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Scenario Analysis 2024

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The challenge of a sustainable future for the energy system

Why is it important to have detailed scenarios on the different possible evolutions of energy?

Combating climate change requires a sustained effort over time to reduce CO_2 emissions by promoting energy efficiency and progressively replacing fossil fuels with renewable energy sources (RES). The European Climate Act enshrines the European Union's goal of achieving carbon neutrality (net zero) by 2050 and the intermediate target of reducing greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels.

In order to achieve such challenging goals, detailed national planning is indispensable, enabling full coordination of all energy players.

For this reason, Snam and Terna published the Scenario Description Document (DDS 2024) in October 2024, a prerequisite for the preparation of development plans for the transmission and transfer grids in the electricity and gas sectors at national level.
The objective of Snam's and Terna's activities is to arrive at a coherent vision of the possible future evolutions of the Italian energy system, bringing together the specific skills of the two operators - in the awareness that the interaction between the two sectors is both complex and fundamental in the process of energy transition.

This forecasting and analysis exercise is in line with what is indicated in Italy by the regulator, ARERA (the energy regulator).

At European level, the approach is similar: ENTSO-E and ENTSO-G, the European Transmission System Operator (TSO) associations for electricity and gas, jointly develop energy scenarios for the construction of the Ten Year Network Development Plan (TYNDP) and for the selection of Projects of Common Interest (PCI).

The scenario definition process was developed on several sites with the support of numerous analysis tools, models and data sources and was characterised by the involvement of electricity and gas distribution companies, as well as industry associations, in dedicated discussion sessions.

The analysis shows that in the coming years, natural gas will be joined by increasing volumes of green gases such as biomethane and hydrogen, which will use the gas network to be transported to the market.

Within the horizon considered, the gas network is also an indispensable infrastructure to ensure the necessary capacity and flexibility of the thermoelectric system.

For more information, the full version of the DDS 2024 (Scenario Description Document) is available at the link

2024 Scenario Description Document (snam.it)

Snam –Terna scenarios for DDS 2024

The DDS 2024 scenarios are jointly developed by Snam and Terna, considering energy and environmental policy objectives at both national and community levels for the horizon years 2030, 2035, and 2040. They incorporate the latest government guidelines on energy and environmental policy, as outlined in the National Energy and Climate Plan (NECP or PNIEC[1]) submitted by the Italian Government to the European Commission on June 30, 2024. The Italian NECP translates the goals of the European legislative package "Fit-for-55" for 2030 into national targets for renewables, efficiency, and emission reductions, and includes the guidelines of the "RepowerEU" plan to support the transition to clean energy and a more resilient energy system.

The Snam Terna scenarios are also developed in coherence with the ENTSOs scenarios, which define a decarbonization pathway in line with the European Union's decision to achieve carbon neutrality by 2050, as stipulated by Regulation (EU) 2021/1119 "European Climate Law". The regulation sets the binding target of climate neutrality in the Union by 2050, to keep the global average temperature increase well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C, as provided for in the Paris Agreement.

Two scenarios have been developed for the year **2030**: **one of policy, "PNIEC Policy",** in line with the 2024 NECP, **and one called "PNIEC Slow"**, which was developed assuming a delay in the implementation of the measures foreseen by the NECP in order to achieve the decarbonisation targets.

The **PNIEC Policy** scenario for Italy targets an emissions reduction target of -50% compared to 1990 with an efficiency contribution that reduces final consumption from approx. 112 Mtoe in 2022 to approx. 102 Mtoe in 2030. For the **PNIEC Slow** the ambition remains lower, for emissions at approx. -45% and for final consumption reduction at 104 Mtoe.

On the reference horizon years **2035 and 2040**, **three different scenarios were developed: a PNIEC Slow** scenario in continuity with the 2030 scenario, **a Global Ambition Italy (GA-IT)** scenario and a **Distributed Energy Italy (DE-IT)** scenario**,** aligned with the storylines of ENTSOs Global Ambition and Distributed Energy. DE-IT and GA-IT are therefore to be regarded as development scenarios, which, through a different technology mix, pursue the same decarbonisation goal (-78% to 2040 vs. 1990) as a further step towards achieving a Net Zero system by 2050.

	POLICY COMPLIANT		POLICY DELAY
2030	PNIEC Policy		PNIEC Slow
2035	Global Ambition IT	Distributed Energy IT	PNIEC Slow
2040	Global Ambition IT	Distributed Energy IT	PNIEC Slow

PNIEC Policy scenario

In line with the objectives of the 2024 NECP:

- CO_2 emissions -55% in EU, -50% in Italy.
- Final consumption (~102 Mtoe to 2030, -10 Mtoe vs. 2022).
- Electricity production from RES at 63% of electricity demand.
- Green gases at 16.4% of gas demand in end use.
- Carbon Capture & Storage (CCS) to capture 4 MtonCO_2 from process and combustion.

Global Ambition IT

- Strong development of biofuels and H_2 in the transport sector.
- Heating of buildings by means of both green gas and electric hybrid heat pumps.
- Industrial heat supplied mainly from H_2 and biomethane.
- Strong development of RES (electricity) generation.
- CCS applied to industrial and thermoelectric emissions.

Distributed Energy IT

- Heavy electrification of transport and residential heating.
- Industrial heat supplied by electricity and supplemented by H_2 and biomethane.
- Maximum development of RES (electricity) generation.
- Green gases and storage used as back-up for intermittent RES generation.
- CCS applied to industrial emissions.

PNIEC Slow

Delayed compared to the objectives of the NECP Policy:

- CO_2 emissions around -46% by 2030 and -65% by 2040.
- Limited development of green gas.
- Lower development of electricity RES.
- CCS development limited to projects in existence by 2030.

(1) PNIEC stands for «Piano Nazionale Integrato per l'Energia e il Clima», which is the italian translation of «National energy and climate plan" (NECP)

Scenarios to 2030

PNIEC Policy

Targets aligned with 2024 NECP:

- Reduction in emissions (-50% vs. 1990).
- Widespread diffusion of efficient and low-emission technologies in end-use consumption that combined with investments in energy efficiency contribute to reducing energy demand in end use (-10 Mtoe vs. 2022) and gross inland consumption (-15 Mtoe vs. 2022).
- Electrification of final consumption expected to increase (27.0% vs. 22% in 2022).
- Strong development of renewable electricity sources that come to cover 63% of national electricity demand, alongside the development of green gases (biomethane, 5 Gm^3, and hydrogen, 9.4 TWh) that come to cover around 16% of gas demand in end use.
- Development of CCS for 4 MtonCO_2 and opening up to new projects.

PNIEC Slow

- Delaying the decarbonisation targets of the 2024 NECP by several years (-46% vs. 1990).
- Delayed reduction in energy demand in end use (-8 Mtoe vs. 2022) of gross inland consumption (-13 Mtoe vs. 2022) due to lower efficiency and lower diffusion of low-consumption technologies.
- Slower electrification of final consumption (25.7%) resulting in reduced electricity demand.
- Delay of a few years in the development of electricity RES, which now covers 58% of the national electricity demand. Limited development of green hydrogen (4 TWh) and non-maximised development of biomethane (2.3 Gm^3).
- CCS development limited to only projects in existence by 2030 (4 Mton).

The PNIEC Policy scenario is almost entirely based on the final text of the National Energy and Climate Plan (NECP) sent by Italy to the European Commission on 30/06/2024. The 2024 NECP is an update of the draft prepared in June 2023, in particular with respect to the macroeconomic scenario, electricity demand, the mix of renewable generation, the penetration of new technologies, including CCS, the evolution of gas demand, including biomethane and hydrogen, and other sources.

In general, the 2030 policy scenario of the DDS 2024 is in line with the “Fit-for-55 2030” scenario developed by Snam and Terna in 2022 and 2023. Minor revisions of the 2030 policy scenario are linked to changes in the socio-economic framework, to the events of the last two years and to the updating of the Italian government’s energy and environment action policies, particularly in the NECP. The PNIEC Policy scenario assumes an efficient mix of investments in gas and electricity grid infrastructures, electric and molecular renewables, storage and new digital technologies that are compatible with the main technical, economic and administrative constraints that might otherwise prevent their realisation in such a tight timeframe.

By 2030, coal-fired thermal power plants are expected to be completely decommissioned and a strong development of non-programmable renewables, in particular photovoltaics and wind power. This development of RES is made possible by the development of grid infrastructure and the presence of storage systems. The development of electricity RES is accompanied by the maximised development of biomethane, which contributes to the decarbonisation of end use, and the launch of the hydrogen market, which already by 2030 with 9.4 TWh sees 70% domestic production complemented by 30% imports.

Challenging emission containment targets also lead to the adoption of carbon dioxide capture and storage (CCS) in the NECP with a target of 4 million tonnes of CO_2 captured and stored as early as 2030 with a possible upside in subsequent years of up to 16 to 20 million tonnes of CO_2.

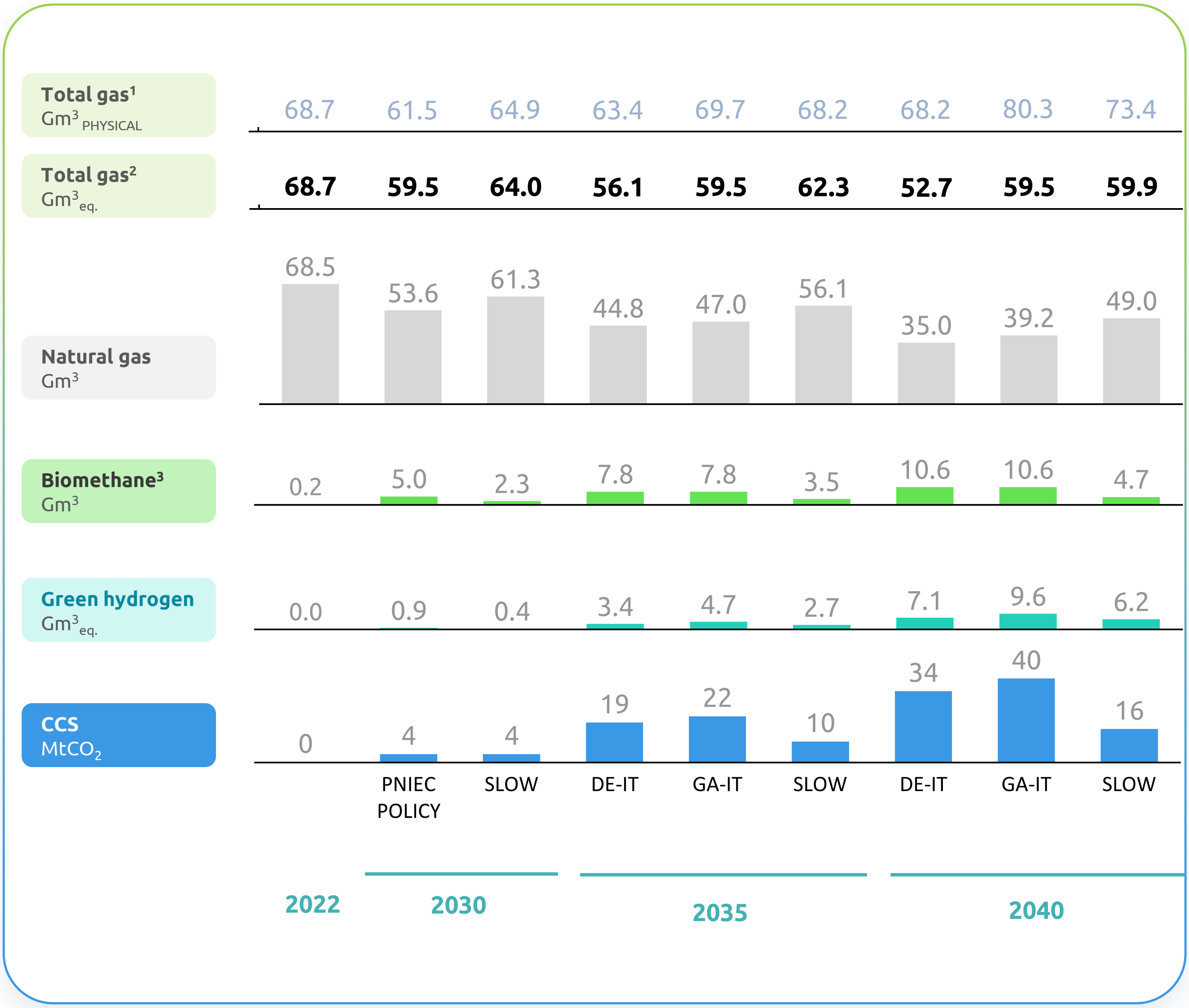
Scenarios to 2035 and 2040

The policy scenarios, Global Ambition Italy (GA-IT) and Distributed Energy Italy (DE-IT), developed for the horizon years 2035 and 2040, represent the intermediate steps of two possible and different pathways to achieve Carbon Neutrality by 2050. They are consistent with the storylines of the ENTSOs scenarios, Global Ambition and Distributed Energy, but with a greater focus on the specific characteristics of the Italian energy system. **Both are based on the PNIEC Policy scenario of 2030. What differs between the two is the contribution of biofuels and hydrogen, the contribution of CCS, the deployment of some technologies and the development of RES capacity.** Common to both scenarios is the maximisation of biomethane and the development of new electrolysers for hydrogen production due to the high penetration of RES-E.

	GLOBAL AMBITION ITALY+ GA-IT	DISTRIBUTED ENERGY ITALY+ DE-IT
Driving forces	• Envisaged decarbonisation of consumption through widespread penetration of green gases and biofuels in end use, with lower electrification in favour of efficient molecular technologies and use of CO_2 capture and storage, both in hard-to-abate and thermoelectric sectors.	• Expected decarbonisation of consumption through high electrification of end use. The use of green gases and biofuels complements electrification. High electricity demand maximises the installation of solar and wind power. Use of CCS in hard to abate sectors.
Transport	• Use of biomethane, hydrogen and biofuels in both light and heavy goods and public transport.	• Relevant electrification in private, public and light goods transport. Use of biomethane, hydrogen and e-fuel mainly in heavy transport.
Civil	• Heating buildings through hybrid and purely electric heat pumps. Start of hydrogen penetration in the sector.	• Heating of buildings through the widespread use of purely electric heat pumps. Limited use of hydrogen.
Industry	• Significant penetration of green fuels (hydrogen and biomethane) for heat production.	• Widespread electrification where possible to replace traditional combustion technologies.
Biomethane	• Maximised production through the development of the agricultural supply chain to reach 10.6 Gm³ by 2040 (including 0.2 Gm³ of synthetic methane).	• Maximised production through the development of the agricultural supply chain to reach 10.6 Gm³ by 2040 (including 0.2 Gm³ of synthetic methane).
Hydrogen	• Widespread penetration of hydrogen in end use (green and blue) with demand for green H_2 reaching 92 TWh by 2040 of which 80% imported.	• H_2 penetration (green and blue) mainly in hard-to-abate and transport with demand for green H_2 reaching 68 TWh by 2040 of which 73% imported.
RES	• Installed wind and solar power totalling 154 GW and renewables covering 74% of the national electricity demand.	• Maximisation of wind and solar power with a total installed capacity of 170 GW and renewable electricity sources reaching 76% of the national electricity demand.

The **PNIEC Slow** scenario was also developed for the 2035 and 2040 time horizons in continuity with what was defined for 2030, thus foreseeing a slowdown of enabling technologies for decarbonisation in end use and a slower penetration than the trajectories defined in the DE-IT and GA-IT scenarios of RES capacity (144 GW to 2040), biomethane (4.7 Gm³ to 2040), Hydrogen (59 TWh to 2040) and a lower use of CCS.

Synthesis of the demand evolution for natural gas, green gases and CCS in Italy



(1) The change from $Gm^3_{eq.}$ to Gm^3 gas involves the application of a factor 3.2 in the volume of hydrogen.
(2) Only green H_2 is considered in the gas total. Grey and blue H_2 is considered as natural gas transported for its production.
(3) Includes synthetic methane

2030 - Outlook

In the **2030 PNIEC Policy** scenario, energy efficiency, electric renewables and the development of biomethane and green hydrogen are leveraged to reach the emission reduction target set in the 2024 NECP document. In addition, the scenario shows the need for carbon dioxide capture and sequestration technologies applied both to process emissions typical of certain industrial sectors and to the capture of combustion emissions in particular in sectors already subject to the ETS (Emission Trading System).

The total gas demand is **59.5 Gm$^3_{eq.}$ (567 TWh),** equivalent to a physical volume of 61.4 Gm^3.

In the **2030 PNIEC Slow** scenario, the slowdown in the implementation of decarbonisation measures delays the entry of hydrogen and biomethane and provides for lower efficiency, while maintaining higher levels of natural gas than in the policy scenario. The total gas demand turns out to be **64.0 Gm$^3_{eq}$ (610 TWh)**, equivalent to a physical volume of 64.9 Gm^3.

SCENARIO	2030 PNIEC Policy		2030 PNIEC Slow	
	Gm^3	TWh	Gm^3	TWh
NATURAL GAS	53.6	510.7	61.3	583.8
BIOMETHANE	5.0	47.8	2.3	22.4
GREEN HYDROGEN (Gm^3 met. $_{eq.}$)	0.9	8.4	0.4	3.9
TOTAL	**59.5**	**566.9**	**64.0**	**610.1**

Natural gas

Natural gas: in the PNIEC Policy scenario is 53.6 Gm^3. In PNIEC Slow, demand is higher and reaches 61.3 Gm^3, mainly due to higher consumption in the civil sector (22.5 Gm^3).

Biomethane

Biomethane: in the PNIEC Policy scenario is 5.0 Gm^3, in line with the measures identified by 2024 NECP, and is intended for the industrial and transport sector. In PNIEC Slow, on the other hand, a quota of 2.3 Gm^3 is envisaged in line with the Reference scenario of 2024 NECP, in which the National Recovery and Resilience Plan (NRRP) target is expected to be reached later.

Hydrogen

Green hydrogen: In the PNIEC Policy scenario, 0.9 Gm$^3_{eq.}$ are allocated to industry and transport (REDIII, Refuel EU Aviation and Refuel EU Maritime). In contrast, the demand for green hydrogen in the PNIEC Slow scenario is 0.4 Gm$^3_{eq.}$ The sectors of use are the same as in the policy scenario, but with slowed development.
Total hydrogen consumption does not end with only the green hydrogen represented here, but also includes consumption of hydrogen derived from fossil sources and produced by steam methane reforming (SMR) that could be decarbonised through the availability of CCS. This consumption is included in the demand for natural gas.

2030 - Natural gas and biomethane: demand by sectors

Bn m^3	NATURAL GAS PNIEC Policy Gm^3	NATURAL GAS PNIEC Slow Gm^3	BIOMETHANE PNIEC Policy Gm^3	BIOMETHANE PNIEC Slow Gm^3
Civil	19.4	22.5	0.0	0.0
Industry	8.9	11.4	3.9	1.5
Transport (incl. Bunkers)	2.2	3.2	1.1	0.8
Other Uses	3.4	3.2	0.0	0.0
Thermoelectric and heat	19.7	21.0	0.0	0.0
Totals	**53.6**	**61.3**	**5.0**	**2.3**

	Natural gas	Biomethane
Civil	In the civil sector, natural gas is 19.4 Gm^3 in the PNIEC Policy scenario. The PNIEC Slow assumed lower savings from energy efficiency measures, assuming a lower rate of building upgrades and less fuel switching, bringing consumption to 22.5 Gm^3.	Not foreseen.
Industry	Natural gas demand in industrial uses is 8.9 Gm^3 in the PNIEC Policy scenario. In the PNIEC Slow, the industrial sector has a higher demand for natural gas (11.4 Gm^3), mainly due to the lower penetration of biomethane in the sector and a lower level of electrification.	The biomethane penetration scenario sees 3.9 Gm^3 in the industrial sector, the main candidate for biomethane use as it is subject to ETS. In the PNIEC Slow its use is limited to 1.5 Gm^3.
Transport	In the transport sector, natural gas consumption in the PNIEC Policy scenario is 2.2 Gm^3, supported by the development of LNG, both for road freight transport and in the maritime sector. In the PNIEC Slow consumption is 3.2 Gm^3, and is expected to increase to compensate for the slowing development of alternative technologies such as electric vehicles, both pure and fuel cell powered, and biomethane.	For biomethane demand in the transport sector in the PNIEC Policy scenario, a volume growth limited to the incentivised share of 1.1 Gm^3 is considered. In the PNIEC Slow scenario, this share is reduced to 0.8 Gm^3 due to the scenario's own narrative.
Thermoelectric	In the thermoelectric and heat sector, demand is 19.7 Gm^3 in the PNIEC Policy. In the PNIEC Slow, consumption reaches 21 Gm^3, rising due to a lower penetration of RES in electricity generation.	Not foreseen.

2030 - Hydrogen: demand by sectors

	HYDROGEN			
	PNIEC Policy		PNIEC Slow	
2030	Gm^3_{eq}	TWh	Gm^3_{eq}	TWh
Civil	0.0	0.0	0.0	0.0
Industry	0.4	3.8	0.2	1.4
Transport (incl. Bunkers)	0.5	4.5	0.3	2.4
Other Uses	0.0	0.0	0.0	0.0
Thermoelectric and heat	0.0	0.0	0.0	0.0
Totals	**0.9**	**8.4**	**0.4**	**3.9**

Hydrogen

Civil

Not foreseen.

Industry

For the industrial sector, the green hydrogen volumes identified for the PNIEC Policy scenario (0.4 $Gm^3_{eq.}$) represent 42% of the projected 2030 industrial hydrogen demand for energy and non-energy end use. This level is in line with the sectoral target identified by RED III. For the PNIEC Slow, a volume of about 0.2 $Gm^3_{eq.}$ is assumed. In this case, the volume of green hydrogen is not sufficient to reach the RED III target.

Transport

Green hydrogen is planned in the transport sector with a volume of 0.5 $Gm^3_{eq.}$ Green hydrogen penetration aims to meet and exceed RED III targets and is used in road freight transport and public transport buses and trains (NRRP projects). Furthermore, green hydrogen and synthetic fuels are also appearing in the aviation and maritime transport sectors, driven by the constraints of the European directives Refuel EU Aviation and Refuel EU Maritime. In the PNIEC Slow, development is slowed down to 0.3 $Gm^3_{eq.}$ The sector target is nevertheless reached, and the undeveloped volume of green hydrogen is replaced by natural gas, which is also considered a mature solution for heavy transport.

Thermoelectric

Not foreseen.

2040 - Outlook

In the Distributed Energy **(DE-IT)** scenario, methane demand is estimated at 45.6 Gm^3. As far as green hydrogen is concerned, demand is expected to be around 7.1 $Gm^3_{eq.}$ The total gas demand is 52.7 $Gm^3_{eq.}$ (502 TWh), equivalent to a physical volume of 68.3 Gm^3.
In the Global Ambition Italia **(GA-IT)** scenario, methane demand is estimated at 49.8 Gm^3. For green hydrogen, demand is expected to be around 9.6 $Gm^3_{eq.}$ The total gas demand is 59.5 $Gm^3_{eq.}$ (567 TWh), equivalent to a physical volume of 80.5 Gm^3.
Common to both scenarios is the maximisation of biomethane and synthetic methane of 10.4 Gm^3 and 0.2 Gm^3 respectively, the development of new electrolysers for hydrogen production due to the strong penetration of RES-E, and the deployment of carbon dioxide capture and storage (CCS) technologies.

The **PNIEC Slow** scenario is representative of a slower transition (compared to the policy scenarios) towards decarbonisation goals with a delay of a few years in the deployment of technologies that impact the decarbonisation pathway.
In this scenario, methane demand is estimated at 53.7 Gm^3, of which 49.0 Gm^3 is natural gas and 4.7 Gm^3 biomethane. With regard to green hydrogen, a demand of about 6.2 $Gm^3_{eq.}$ is expected, with lower volumes in all main consumption sectors compared to policy scenarios. Therefore, the total gas demand is 59.9 $Gm^3_{eq.}$, (570 TWh), equivalent to a physical volume of 73.3 Gm^3.

	2040 DE-IT		2040 GA-IT		2040 PNIEC Slow	
SCENARIO	Gm^3	TWh	Gm^3	TWh	Gm^3	TWh
NATURAL GAS	35.0	333.3	39.2	373.8	49.0	467.0
BIOMETHANE	10.6	100.7	10.6	101.0	4.7	44.4
GREEN HYDROGEN (Gm^3 met. $_{eq.}$)	7.1	68.1	9.6	91.9	6.2	58.9
TOTAL	**52.7**	**502.1**	**59.5**	**566.6**	**59.9**	**570.3**

Natural gas

Natural gas: is 35.0 Gm^3 in the DE-IT scenario and 39.2 Gm^3 in the GA-IT. The differences between the two scenarios are limited and mainly due to the volumes in the civil sector. In the PNIEC Slow, consumption is seen to be on the rise and at 49.0 Gm^3.

Biomethane

Biomethane and synthetic methane: The demand for biomethane in both policy scenarios to 2040 is 10.4 Gm^3, reaching the maximum potential identified for the time horizon. In addition to biomethane, synthetic methane with a volume of about 0.2 Gm^3 is also expected to be introduced, which, together with biomethane and green hydrogen, contributes to the decarbonisation of gas demand. In the 2040 PNIEC Slow scenario, the demand for green methane is 4.7 Gm^3, consisting of biomethane alone.

Hydrogen

Hydrogen: demand for green hydrogen reaches 7.1 $Gm^3_{eq.}$ in the DE-IT scenario and 9.6 $Gm^3_{eq.}$ in the GA-IT. Demand is mainly concentrated in the transport sector, as a decarbonised alternative to petroleum products. Green hydrogen also finds a use in shipping with a share in bunkers. It is also beginning to establish itself in the industrial sector (hard-to-abate sectors) and enters the civil sector as an alternative to electric heat pumps, particularly in the GA-IT scenario, characterised by less electrification of heating consumption. In the PNIEC Slow scenario, on the other hand, a demand for green hydrogen of 6.2 Gm^3_{eq} is assumed. The sectors of use are the same as in the policy scenarios for which a lower diffusion is assumed. In addition to the consumption of green hydrogen depicted here, there is also consumption of hydrogen derived from natural gas that could be decarbonised through CCS. This consumption is included in the demand for natural gas.

2040 - Natural gas and green methane: demand by sectors

2040	NATURAL GAS DE-IT	NATURAL GAS GA-IT	NATURAL GAS PNIEC Slow	BIOMETHANE and SYNTHETIC METHANE DE-IT	BIOMETHANE and SYNTHETIC METHANE GA-IT	BIOMETHANE and SYNTHETIC METHANE PNIEC Slow
	Gm^3	Gm^3	Gm^3	Gm^3	Gm^3	Gm^3
Civil	10.2	12.0	17.7	4.0	3.8	0.2
Industry	4.0	4.8	8.0	3.9	3.9	2.5
Transport (incl. Bunkers)	2.2	2.9	3.5	2.6	2.7	1.8
Other Uses	4.8	5.2	5.0	0.1	0.1	0.1
Thermoelectric and heat	13.8	14.4	14.8	0.0	0.0	0.0
Totals	**35.0**	**39.2**	**49.0**	**10.6**	**10.6**	**4.7**

	Natural gas	**Biomethane and synthetic methane**
Civil	In the civil sector, natural gas is 10.2 Gm^3 in the DE-IT scenario and 12.0 Gm^3 in the GA-IT scenario. In the PNIEC Slow it is 17.7 Gm^3, up due to fewer energy efficiency measures, less fuel switching to the electric carrier and slower development of biomethane.	Green methane in the civil sector contributes to decarbonisation with a volume of 4.0 Gm^3 in DE-IT and 3.8 Gm^3 in GA-IT. In the PNIEC Slow, biomethane is seen at an embryonic stage (0.2 Gm^3).
Industry	Natural gas demand in industrial uses is 4.0 Gm^3 in the DE-IT scenario and 4.8 Gm^3 in the GA-IT scenario. In the PNIEC Slow, the industrial sector has a higher natural gas demand (8.0 Gm^3) due to lower efficiency and less use of green gas.	A green methane volume of 3.9 Gm^3 in the policy scenarios is expected in industry, which ensures substantial decarbonisation of the sector. In the PNIEC Slow, biomethane is 2.5 Gm^3.
Transport	In transport, natural gas in the DE-IT scenario is 2.2 Gm^3 and in GA-IT 2.9 Gm^3. Volumes are supported by the development of LNG, both for road freight transport and in the maritime sector. In the PNIEC Slow it is 3.5 Gm^3, and is expected to increase to compensate for the slow development of alternative technologies.	In the transport sector, a volume of 2.6 Gm^3 of green methane is expected in the DE-IT scenario and 2.7 Gm^3 in the GA-IT scenario, reaching volumes comparable to those of natural gas. In the PNIEC Slow, the consumption of biomethane is 1.8 Gm^3.
Thermoelectric	In the thermoelectric sector (including heat), demand is 13.8 Gm^3 in DE-IT and 14.4 Gm^3 in GA-IT. In the PNIEC Slow, consumption reaches 14.8 Gm^3, due to lower penetration of electricity generation from RES.	Not foreseen.

2040 - Hydrogen: demand by sectors

GREEN HYDROGEN

2040	DE-IT		GA-IT		PNIEC Slow	
	$Gm^3_{eq.}$	TWh	$Gm^3_{eq.}$	TWh	$Gm^3_{eq.}$	TWh
Civil	0.2	2.0	1.8	16.8	0.8	7.5
Industry	2.1	19.9	2.6	24.9	1.7	16.3
Transport (incl. Bunkers)	2.4	22.4	3.2	30.9	2.1	20.1
Other Uses	2.5	23.7	2.0	19.3	1.6	14.9
Thermoelectric and heat	0.0	0.0	0.0	0.0	0.0	0.0
Totals	**7.1**	**68.1**	**9.6**	**91.9**	**6.2**	**58.9**

Hydrogen

Civil

Green hydrogen in 2040 also penetrates the civil sector, marginally in DE-IT (0.2 $Gm^3_{eq.}$) and with a higher development in the GA-IT scenario (1.8 $Gm^3_{eq.}$). In the PNIEC Slow, consumption is 0.8 $Gm^3_{eq.}$

Industry

For the industrial sector, the identified volume of green hydrogen is 2.1 $Gm^3_{eq.}$ in the DE-IT scenario and 2.6 $Gm^3_{eq.}$ in the GA-IT, in line with the 2030 outlined pathway. In the PNIEC Slow scenario, the development of green hydrogen is slowed down to 1.7 $Gm^3_{eq.}$

Transport

Green hydrogen in policy scenarios envisages expansion to all major modes of transport. The demand is 2.4 $Gm^3_{eq.}$ in DE-IT and 3.2 $Gm^3_{eq.}$ in GA-IT, where it reaches the maximum development identified for the time horizon in question. In the PNIEC Slow scenario, the development of green hydrogen is slowed down to 2.1 $Gm^3_{eq.}$

Thermoelectric

Not foreseen.

The role of CCS

CCUS (Carbon Capture, Utilisation and Storage) is a technological process that avoids the release of carbon dioxide from large industrial and/or power generation plants into the atmosphere through its capture and subsequent utilisation or long-term geological storage.

The importance of CCUS in general, and of CCS in particular, in the energy transition is primarily linked to its role in decarbonising industry, particularly in its most energy-hungry hard-to-abate sectors and the thermoelectric sector, whose contribution is needed to ensure the back-up of non-programmable renewable resources.

Another important aspect for the economic sustainability and efficiency of CCUS/CCS projects is the possibility of exploiting economies of scale, especially of a logistical nature. These economies relate to the development of a CO_2 transport network and the availability of geological storage, which become critical project factors. Thus, the concept of a “CCUS Hub” was born, where several industrial players can come together to share transport and storage infrastructure.

Such projects can have a significant impact in reducing the unit costs of emission capture, thus determining the economic competitiveness of CCUS/CCS against other available alternatives.

Current knowledge suggests that carbon neutrality will require the use of CO_2 capture and storage systems.

Also in light of these considerations, the DDS 2024 scenarios envisage the use of CCS as early as 2030, with 4 $MtCO_2$ captured, and its expansion to 2040 in the DE-IT and GA-IT scenarios with a value of 34 $MtCO_2$ and 40 $MtCO_2$ respectively. The capture of these quantities, combined with the other decarbonisation measures, makes it possible to achieve a reduction in emissions compared to 1990 levels of around -78%.

In the PNIEC Slow scenario, CCS development is limited to 16 $MtCO_2$ by 2040 and the scenario achieves an emissions reduction of -65% compared to 1990.

Increasing flexibility required of the gas system to ensure grid stability

To assess the peak gas demand, different daily consumption scenarios are considered, taking into account seasonal consumption. In particular, a winter peak demand scenario is considered under exceptional conditions, i.e., assessing a winter with a probability of occurrence of 1 in 20 years, and a summer peak demand scenario under a condition defined as average summer.

In exceptionally cold conditions, the peak demand projected by the PNIEC Policy scenario to 2030 is 425 $Mm^3_{eq.}$/g (of which 423 Mm^3/g of methane), showing a substantial invariance with respect to historical peak demand, which in recent years has been around 400 Mm^3/g, with fluctuations between 333 Mm^3/g and 425 Mm^3/g linked to contingent situations. Despite this, in exceptionally cold conditions, the daily peak demand can reach higher values. In this regard, it is recalled that the historical maximum peak demand was 464 Mm^3/g recorded in February 2012 and mainly supported by daily heating demand.

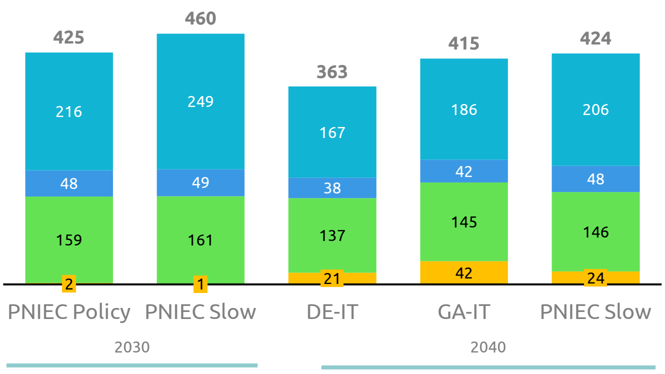
By 2040, peak demand in the DE-IT and GA-IT scenarios is 363 $Mm^3_{eq.}$/g (of which 342 Mm^3/g of methane) and 415 $Mm^3_{eq.}$/g (of which 373 Mm^3/g of methane), respectively, down from 2030, due to reduced demand in the civil sector. Daily thermoelectric demand remains high (137 Mm^3/g and 145 Mm^3/g) due to the back-up needs of renewable generation.

The thermoelectric peak could also be affected by the unavailability of renewable generation. The occurrence of this situation may lead to an increase of about 20-40 Mm^3/g between 2030 and 2040.

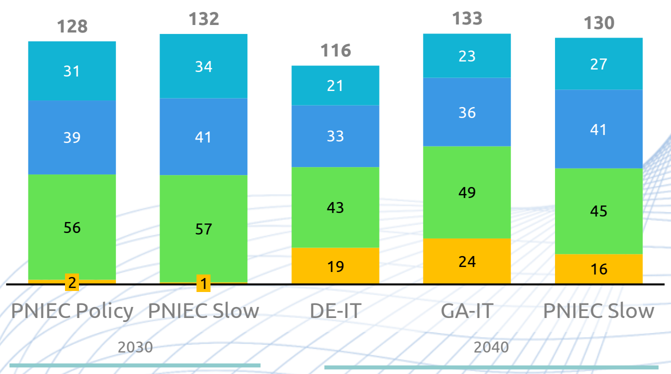
Daily summer demand fluctuates over the period analysed by the scenarios between 116 $Mm^3_{eq.}$/g and 133 $Mm^3_{eq.}$/g . The peak is sustained by thermoelectric power, which constitutes the largest of the sectoral withdrawals. Summer peak demand is reduced by 2040 mainly due to the reduction of daily thermoelectric withdrawal to below 50 Mm^3/g.

The daily data therefore show that the gas-fired thermoelectric system will have to offer flexibility services characterised by rapid intervention to cover the variability of daily production from wind and photovoltaics.

Exceptional winter gas peak, $Mm^3_{eq.}$/day



Average summer, $Mm^3_{eq.}$/day



Civil Industry and other Thermoelectric Hydrogen

H2 Backbone

According to demand scenarios, hydrogen already stands at 0.9 Gm^3_{eq} by 2030 (9.4 TWh), then 7.1 $Gm^3_{eq.}$ (68.1 TWh) for DE-IT and 9.6 $Gm^3_{eq.}$ (91.9 TWh) for the GA-IT to 2040. To meet these hydrogen volumes, it will be essential to rely not only on domestic production but also to significant levels of imports, which can be either by pipeline, at high pressure in gaseous form, or by ship, in liquid form.

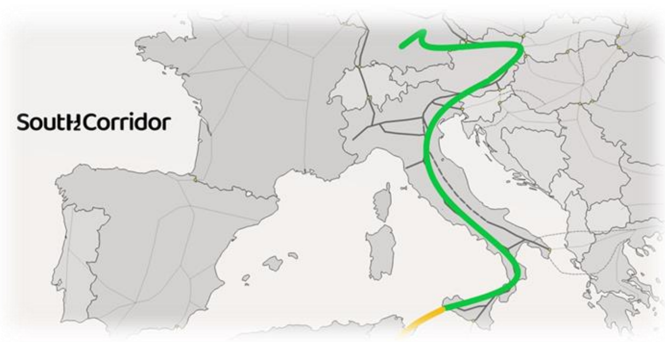
In this sense, Snam has planned the development of an Italian H2 Backbone capable of connecting national hydrogen production, located in the South, and additional import volumes from North Africa, with the main Italian consumption areas up to interconnection points with foreign networks. The project envisages the development of a hydrogen backbone of about 2,300 km using mainly existing gas infrastructure converted to hydrogen transport, together with new sections to be built. The Italian hydrogen backbone, in addition to guaranteeing coverage of domestic demand, makes it possible to contribute to satisfying European demand, allowing Italy to play a key role in the development of the hydrogen market and supporting the achievement of the objectives defined in the REPowerEU plan (20 mln tonnes of H_2 by 2030, of which 10 mln tonnes from imports).

In the context of the European Hydrogen Backbone (EHB), the Italian backbone is integrated into the broader SoutH2Corridor, which connects Italy, Austria and Germany, and represents one of the five priority corridors for hydrogen supply strategic importance recognised at European level. In addition to the support of the Italian government and the governments of Austria and Germany, the SoutH2Corridor has also been approved by the European Parliament as a project of common interest (PCI) under the new Trans-European Energy Infrastructure (TEN-E) Regulation (EU) 2022/869. The project envisages a potential import of about 130 TWh from North Africa and about 55 TWh of exports to Switzerland and Austria.

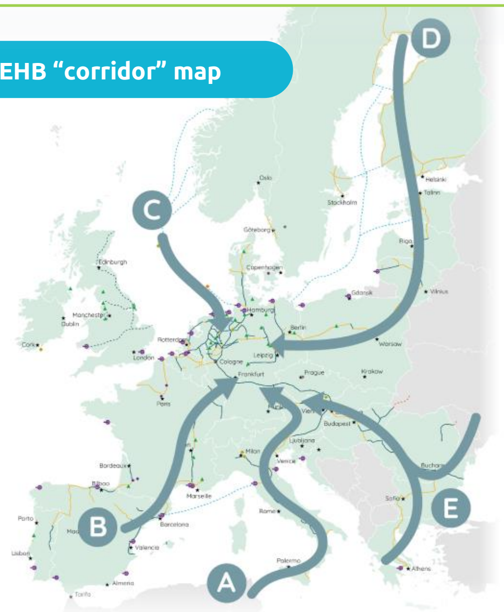
High-pressure pipeline imports could be complemented by the development of hydrogen import terminals by ship in liquid form (e.g., ammonia) that could increase the diversification of hydrogen supply and provide greater flexibility and energy security.

Parallel to the development of dedicated hydrogen transport infrastructure, there is the possibility of exploiting existing gas infrastructure through blending (hydrogen mixed with natural gas) in quantities consistent with the technical and regulatory limitations of transport infrastructure.

SouthH2Corridor



EHB “corridor” map



Gross inland energy consumption and final consumption

Gross inland energy consumption

In the DDS 2024 scenarios, gross inland energy consumption is expected to decrease from current levels.

In the 2030 PNIEC Policy scenario, it is 130.4 Mtoe, while in 2040 it reaches 114.6 Mtoe in the DE-IT scenario, and 118.4 Mtoe in the GA-IT.

The PNIEC Slow scenario forecasts higher values, with 2030 ending at 132.4 Mtoe and 2040 reaching 122.9 Mtoe.

It is emphasised that the decline in gross inland energy consumption is solely due to the efficiency and electrification dynamics of the energy system. The GDP trend is in fact expected to be upward over the entire time horizon analysed.

Final energy consumption

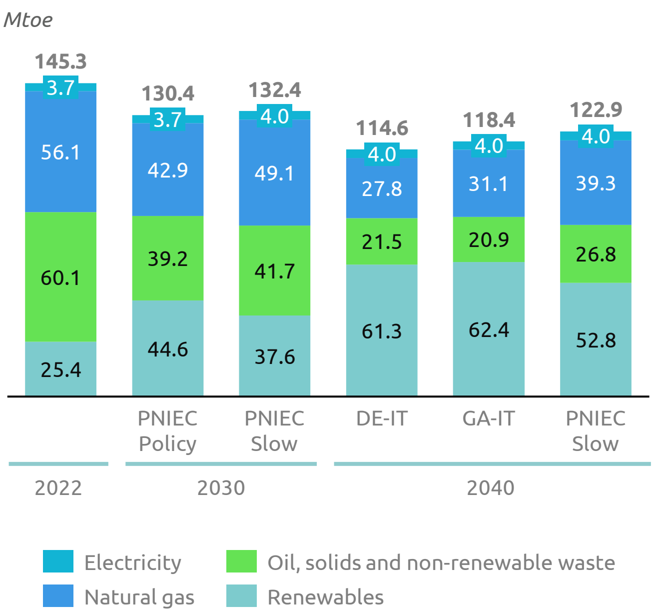
All scenarios in the DDS 2024 envisage a reduction in final energy consumption, which is achieved mainly through the spread of more efficient technologies (heat pumps, electric vehicles, both pure and fuel cells, etc.) and the renovation of building stock.

In particular, by 2030 the reduction compared to 2022 is between 8 Mtoe and 10 Mtoe in the PNIEC Slow and PNIEC Policy scenarios, respectively.

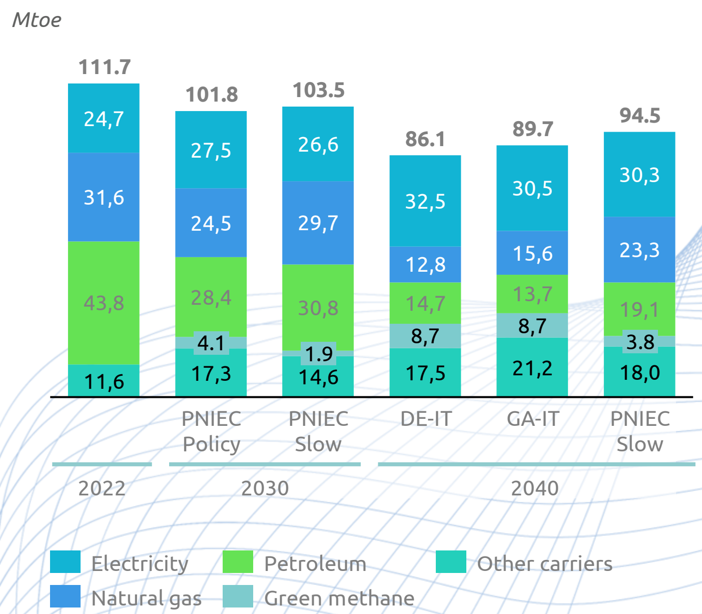
The use of fossil fuels in end use is reduced by increased electrification and greater development of biomethane and other low-emission carriers (biofuels, hydrogen and e-fuels).

The reduction continues to 2040 with a further contraction of final consumption of between approx. 12 Mtoe and 16 Mtoe in the policy scenarios. In the PNIEC Slow scenario, the level reached is 94.5 Mtoe, resulting in a reduction of about 9 Mtoe compared to the same scenario in 2030.

Gross inland consumption[1] (Mtoe)



Final energy[2] (Mtoe)



(1) Gross inland energy consumption (Europe 2020-2030) [GIC2020-2030].
(2) Final Energy Consumption (Europe 2020-2030) [FEC2020-2030].