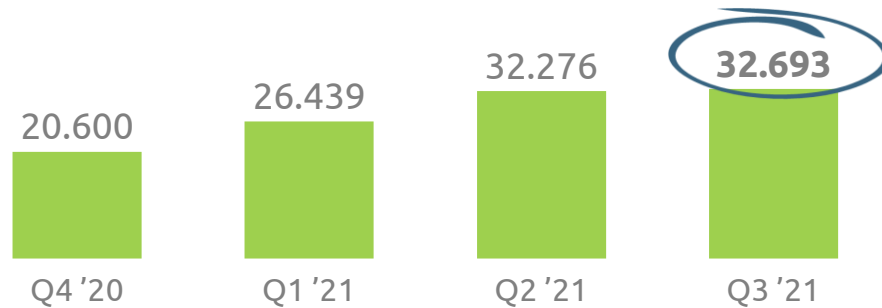
1. Lower bound considering daily storage to manage intermittency – Upper bound considering monthly storage.  
2. Lower bound considering 60% power from grid and 40% from RES – Upper bound considering 100% power from grid.

Source: Snam team analysis.

# Snam pipelines are verified for H2 transport

## 100% of Snam network verified for H2 transport

(km, cumulated)



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**Snam network** verified according to ASME regulation

### ≈ 99% of the network

is ready<sup>1</sup> to transport 100% H2  
70% with no or limited reductions on max operating pressure.

Future revisions of the technical standards are expected to overcome limitations



1. Based on Option A of ASME B31.12.

## Setting standards for H2 transport



First example in EU of network H2 readiness certification



H2 Gas  
Assets Readiness

Co-operation with other European TSOs to share test results, analysis, studies



### Collaborations with universities and institutions

Collaboration with fire department and universities to develop technical standards for H2 transport



# Longer term potential for H2 backbone...

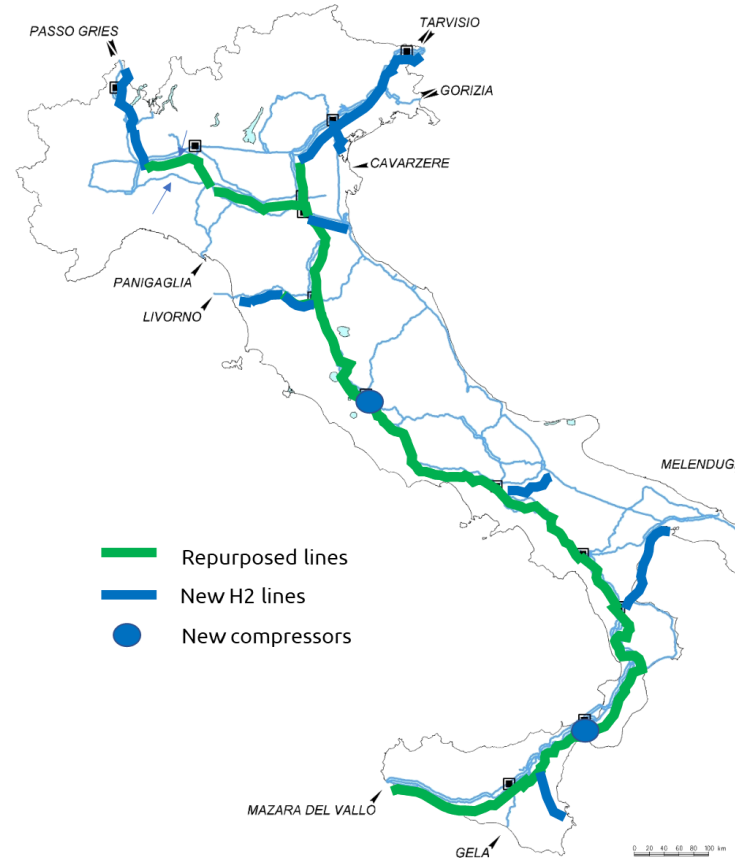
## H2 backbone

Ca 2,700km of H2 network to bring production from north Africa and Southern Italy to consumption areas

- 75% of km from repurposing
- 50MW for compression stations to ensure suitable pressures on the network

## Key figures

- Cost of repurposing ca €0.6m per km
- Cost of new build ca €2m per km



Ca €3bn

Cumulated capex 2021-2030

Premium regulated

Return expected

Our project for an Italian H2 backbone



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# The European Hydrogen Backbone – a vision for a truly interconnected H2 market for Europe

- The European Hydrogen Backbone (EHB) is a **pan-European dedicated hydrogen pipeline transport network**, connecting hydrogen supply and demand at an international level and create a EU market
- **23 gas infrastructure companies from 21 countries** (19 European Member States, UK and Switzerland).
- The backbone has expanded in length: the updated network covers a **total distance of around 40.000 km**.
- The extended backbone requires an **estimated total investment cost of € 43-81 billion by 2040**, based on using **69% of repurposed natural gas pipelines** and 31% new pipeline stretches.
- **Levelized transport costs amount to 0.11-0.21 €/kg per 1000 km**








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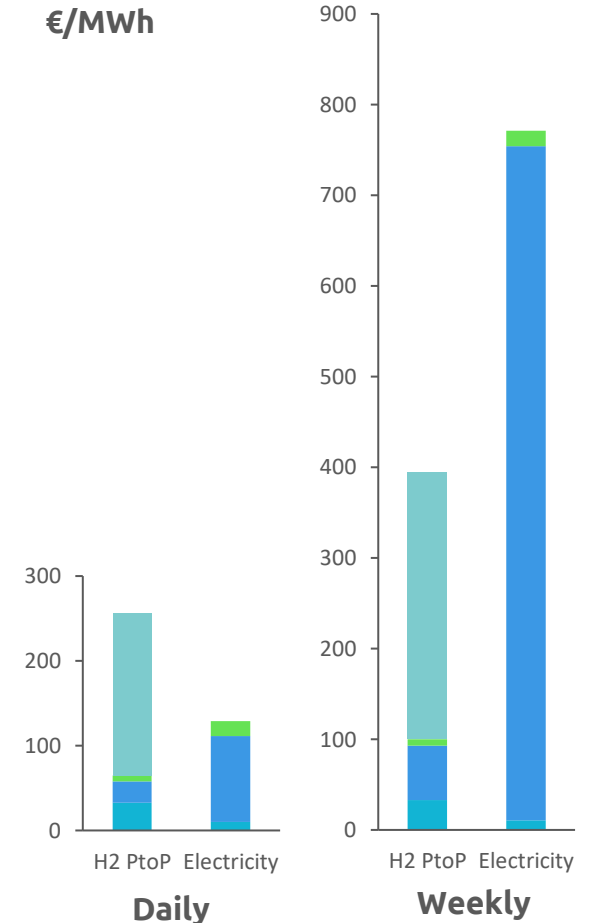
# Green gasses can leverage efficient energy storage

## Green molecules provide competitive solutions for storage

Levelized cost of storage for different technologies<sup>1</sup>, €/MWh

		Today capex range	Daily	Weekly	Monthly	Yearly
Electricity storage	Li-ion battery <sup>2</sup> 	250 €/kWh	110	770	3.000+	10.000+
	H2 tank <sup>3</sup> 	5-20 €/kWh	20 - 30	50 - 70	100 - 200	1.000 – 2.000
Hydrogen storage	H2 salt cavern 	0,4 €/kWh	2	3	6	40
	H2 in depleted field 	0,1 €/kWh	3	18	20	30
Biomethane storage	CH4 depleted field 	0,05 €/kWh	2	4	4	5

## H2 PowerToPower costs half vs batteries for weekly cycles



1. Assumptions: Cost of capital 8%, Exchange rate 0,84 €/\$.  
 2. Large scale Li-ion battery with 4h duration (BNEF cost assumptions: 300 \$/kWh).  
 3. Ranges refer to Compressed H2 (350-700 bar) tanks and LH2 tanks.

Source: BNEF, Snam team analysis.

# Storage: tests confirm the possibility to store H2 in depleted fields

## Test Results

### Mineralogical Analysis

Exposure of reservoir & cap-rock samples to gas mixture with increasing H2 blend

- » ✓ No risk of dissolution / alteration of reservoir & cap rock minerals in **100% H2 environment**

### Diffusivity Tests

Gas diffusion measurements for cap rock samples representative of Stogit fields

- » ✓ Confirmed gas-tightness of reservoir for blends **up to 100% H2**

### Microbiological Analysis

Microbiological reservoir characterization based on bio-chemical kinetics

- » ✓ No risk of H2S production or methanation in the reservoirs by microbial activity

### Test on Well Specimens

Testing on wells material

- » ✓ No impact on cements **up to 100% H2** and to elastomeric up to 20% H2\*

## Tests with multi-reactor

**Ongoing tests in a reactor** on microbiological activity with **up to 50% H2 blending** (up to 100% in 2022) at reservoir pressure & temperature conditions



### Pilot test

**Development of a pilot test in Snam storage sites** to confirm test results in the long-term behavior



**Tests confirm it is possible to store H2 in our natural gas depleted fields**

\* Ongoing test on 100% H2.

# Asset readiness: H2 injection campaign



In 2019, Snam successfully completed two injection campaigns injecting H2NG blend into the network, with percentages of 5% and 10% by volume. The campaigns were aimed at verifying the readiness of existing assets with respect to these blending percentages.

These H2NG blends were used by two industrial offtakers (a pasta factory and a water bottling plant) for the production of heat within their factories



With this experimentation, Snam has initiated the transition for the transport of ever-increasing volumes of hydrogen in its assets, even creating an **internal standard for the transport of hydrogen in pipelines**



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# Turbochargers – Full scale Factory/Field Tests

## Factory test - TC BH , model NOVA LT12 (New Supply) for Istrana Compressor Station BH

- factory test in Florence to verify gas turbine operation fueled with H2NG mixture (H2 up to 5% in volume and variable over time)



### Factory Test Procedure

ID	Phase	FUEL
1	Start	Natural Gas (NG)
2	Warm up	NG
3	Operation	NG
4	Full load	NG
5	Full load	NG + 3% H2
6	Full load	NG + 5% H2
7	Partial load (75%)	NG
8	Partial load (75%)	NG + 3% H2
9	Partial load (75%)	NG + 4% H2
10	Partial load (50%)	NG
11	Partial load (50%)	NG+ 3% H2
12	Partial load (50%)	NG + 4% H2
13	Partial load (50%)	NG
14	Stop	NG



## Factory test - TC BH, model PGT 25 for Sergnano Compressor Station (Storage plant)

- Test procedure to verify gas turbine operation (H2 up to 5% in volume and variable over time)

## Field test – TC SOLAR, TC BH model NOVA LT12

- Test procedure for a field test to verify gas turbine operation (H2 up to 5% in volume and variable over time)

# Snam Italian H<sub>2</sub> projects

## The collaboration with Iris Ceramica Group



Snam and **Iris Ceramica Group** have signed a MoU in order to develop a **the first H<sub>2</sub>-based factory ceramic factory**. The company is responsible for 90% of the national ceramic production and the new factory will be 100% hydrogen ready.

## Decarbonization of steel making sector



On may 2021, within the Forgiatura A. Vienna plant, the **first global NG-H<sub>2</sub> blend test composed by 30% of H<sub>2</sub>** has been performed in forging processes employed in industrial scale steel manufacturing.

**Tenaris, Edison and Snam** will collaborate to implement the most suitable solutions for the **production, distribution and use of green H<sub>2</sub>** at the Tenaris mill, contributing their skills to invest in the best available technologies.



## Airports decarbonization



The agreement between **Snam and Sea Milano** for supplying **green H<sub>2</sub> for the refuelling of vehicles** used for internal and external transport at Malpensa Airport

**Snam and Sagat** (Turin Airport) have signed a termsheet for **the installation of 1.2 MW FC to decarbonise the production of electricity and heat** consumed at the airport



## Valcamonica project

On 9th December 2020 FNM, a2a and Snam signed an MOU for the **conversion from Diesel to Hydrogen of the railway service on the section Brescia - Iseo – Edolo**. The project foresees the commissioning of **14 Ilint-coradia hydrogen trains** from Alstom **by 2024**





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**Thanks for your attention**