GAS REGIONAL INVESTMENT PLAN SOUTH REGION

BASED ON ENTSOG's TYNDP 2020

enagas GRTgaz reganosa

REN Teréga GAS, ACCELERATING THE FUTURE

SOUTH REGION

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1 FOREWORD

It is a pleasure to present the fifth edition of the South European Gas Regional Investment Plan (South GRIP). This edition builds on the previous editions of the GRIP South, published in 2011, 2014, 2017 and 2019 (concise version), and also complements the Ten-Year Network Development Plan (TYNDP) 2020 published by ENTSOG in July 2021.

The launch of the European Green Deal in December 2019 has been the trigger to boost the development and implementation of numerous policies and initiatives by European and national authorities to lay the foundations for a comprehensive and inclusive decarbonisation roadmap.

Transmission System Operators are committed to play an active role in the decarbonisation process by planning new types of projects in order to roll out the infrastructure in response to these policies and initiatives (National Energy and Climate Plans 2021-2030 (NECP), the EU Energy System Integration and the EU Hydrogen strategies, the revision of the TEN-E regulation and the Hydrogen and Gas Markets Decarbonisation Package).

This South GRIP is the result of a close cooperation between the Transmission System Operators (TSOs) in the three countries of this European Region: France, Portugal and Spain. This fruitful cooperation between the five involved TSOs, namely Enagás, GRTgaz, Reganosa, REN, and TEREGA, continues with new type of projects for developing a prosperous, modern, competitive and climate-neutral energy system.

Consequently, and for the first in the South GRIP, Transmission System Operators have included renewables and low carbon gases projects in order to meet EU climate and energy goals.

Additionally, the reader shall be aware that after Ukraine invasion by Russia, new projects were announced in Europe as part of the RepowerEU strategy seeking to reduce dependence of Russian gas supplies. Following this aim, hydrogen projects and new interconnection capacity were proposed in the South region. However, those projects are not included in the South Grip 2021 as announcements arrived during the end of the editing phase of this publication.

The coordination of this document was driven by Reganosa (Spain). As this document is the outcome of common work, it is really appreciated counting on with all colleagues from the different TSOs involved in the South GRIP process and their beneficial support and active work.

Lastly, providing comments and proposals by all stakeholders and other interested parties would be highly valued in order to improve this document and the role of Transmission System Operators in the decarbonisation process.

2 EXECUTIVE SUMMARY/ CONCLUSIONS

The current gas infrastructure shows a strong resilience in terms of security of supply, efficient competition and market integration. However, investments in renewables, decarbonisation and infrastructure conversion are needed. Energy Transition (ETR) projects included in TYNDP 2020 demonstrate their capability to decarbonise the energy system.

The south regional gas system plays a key role in achieving the European energy and climate targets. The gas infrastructure offers unique opportunities – in energy storage, transmission and integration of renewables – to support the decarbonisation of the overall energy system in a cost effective, secure and achievable manner.

Planning and development of gas infrastructure are vital for meeting the EU climate and energy goals. The fifth edition of the South Gas Regional Investment Plan is strongly linked with the EU-wide Ten-Year Network Development Plan 2020 (TYNDP 2020). Thus, the South GRIP supports and complements the TYNDP 2020 since a harmonised data set is used for developing both reports.

Demand & Supply

For the South Region, TYNDP 2020 demand scenarios show a decreasing trend mainly due to decarbonisation commitments in the long term, highly focused on renewable energy deployment along with electrification. In particular, the Distributed Energy scenario describes the most pronounced decreasing trend, since this scenario has the highest annual electricity demand, leading to higher electrification rates across all sectors.

Domestic gas production is practically non-existent in France, Portugal and Spain. Hence, the South Region imports nearly all of its natural gas consumption. In the recent years, the deployment of renewable gases, in alignment with the EU decarbonisation targets, has fostered the injection of biomethane into the natural gas network. Nevertheless, despite the significant development undertaken in recent years, the injection of biomethane in the South Region is still limited.


Picture courtesy of Enagás

In the long term, the volumes of renewables and low carbon gases considered within the TYNDP 2020 scenarios reach 40 TWh/y in Portugal by 2040, 135 TWh/y in Spain and almost 190 TWh/y in France in the Distributed Energy Scenario.

South Region towards net-zero 2050

In response to the roadmap defined in the European Green Deal, Member States of the South Region have launched several national policies and initiatives aimed at supporting the EU 2030 and 2040 energy and climate targets for reducing greenhouse gas emissions, improving energy efficiency and enhancing renewable energy shares, as well as to pave the way towards fulfilling the overall climate neutrality ambition by 2050.

In particular, the release of the EU Hydrogen Strategy and the Energy System Integration Strategy by the European Commission in July 2020 has shed light on the crucial role that renewable and low-carbon gases will play in the deep decarbonisation of the European Union.

Member States of the South Region have also sought to align with these expectations and have adopted new measures in support of low carbon gas fuels, albeit to different extents.

Decarbonisation projects in South GRIP

As part of the South Region's engagement to EU climate and energy ambitions, several stakeholders, including gas TSOs, are currently proactively involved in diverse projects and initiatives aiming to materialise those efforts to advance towards climate neutrality.

In particular, gas TSOs in the South Region are fully committed to ensure that sustainable gas and gas infrastructures play a central role in decarbonising the EU economy and society. In this regard, 18 gas infrastructure projects are planned for implementation in the South Region.

The vast majority of ETR projects promoted by gas TSOs in the South Region relate to hydrogen and biomethane developments intended to scale up production capacities of these renewable gases. In particular, some of these projects comprise power-to-gas technologies and reverse flow.

In addition, there are other developments that are being carried out in the South Region, mainly focused on Carbon Capture and Storage/Utilisation of CO_2 emissions (CCS/CCU), R&D for hydrogen production, smart multi energy system and compressed natural gas (CNG)/liquified natural gas (LNG) for transport.

3 INTRODUCTION

3.1 PREAMBLE

The European Directive 2009/73/EC underlines the need to promote regional cooperation for supporting market integration and developing the security of supply of all Member States. This recognition is further detailed by the Regulation nº 715/2009 in Article 12, which states that "transmission system operators shall establish regional cooperation within ENTSO for Gas [...]. In particular, they shall publish a regional investment plan every two years".

In order to comply with this legal requirement, the five TSOs of the South Region (Enagás, GRTgaz, Reganosa, REN and Teréga) have worked in close cooperation since 2011 for the elaboration of the Gas Regional Investment Plans for the South Region (South GRIP), which covers France, Portugal and Spain. This report represents the fifth edition of the South GRIP aiming at supporting and complementing the latest EU-wide Ten-Year Network Development Plan (TYNDP 2020), produced by the European Network of Transmission System Operator for Gas (ENTSOG), by focusing on issues of specific regional relevance.

In particular, this 2021 edition of the South GRIP constitutes a change of approach from previous editions, since the key focus, for the first time, is on energy transition and on the potential future role of the gas sector in the South Region, in line with the energy and climate policy priorities of the European Union delivered by the European Green Deal.

In this regard, this report provides an overview of projects and initiatives that have been or are being developed across the South Region to facilitate the energy transition and specifically, to endorse the contribution of renewable and low-carbon gases to the decarbonisation of the overall EU society and economy. Particularly, these projects reflect the commitment of gas Transmission System Operators (TSOs) of the South Region to actively engage in and contribute to advance towards climate neutrality. Transmission System Operators of the South Region wish that this document will provide useful information to all stakeholders and will support fruitful discussions when assessing the role of the gas sector in energy transition.

3.2 OBJECTIVES AND ENHANCEMENTS

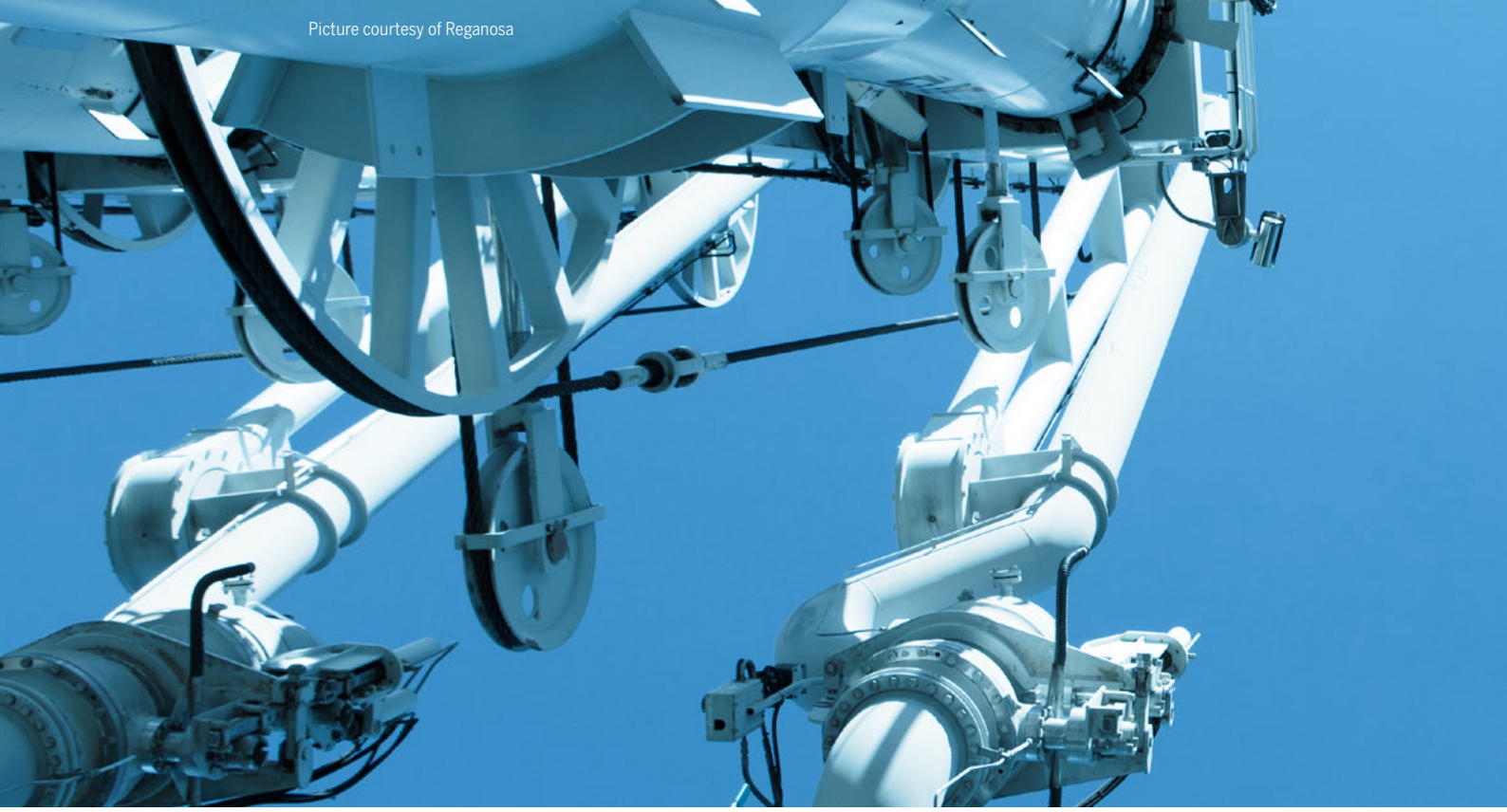
The main purpose of the GRIPs is to provide a regional zoom on the last published TYNDP. The TYNDP 2020 constitutes a step forward compared to previous editions, since it includes and assesses for the first time the so-called "energy transition projects" (hereinafter, ETR projects) meant to decarbonise the European energy system.

Therefore, this edition of the South GRIP intends to take a closer look at the deep change of paradigm we are witnessing in response to the urgent need to transform our economy and society towards a more sustainable and modern one. The presentation of the European Green Deal in December 2019 has been the trigger to boost the development and implementation of numerous policies and initiatives by European and national authorities to lay the foundations for a comprehensive and inclusive decarbonisation roadmap. Similarly, many other stakeholders, including gas TSOs, are joining forces to actively contribute to the EU energy and climate goals. This fifth edition of the South GRIP hence provides added value to capture the necessary transformation of the traditional energy system towards a more integrated one that leverages the diverse energy carriers and technologies offering sustainable solutions and, in particular, to give a clear picture of the different ETR projects in which gas TSOs of the South Region are involved.

Regarding the contents of this GRIP, the report first provides a general overview of the energy transition policies put in place at European level followed by detailed information framed in the regional context concerning France, Portugal and Spain. In this regard, the document outlines, on the one hand, the main issues on gas market and on historical data and long-term trends related to demand and supply in the South Region. On the other hand, the last two chapters of the GRIP focus on:

- Describing national initiatives launched in France, Portugal and Spain foreseeing a role for renewable and low-carbon gases in response to the EU ambition to reach climate neutrality by 2050.
- Identification of future challenges and opportunities of gas markets in the South Region.
- Specific energy transition projects being assessed by TSOs in the South Region.

Picture courtesy of Teréga



Picture courtesy of Reganosa

4 EUROPEAN UNION TOWARDS NET-ZERO 2050

Following the presentation of the Green Deal, the European Union has embarked on the path to become carbon neutral by 2050. The political commitment to become the first ever climate neutral continent has been translated into a set of actions designed to update the energy regulatory framework accordingly. This crucial journey will mobilise the gas network and infrastructure towards this ambition. In particular, the integration of energy systems as well as the increased uptake of low-carbon gases are among the main building blocks considered for the fulfilment of this ambition.

The European Green Deal: towards climate neutrality

In 2019, the newly designated European Commission unveiled its vision for a European Green Deal as a "new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use"[1].

With the objective to become the first ever carbon neutral continent, the Green Deal comprises a wide set of actions designed to mobilise each segment of the economy towards decarbonisation and the protection of the environment and biodiversity. In line with this ambition, the European Commission listed a proposal for a European Climate Law to set this vision into motion. Consequently, the European co-legislators adopted the legally binding objective to reach carbon neutrality by 2050, a commitment to negative emissions afterwards as well as an ambitious 2030 emission reduction target of at least 55 % as compared to 1990 (increasing the previously agreed target of at least 40 % emissions reduction compared to the same baseline).

1 "The European Green Deal", Communication from the European Commission, December 2019

Gas infrastructure at the heart of the transition towards a low-carbon energy system

In the context of a future energy system based on both molecules and electrons, the operational translation of the European Green Deal implies several important initiatives for the future of the European gas network.

In July 2019, the European Commission published a Strategy for Energy System Integration as well as a Hydrogen Strategy. The former aims to foster "the coordinated planning and operation of the energy system 'as a whole', across multiple energy carriers, infrastructures, and consumption sectors"[2]. This transition towards energy system integration is designed to deliver on several objectives, supporting "a climate neutral economy at the least cost across sectors – while strengthening energy security, protecting health and the environment, and promoting growth, innovation and global industrial leadership"[3]. In that regard, making the most of the complementarity between electrification, the optimal use of the existing gas network, including gas storages, and an increased share of renewable energy and low-carbon gases in the energy mix will be key to fulfil the European climate ambition.

The Hydrogen Strategy acknowledges the potential of hydrogen to act as the missing link of the energy transition. Being used as an energy carrier, hydrogen will be instrumental in coupling the electricity and gas sectors via existing infrastructure. Hydrogen also has the ability to support the decarbonisation of hard-to-decarbonise end-use sectors, such as industry or mobility, and to provide flexibility to the renewable energy system by offering large-scale, long-term storage services. To support the development of a hydrogen market, the European Commission launched the European Clean Hydrogen Alliance bringing together the private sector, public authorities and the European Investment Bank with the objective to help scale-up the hydrogen industry.

As a consequence, 2021 is the starting point of the legislative translation of these policy orientations. The European Commission aims to adapt the European Union energy regulatory framework to the ambition of the Green Deal and, in particular, the newly adopted climate targets. Its work program for 2021 includes an ambitious revision of its current legislation, known as the "Fit for 55 Package".

This batch of proposals and initiatives will be supplemented by a proposal for the revision of the Third Energy Package for gas, foreseen to be released by the end of the year, which intends to lay the ground for enabling the uptake of a renewable and low-carbon hydrogen market. Likewise, the revision of the TEN-E regulation, aiming at fostering the development of a more modern and sustainable EU cross-border energy infrastructure, has already been listed and the legislative discussion is underway at the European Parliament and the Council of the European Union.

2/3 "Powering a climate-neutral economy: An EU Strategy for Energy System Integration", Communication from the European Commission, July 2019

5 SOUTH REGION CONTEXT

MARKET OVERVIEW

5.1 DESCRIPTION OF GAS HUBS

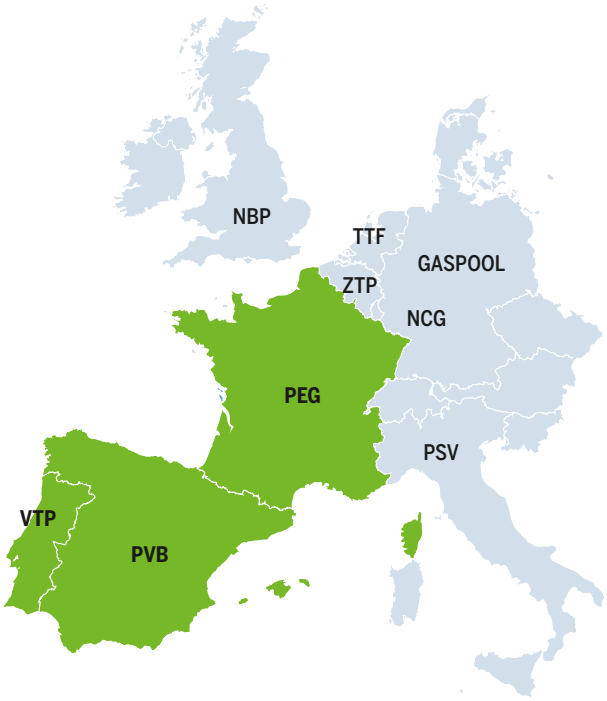


Figure 1. Main Virtual Points in Europe (the South Region in green).

In Europe, there are several organised gas markets, usually at country level. However, in some countries, there is more than one market area.

In the South Region, there are three organised gas markets or hubs already in place: in France, the organised gas market is operated by EXX; and in the Iberian Peninsula, the organised markets in Portugal and Spain are operated by MIBGAS[4]. The organised market in Portugal launched its products in March 2021.

As it is shown in figure 1, the South Region currently has three virtual points: PEG, a virtual exchange point within the Trading Region of France (TRF); PVB, a Virtual Balancing Point in Spain5; and a Virtual Trading Point (VTP) in Portugal.

4 On the 18th of June, Powernext also started to operate in Spain through the platform PEGAS

5 Since 2020, the MIBGAS platform also trades in products to be delivered at Virtual Balancing Tank (TVB) and at Virtual Balancing UGS (AVB)

5.1.1 FRENCH GAS MARKET

The French gas trading is organised as follows:

1. OTC (over-the-counter) or brokered exchanges

- On an over-the-counter basis, for example under long-term contracts covering most gas imports from Russia, Algeria and Norway. These contracts generally cover long-term periods (20 or 30 years).

- Through the brokered market, which includes the organised market (exchange) and brokers (brokered OTC contracts). The market comprises trading platforms on which various types of spot and futures contracts are bought and sold. Non-brokered OTC transactions can be carried out for products identical to those traded on the brokered markets.

2. Gas Trading Points

- The organised gas market in France was established in 2009 with different trading regions. From April 2015 to November 2018, there were two virtual Gas Trading Points (known in French by the acronym "PEG"), which were linked to the three balancing zones of the French transmission network: PEG Nord, linked to the GRTgaz Nord network zone; and TRS (Trading Region South), linked to the balancing zones of GRTgaz and Teréga.

- Since November 2018, these areas merged into one "Trading Region France" (TRF), which forms a single entry/exit zone, and a single balancing zone. All purchases and sales of gas for the whole TRF are concentrated at a single virtual gas trading point, PEG . The creation of the single TRF marketplace has for objective to establish a single price on the French market, to make it more competitive, to increase liquidity and to improve the security of supply in France.

The traded volumes on the French organised market and the number of active shippers on the PEG are as follows[6]:

PEG	Traded Volumes (TWh)	% of national demand
2018	677	144 %
2019	738	154 %
2020	781	176 %

Table 1. Volumes traded on the French organised market in 2018, 2019 and 2020.

PEG	Active Shippers at PEG
2018	112
2019	127
2020	115

Table 2. Number of active shippers on the PEG in 2018, 2019 and 2020 (Source: Commission de Régulation de L'énergie).

5.1.2 SPANISH GAS MARKET

The Organised Gas Market in Spain was established in December 2015, with the creation of a platform for trading gas products to be delivered at the Spanish Virtual Balancing Point (PVB) for different time horizons. MIBGAS was designated as the Organised Gas Market Operator and Enagás as Technical System Manager. This market is organised in trading sessions, with the possibility of trading one or more products at each one of them. There are currently two types of sessions[7]:

- Daily Trading Session, with trading in Daily Product, Month-Ahead Product and Balance of Month Product.

- Intraday Trading Session, with trading in Intraday Product.

In this regard, the products traded on the Organised Gas Market can be[8]:

- Normalised titled products at the virtual balancing point (PVB) with a time horizon up to the last day of the month following the arrangement of the trade. The Balance of Month and Month Ahead products will be cleared by OMIClear[9].

6 Source: Commission de Régulation de L'énergie

7 Source: MIBGAS

8 Source: MIBGAS

9 Source: OMIClear

- Short-term normalised products that Enagás, as Technical System Manager, may purchase or sell in order to conduct its balancing duties, involving the transfer of ownership of the gas located either at the Virtual Balancing Point or at one or more specific entry or exit points on the same (local products).

- In addition, trading may involve other products related to the gas supply chain, such as, for example, operation gas, working gas, cushion gas, gas for the supply to last-resort consumers, liquefied natural gas, etc.

MIBGAS Derivatives manages the exchange trading of future natural gas products, spot liquefied natural gas products and spot underground storage products in the Iberian Peninsula.

MIBGAS products can be traded on MIBGAS's platform and also through Trayport's Joule portal.

Hereunder a brief overview of the volume traded in MIBGAS in Spain is provided:

- In 2018: 24.3 TWh traded in normalised products and 2 TWh in derivatives, including the participation of 82 agents in the organised market. In comparison, the volume traded by means of bilateral agreements (market OTC) was 497 TWh and 258 TWh registered in the PVB (96 % of national demand)[10].

- In 2019: 48.27 TWh in normalised products (99 % increase over 2018) and 7.8 TWh in derivatives, with the participation of 105 agents in the organised market. In comparison, the volume traded by means of bilateral agreements (market OTC) was 716 TWh, which means 51.8 % traded in the PVB and the rest on the LNG terminals and UGS[11].

- In 2020: 39.8 TWh in normalised products (16 % decrease from 2019) and 7.5 TWh in derivatives, with the participation of 144 agents in the organised market. This volume means 13.6 % of the national demand. In comparison, the volume traded using bilateral agreements (market OTC) was 750.7 TWh, 337.8 TWh registered in the PVB (96 % of national demand), and 403.5 TWh in the TVB[12].

Traded Volumes MIBGAS	Normalised products (TWh)	Derivatives (TWh)
2018	24.3	2
2019	48.3	7.8
2020	39.8	7.5

Table 3. Volumes traded in Spain in normalised products and derivatives in 2018, 2019 and 2020
(Source: MIBGAS Annual Report, Spanish Gas System Report and Wholesale Market Report).

Traded Volumes OTC bilateral agreements	Total (TWh)	PVB (TWh)	TVB (TWh)	AVB (TWh)
2018	498	258	237	1.9
2019	717	339	372	6.2
2020	750	337	403	9,4

Table 4. Volumes traded in Spain via OTC bilateral agreements in 2018, 2019 and 2020
(Source: MIBGAS Annual Report, Spanish Gas System Report and Wholesale Market Report).

5.1.3 PORTUGUESE GAS MARKET

On 16 March 2021, the Organised Gas Market in Portugal launched its products with physical delivery at the VTP (Virtual Trading Point) on MIBGAS's platform. The national Transmission System Operator, REN-Gasodutos, is the Global Technical Manager of the National Gas System (SNG), and MIBGAS, the Operator of the Iberian Natural Gas Market.

Products can be traded on MIBGAS's platform and Trayport's Joule portal, as currently happens in the Spanish organised gas market.

Trading started with intraday, daily and weekend natural gas products. At a later date, the monthly and rest-of-month products will be added, which will be settled through the Portuguese clearing house OMIClear.

10 Source: MIBGAS Annual Report 2018, Spanish Gas System Report 2018 and Wholesale Market Report 2018

11 Source: MIBGAS Annual Report 2019, Spanish Gas System Report 2019 and Wholesale Market Report 2019

12 Source: MIBGAS Annual Report 2020, Spanish Gas System Report 2020 and Wholesale Market Report 2020

5.2 LIQUIDITY

The volume of gas traded[13] on the French and Iberian organised markets have been growing steadily since their creation, reaching a total of 1,187 TWh in 2020 (905 TWh in France and almost 282 TWh in Spain[14]). For 2018, 2019 and 2020, the monthly gas volume traded in France was between 63–70 TWh from June to September; and 80–100 TWh from October/November to May. Figure 2 shows the traded volume on the organised market in France since 2018:

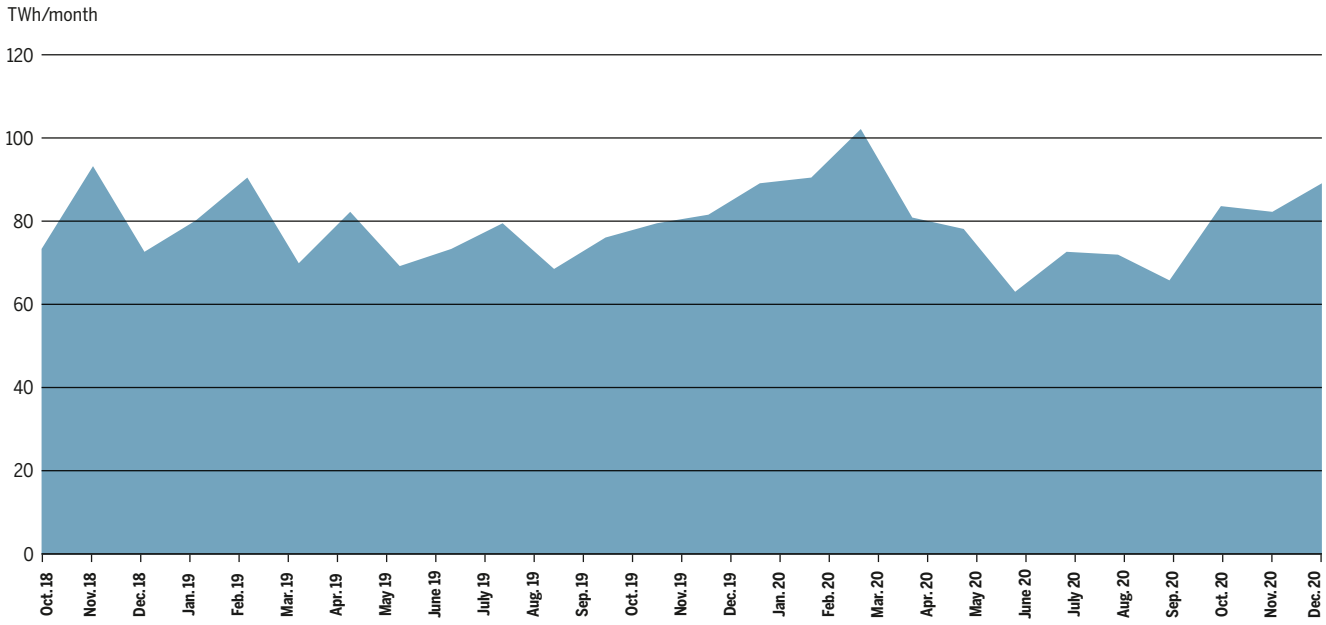


Figure 2. Monthly traded volumes in France in 2018, 2019 and 2020 (Source: GRTgaz (Vigilance Outlook) for France and MIB and TSO own elaboration).

The Churn ratio (traded volume divided by physical volume) represents how many times gas is traded on a hub before its consumption. The following figure shows the French churn ratio, which is quite stable, with values between 3 and 4 on average[15], except in February 2018, April 2019 and April/May 2020, where it is lower than 3; and September 2019 and 2020, where it is higher than 4.

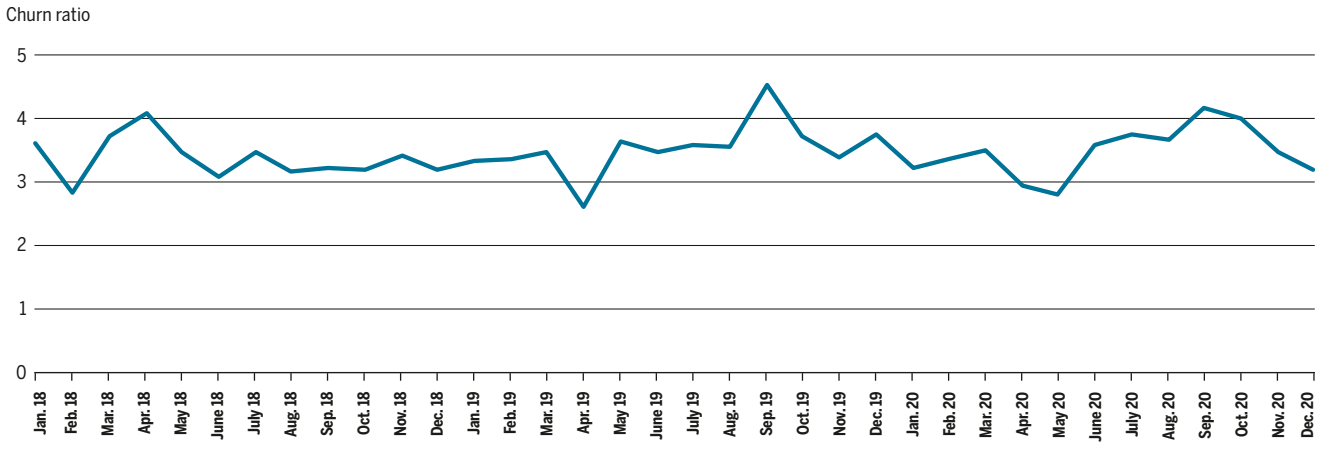


Figure 3. Churn ratio in France in 2018, 2019 and 2020 (Source: TSO own elaboration).

13 This section analyses 2018, 2019 and 2020. As Portugal launched its gas products in March 2021, it will not be analysed.

14 The Spanish traded volume includes both MIBGAS and OTC bilateral agreements.

15 No data available for gas volume physically traded in Spain.

For 2018, 2019 and 2020, the monthly gas volume traded in Spain was between 63–70 TWh from June to September and 80–100 TWh from October/November to May. Trading at the PVB has improved significantly since it was created in late 2015, but it is still incipient when compared to other European gas hubs. The following figure shows the traded volume in recent years:

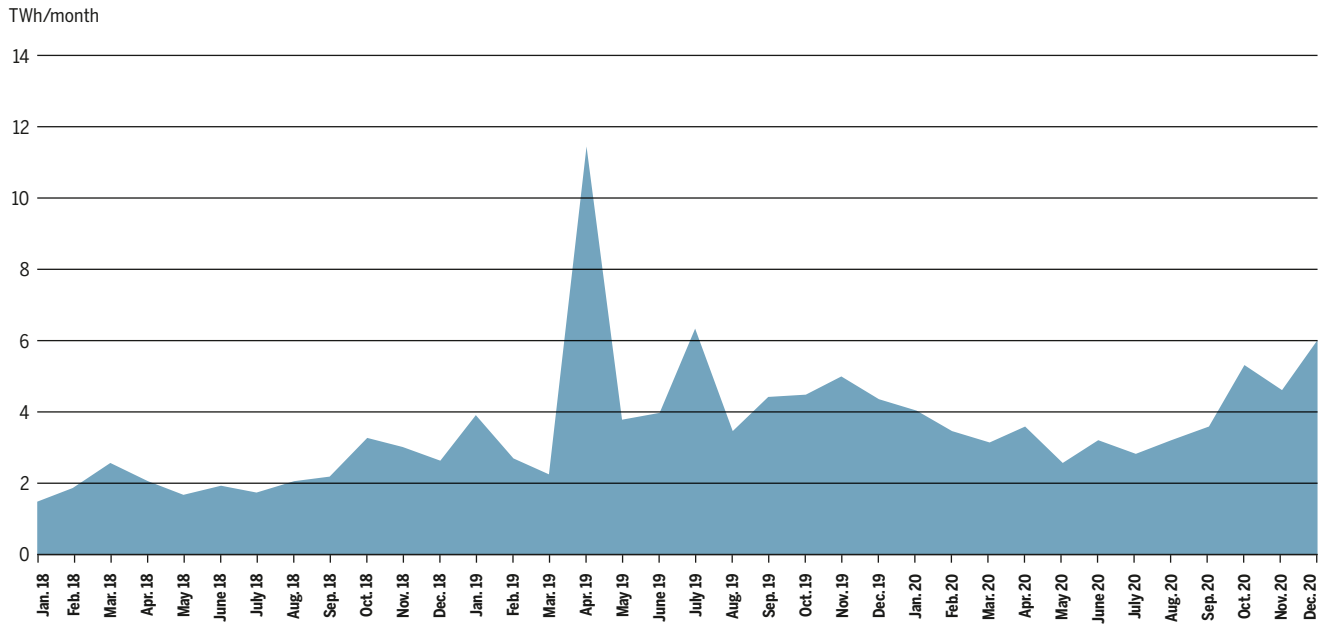


Figure 4. Monthly traded volumes in MIBGAS, Spain, in 2018 (Source: MIBGAS Annual Report 2018 and TSO own elaboration).

5.3 PRICES

5.3.1 EVOLUTION OF EUROPEAN GAS HUBS

In order to show the evolution of main European natural gas hubs, we have analysed the behaviour of energy prices in these organised markets, resulting in the following key insights:

- In general terms, convergence of day-ahead prices on main European hubs has been achieved, except for the Italian PSV and the Spanish PVB, which remained higher for most of the period.
- In 2018, during the previous months to the merge of the French gas market, TRS average prices were higher than PEG NORD. The maximum prices for the hubs were in September.
- In 2019, the prices followed a decreasing trend compared to 2018, with the Italian PSV and Spanish PVB prices above the rest of the hubs (up to 3 €/MWh).
- In 2020, the prices kept a decreasing trend for all hubs until May and were steady until July. After the summer, there is V-Shaped Recovery for all the Hubs. At the end of 2020, the PVB prices were the highest again.

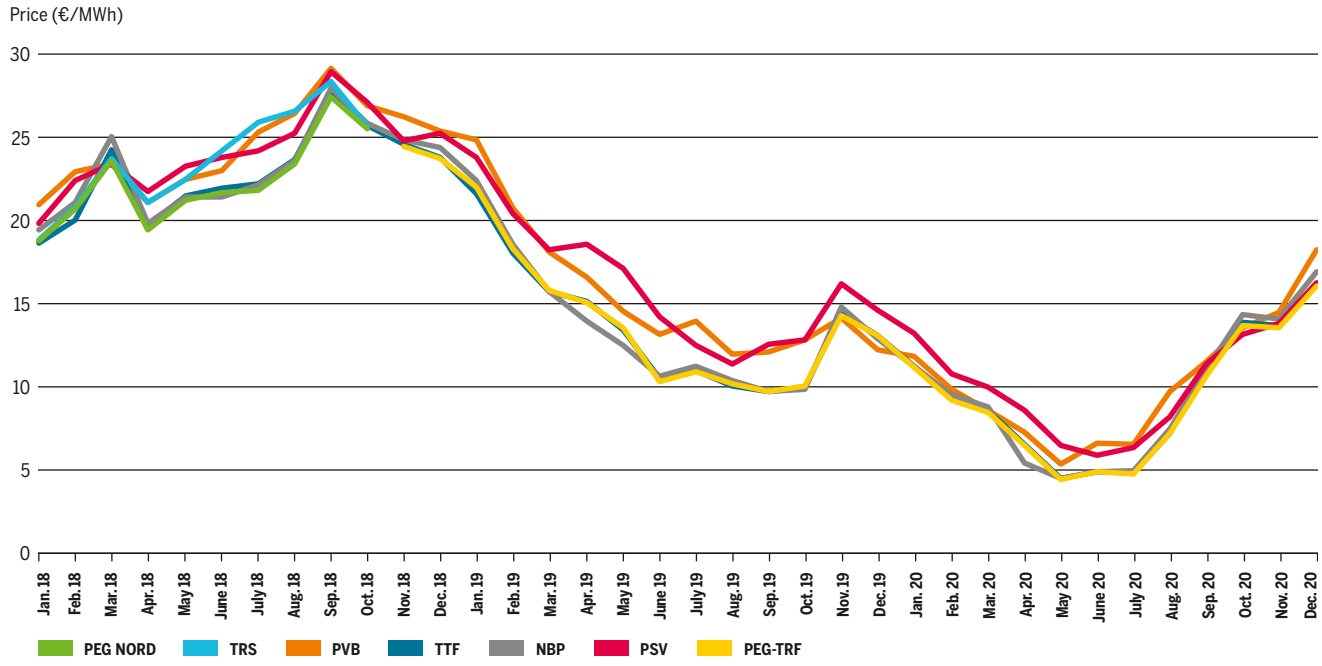


Figure 5. Monthly average gas prices of main European hubs (Source: TSOs own elaboration).

5.3.2 MARKET SPREADS

Focusing on spread for the South Region, a disconnection between prices of PVB and PEG-TRF is observed, with the spread between 0 and 3 €/MWh in 2019 and 0 and 2.5 €/MW in 2020, except for negative values in December 2019 and October 2020. The following figure shows this analysis in detail:

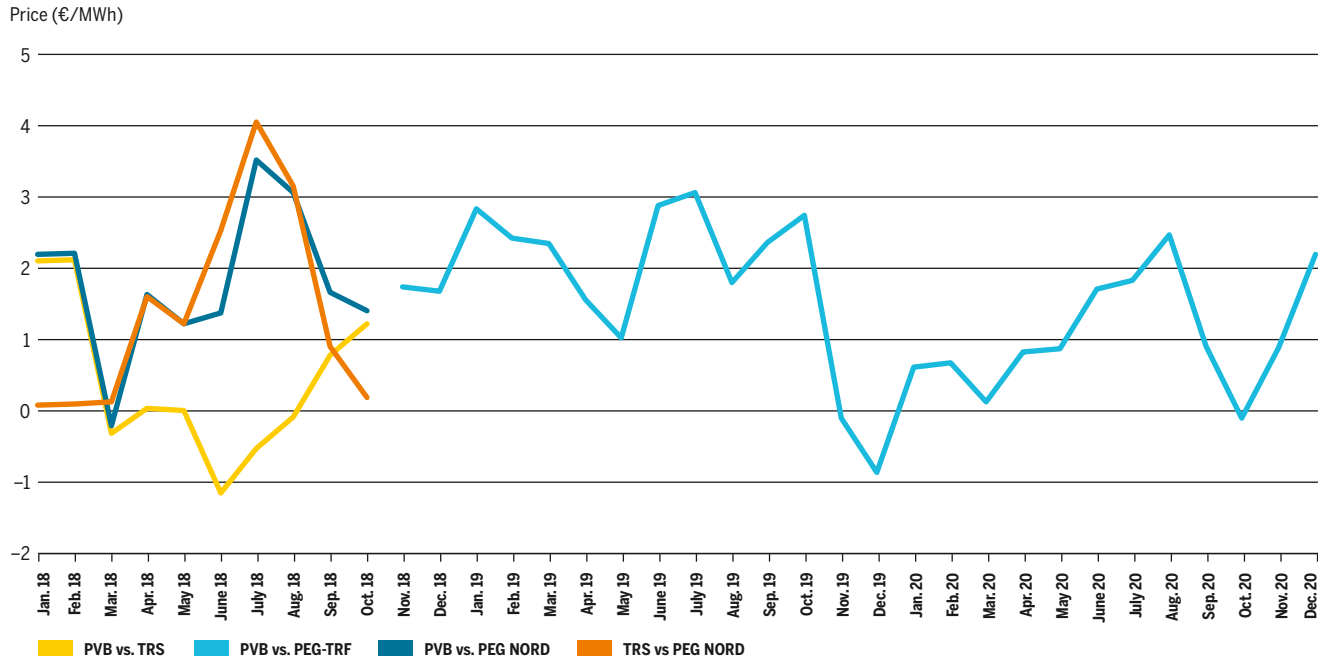


Figure 6. Gas market spreads in the South Region: TRS vs PEG NORD; and PVB vs PEG-TRF, TRS & PEG NORD (Source: Platts, ENTSOG & TSO own elaboration).

Comparing the South Region hubs versus the TTF, it can be noticed that the PEG-TRF and TTF prices are quite aligned, while the PVB has a spread up to 3.2 €/MWh in 2019 and 2.5 €/MWh. The following figure shows this analysis in detail.

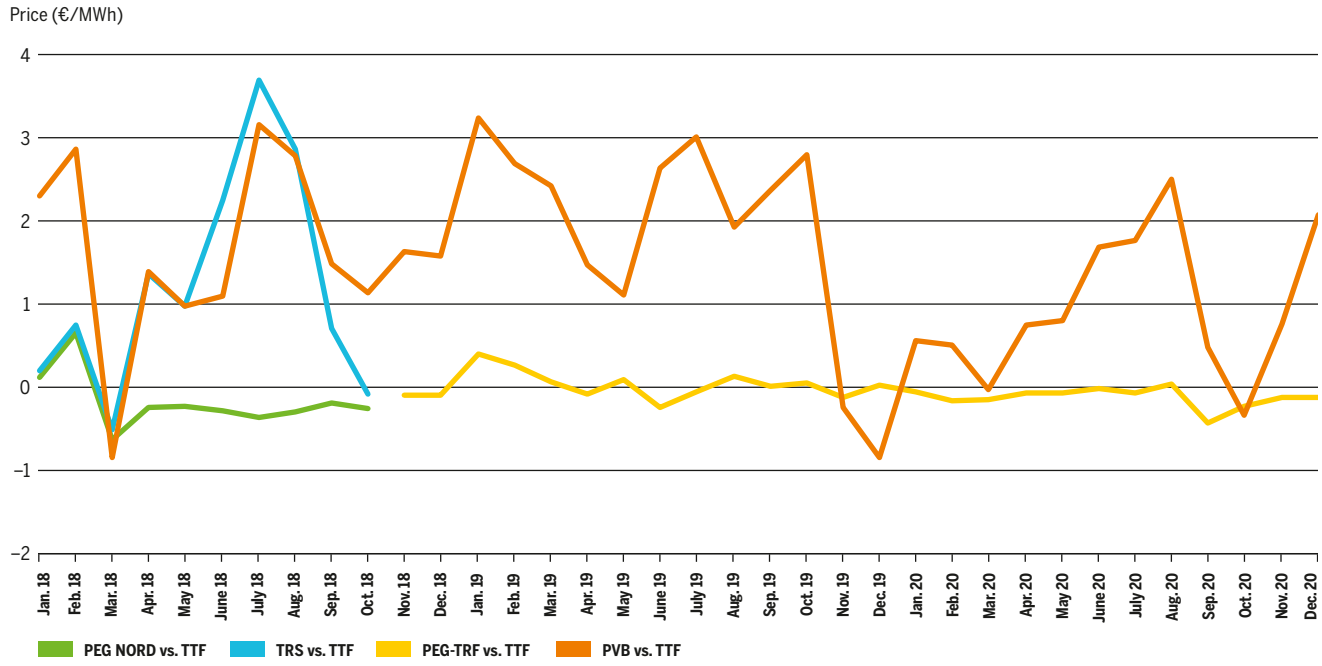


Figure 7. Gas market spreads in main European Hubs: TTF vs PVB, PEG-TRF, TRS & PEG NORD (Source: TSO own elaboration).

5.3.3 EVOLUTION OF SPOT LNG PRICES WORLDWIDE

LNG enables the connection of Europe to the global world market and a large number of producing countries in the Middle East, the Atlantic (including the Mediterranean) and the Pacific basins. It gives access to reliable and diversified supply, offering the shippers arbitrage opportunities at a global scale between different sources and regional markets.

In 2018, the LNG market growth at a rate of 8 %, with deliveries amounting to 314 MT. In general, 2018 saw the return of an active market for LNG, with higher oil and spot LNG prices for most of the year and record-high charter rates for spot shipping during the last quarter.[16]

In 2019, the LNG market grew at a rate of 13.0 %, reaching 354.7 MT. Thus, 2019 marked an all-time record increase in annual LNG production, driven by new liquefaction trains and ramp-ups in the United States, Russia and Australia.[17]

Meanwhile, 2020 had a great volatility in LNG prices. Despite a reduction in global energy consumption due to lockdowns around the world, LNG trade grew by 0.4 %, reaching 356.1 MT at the end of the year. In the first half of 2020, natural gas demand began to be impacted in many countries as COVID-19 spread. Towards the end of the year, the market experienced price spikes and record high spot shipping charter rates due to infrastructure bottlenecks and colder than usual weather.[18]

As the following figure shows since the beginning of 2019 worldwide LNG prices trends for all basins are aligned between them except for China. LNG prices for China are usually lower than for the rest of basins, reaching a 10 €/MWh gap in 2018 and being more aligned in 2019 and 2020. On the other hand, there is a disengagement between LNG and Brent prices.

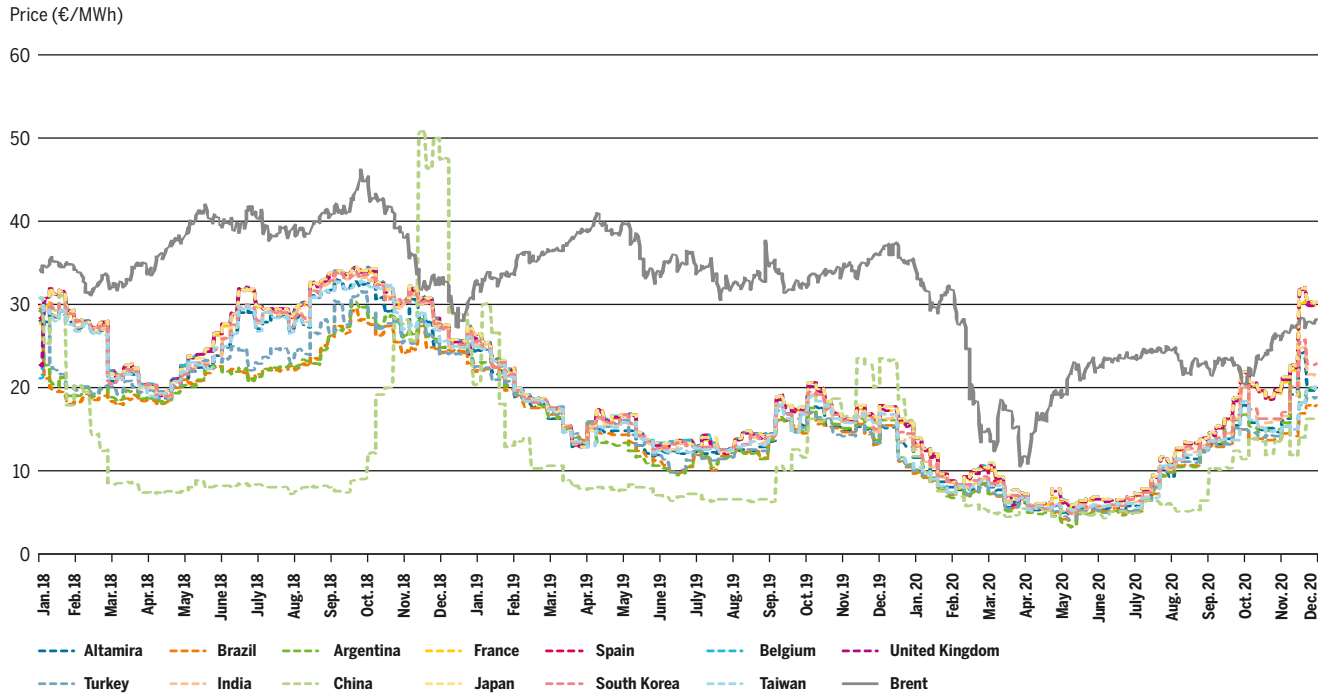


Figure 8. Main LNG importing areas average prices vs Brent (Source: Reuters, Refinitiv Eikon data).

16 Source: GIGNL Annual Report 2019

17 Source: GIGNL Annual Report 2020

18 Source: GIGNL Annual Report 2021

5.4 IP SUBSCRIPTION AND USE

5.4.1 CAPACITY SUBSCRIPTION AT IPS BETWEEN SPAIN AND FRANCE (VIP PIRINEOS)

In October 2014, Enagás and Teréga created a Virtual Interconnection Point between Spain and France, called VIP Pirineos, for the purpose of providing a single capacity service. The VIP Pirineos comprises the two physical interconnections points between France and Spain: Larrau IP and Biriatou (FR)/Irun (ES) IP.

The total technical capacity at VIP Pirineos is equal to or higher than the sum of the technical capacities at each of the interconnection points contributing to the VIP Pirineos.

The technical capacity from October 2019 to September 2024 for the VIP Pirineos between Enagás and Teréga is summarised in table 5.

	Enagás side		Teréga side	
GWh/d	Firm	Interruptible	Firm	Interruptible
From France to Spain	225	0	165 (W) / 175 (S)	60
From Spain to France	225	0	225	0

Table 5. Existing capacities at VIP Pirineos (Source: TSO own elaboration).

Regarding the capacity subscription on the VIP Pirineos, the following exhibit shows the capacity bookings during 2018, 2019 and 2020 compared to the maximum capacities.

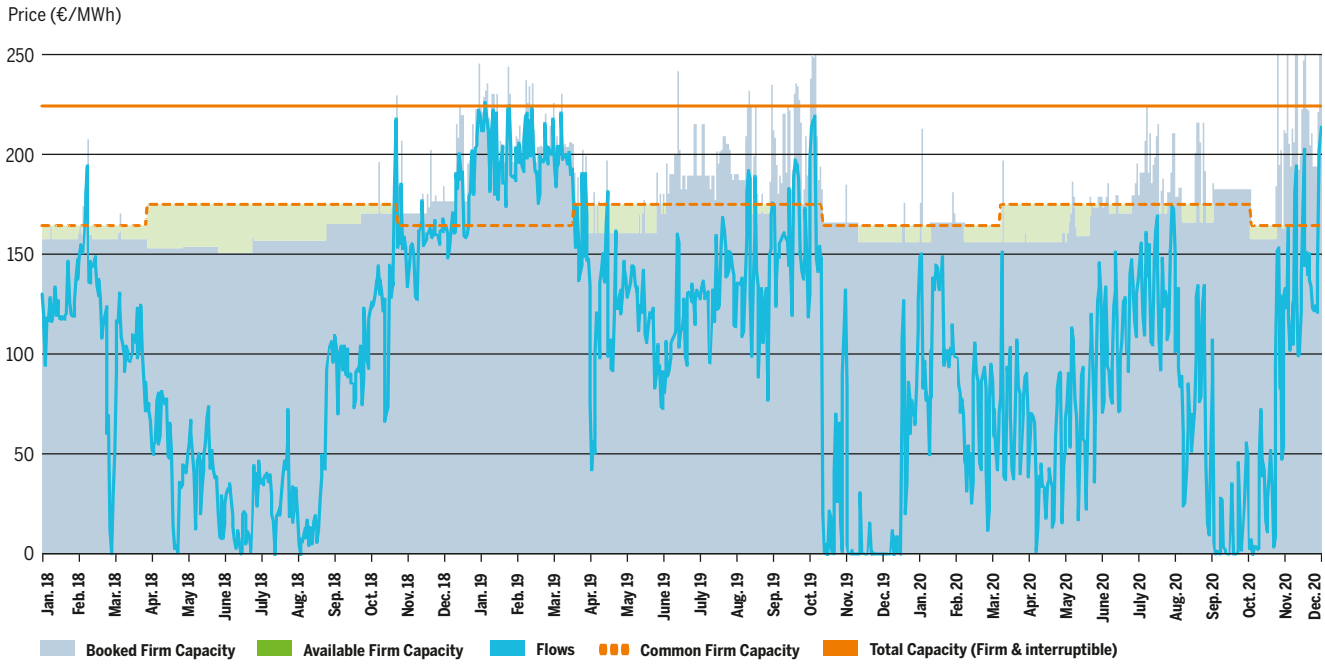


Figure 9. Capacity subscription at VIP PIRINEOS from France to Spain (in the French side). (Source: TSO own elaboration).

A structural change has taken place since the Trading Region France was put in operation. The average utilisation (physical flow) has consistently stayed over common firm capacity at VIP Pirineos during the winter of 2018 and 2020 and the beginning of winter of 2019. Under this scenario, capacity at the annual auction for yearly products and the yearly auction for the winter quarters were allocated at a premium over the reserve price. According to the European Commission Decision of 24 August 2012[19] and ACER´s criteria, there was a contractual congestion during the winter period.

19 Source: European Commission Decision 24 August 2012

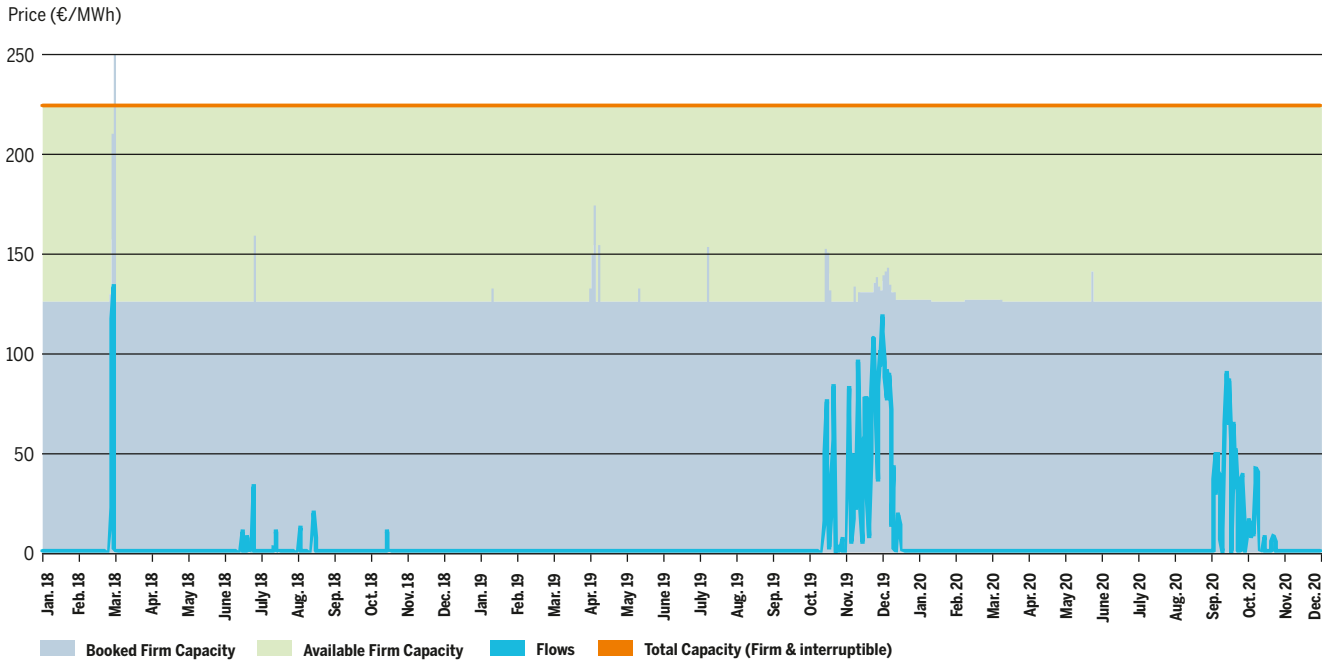


Figure 10. Capacity subscription at VIP PIRINEOS from Spain to France (in the French side). (Source: TSO own elaboration).

As the previous figure shows, almost all the physical flow during this period flows from France to Spain, except during March 2018 and the winters of 2019 and 2020, due to some strong cold spells across Europe.

5.4.2 CAPACITY SUBSCRIPTION AT IPS BETWEEN SPAIN AND PORTUGAL (VIP IBERICO)

After October 2014, the cross-border capacity between Spain and Portugal is marketed in the VIP Ibérico. The technical capacity from October 2019 to September 2024 for the VIP Ibérico between Enagás and REN is shown in table 6.

GWh/d	Enagás side	REN side
From Portugal to Spain	80	80
From Spain to Portugal	144	144

Table 6. VIP Ibérico technical capacity (Source: TSO own elaboration).

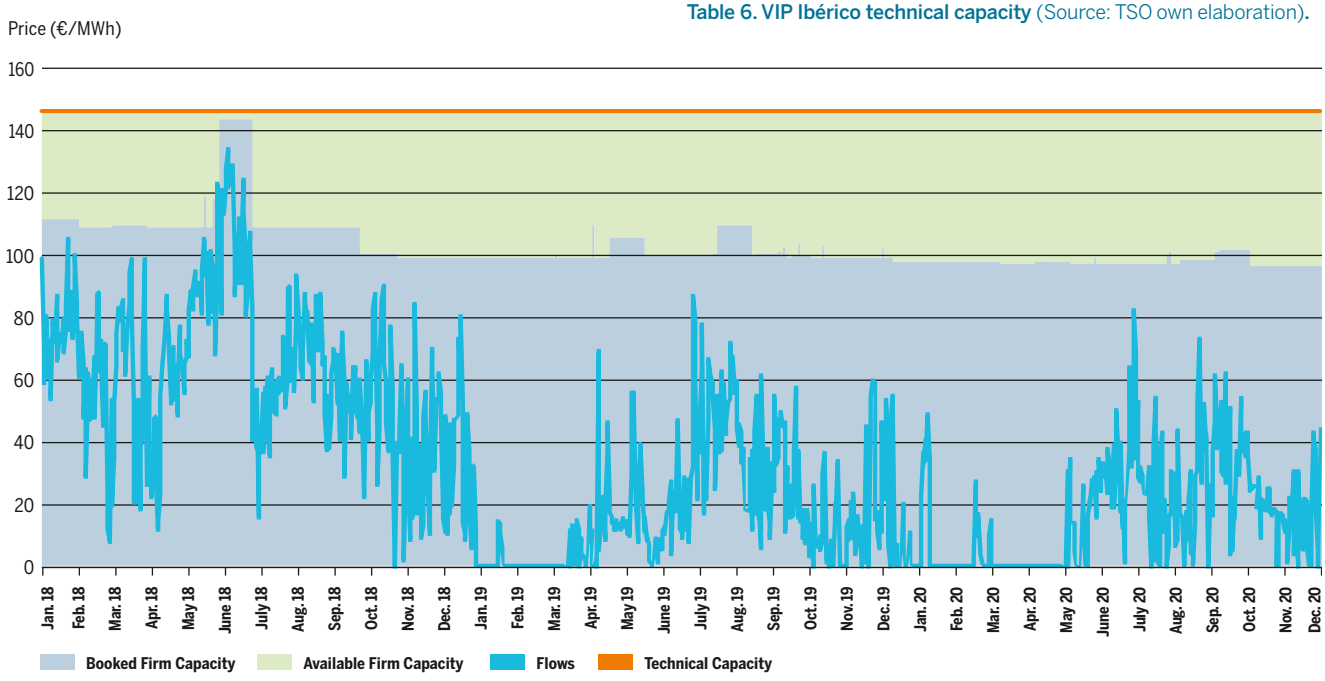


Figure 11. Capacity subscription at IPs from Spain to Portugal, VIP IBERICO - Spanish side (Source: TSO own elaboration).

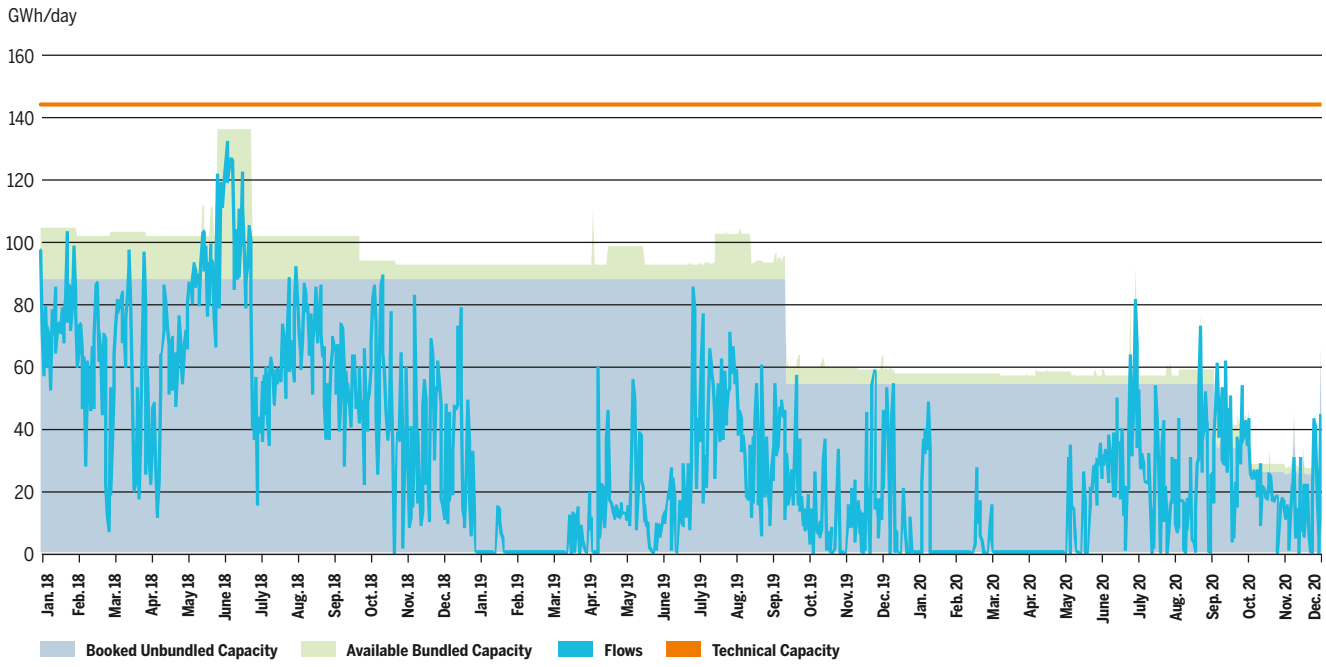


Figure 12. Capacity subscription at IPs from Spain to Portugal, VIP IBERICO – Portuguese side (Source: TSO own elaboration).

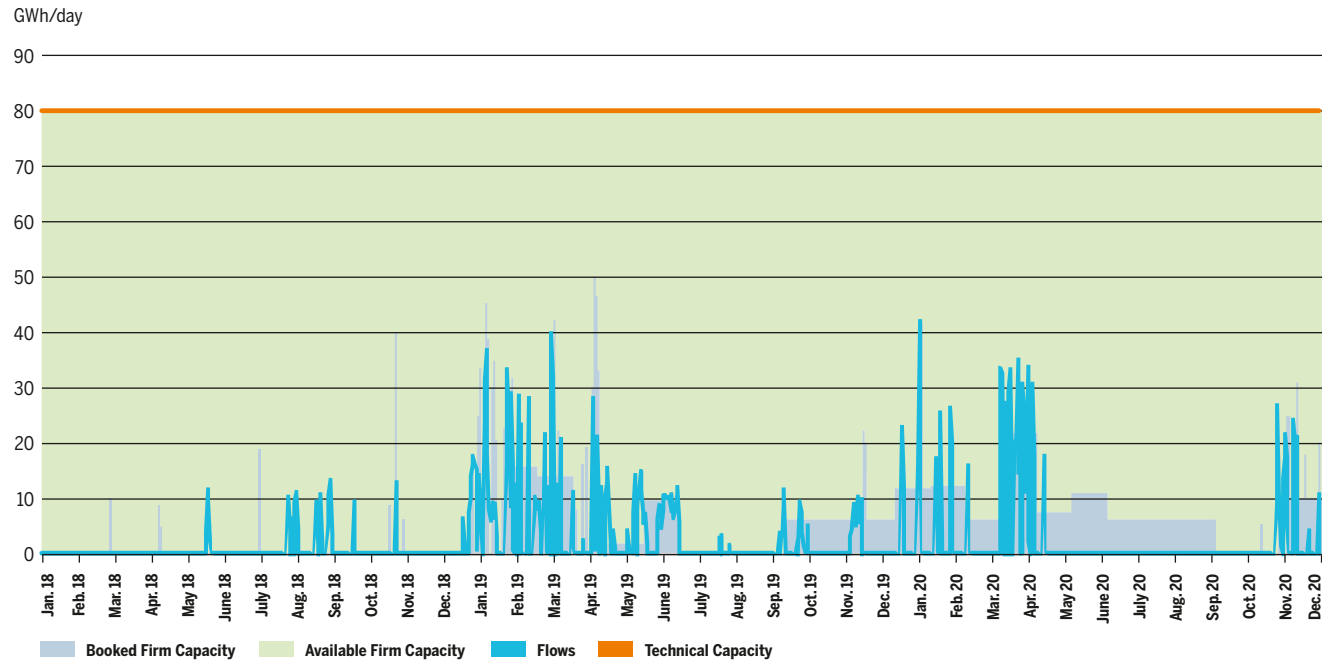


Figure 13. Capacity subscription at IPs from Portugal to Spain, VIP IBERICO - Spanish side (Source: TSO own elaboration).

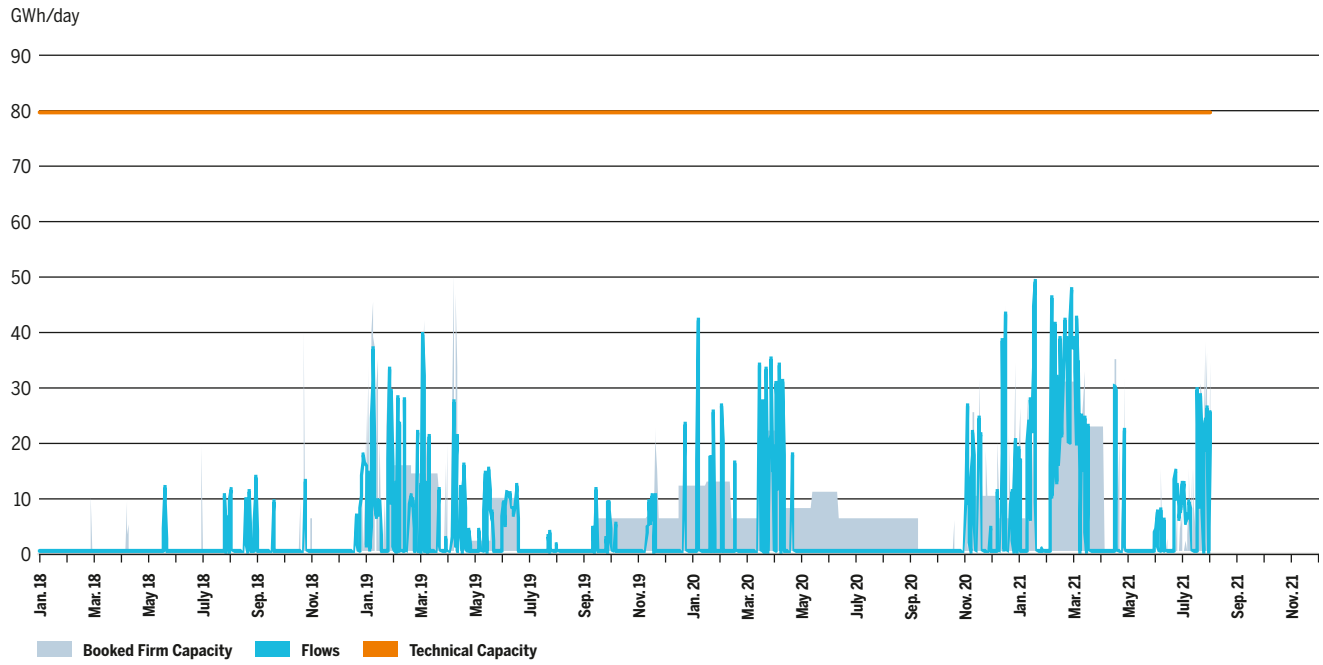


Figure 14. Capacity subscription at IPs from Portugal to Spain, VIP IBERICO – Portuguese side (Source: TSO own elaboration).

Historically, most of the physical flow has been from Spain to Portugal, but as the previous exhibit shows, from 2019 to the middle of 2020, the gas flow was from Portugal to Spain.

5.5 REGIONAL OVERVIEW OF GAS DEMAND

5.5.1 PRIMARY ENERGY CONSUMPTION

In 2019, the primary energy consumption in the South Region was 4,522 TWh, 19 % of that being natural gas (figure 13)..

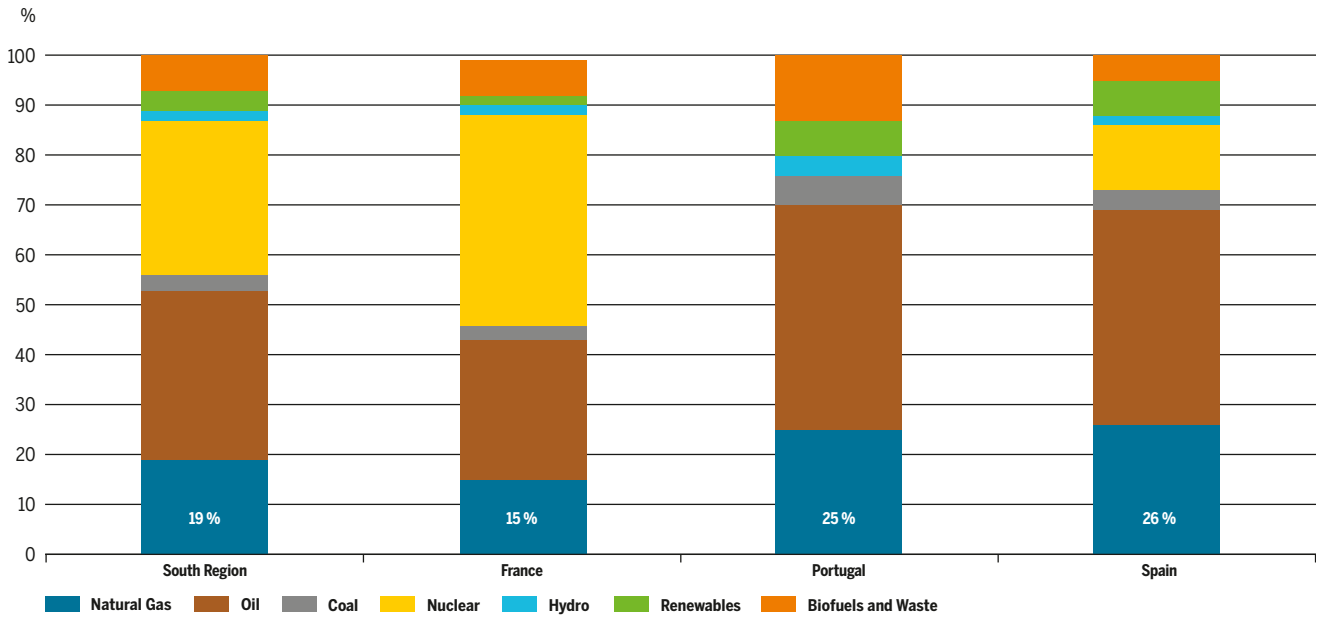


Figure 15. Total energy supply by source in 2019 for South Region countries (Source: IEA World Energy Balances 2020, own elaboration).

5.5.2 YEARLY GAS DEMAND

The natural gas demand can be split between:

- The final gas demand including Industrial, Commercial, Residential and Cogeneration (CHP) demand.
- Gas demand for power generation. This sector includes combined cycle gas turbines (CCGTs) and Open Cycle Turbines.

Gas demand is highly influenced by weather conditions. In particular, temperature has a significant impact in space heating, especially in residential and commercial segment, whereas variations in solar and wind power together with hydro reshape how much coal and/or natural gas is fired for power generation.

In the South Region, total gas demand growth in year 2019 was 7 % year on year. In 2020, despite the lockdown during COVID-19 sanitary crisis, the gas demand remained at the same level as year 2018, with a slight fall lower than 1 %. The final gas demand represented 81 % of the total gas demand in 2019, and 82 % in 2020. This breakdown of the demand varies from one country to another (Figure 16).

Figure 16. Share of power generation in total gas demand in the South Region and for France, Portugal and Spain in 2018, 2019 and 2020 (Source: TSOs).


Picture courtesy of Teréga

5.5.3 DEMAND MODULATION

Gas demand varies through the year, week and day due to changes in the meteorological conditions, economical and residential activities and the competition between different sources of energy. The yearly modulation factor is defined as the daily average gas demand divided by the daily peak demand. A high yearly modulation factor means demand is relatively uniform, even in peak situation. A low yearly modulation factor shows that a high demand is set; to service that peak demand, capacity is sitting idle for long periods.

As can be seen in figure 17, France's total yearly modulation factor is lower compared to Portugal and Spain. This is mostly due to a more pronounced seasonal modulation in France than in Portugal and Spain. In order to cope with this seasonal modulation, France has developed a significant storage capacity in underground facilities.

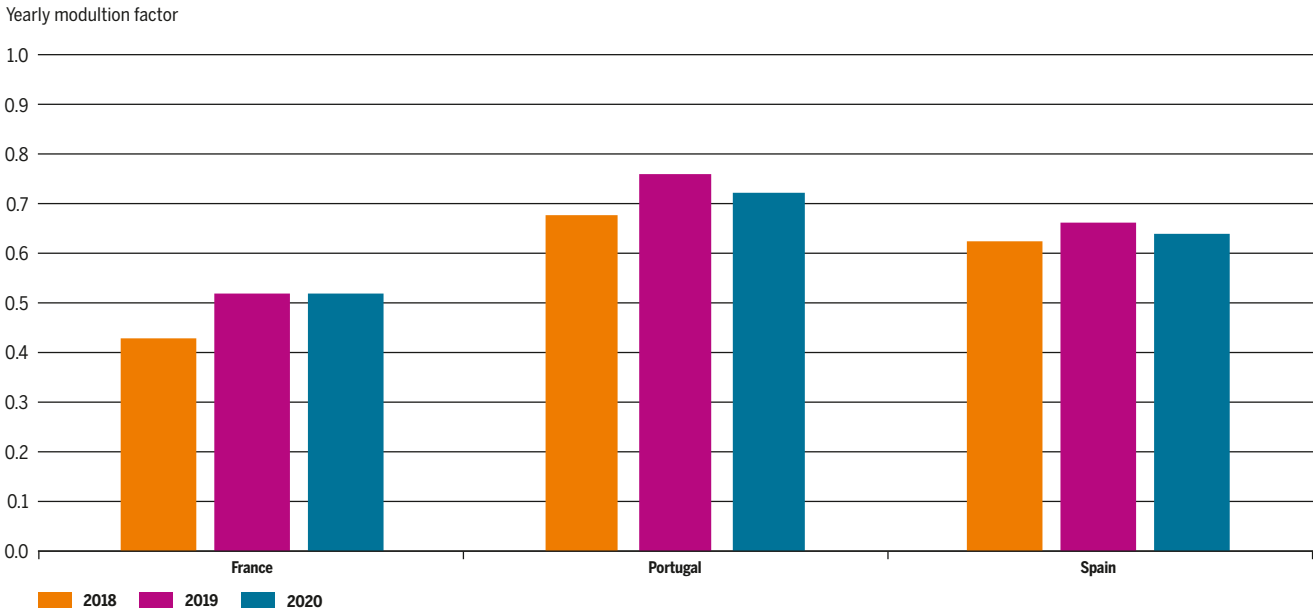


Figure 17. Yearly modulation factor for total demand for France, Portugal and Spain
(Source: TSOs & REN Dados técnicos for Portuguese daily peak demand).

5.5.4 GAS DEMAND SCENARIOS TO 2040

This section illustrates the long-term demand scenarios considered in TYNDP 2020 for the South Region.

The figures below are taken from ENTSOs TYNDP 2020 Final Scenario Report , where a detailed description of the storylines behind each of the scenarios is provided.

5.5.4.1 Yearly Average demand

The yearly average total demand is shown in figure 18.

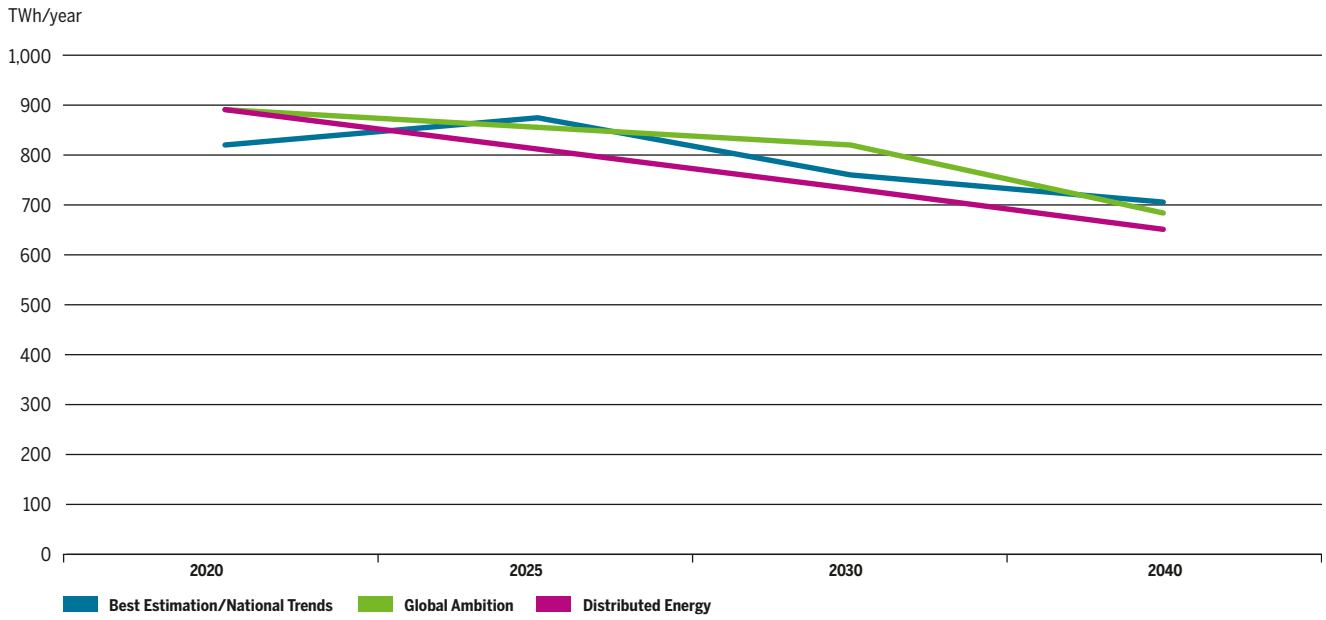


Figure 18. Yearly average total demand (Source: TYNDP 2020 data, own elaboration).

For the South Region, all scenarios consider a decreasing trend mainly due to decarbonisation commitments in the longer term, highly focused on renewable energy deployment along with electrification. In particular, the Distributed Energy scenario describes the most pronounced decreasing trend, since its storyline has the highest annual electricity demand, leading to higher electrification rates across all sectors.

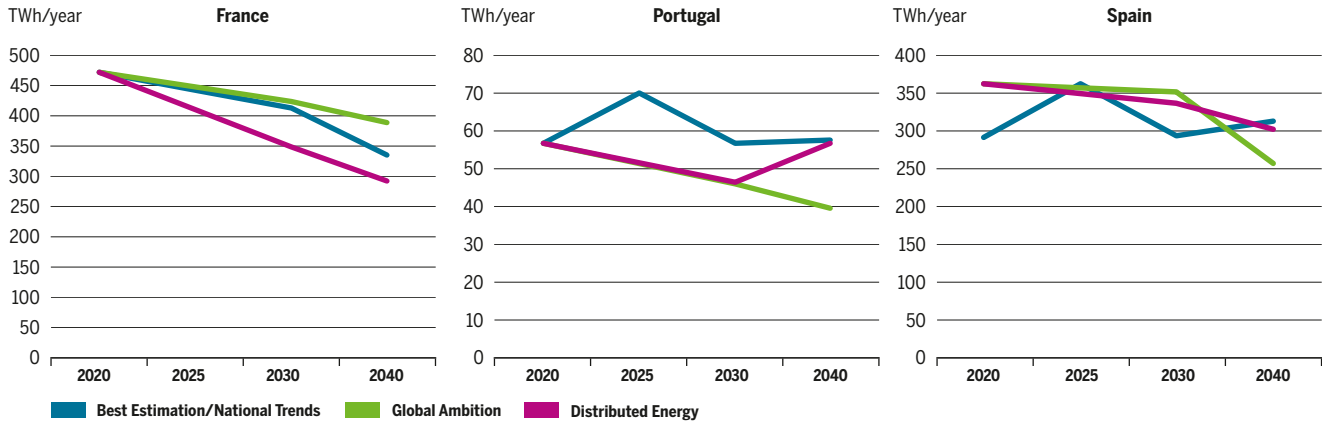


Figure 19. Total demand scenarios in France, Portugal and Spain (Source: TYNDP 2020 data, own elaboration).

For France, demand clearly decreases in all three scenarios. The Distributed Energy scenario shows the strongest decrease, while the Best Estimate NT and Global Ambition scenarios describe a slight decreasing trend up to 2030 followed by a more pronounced decrease for the 30–40 period.

In Portugal, demand increases in Best Estimate NT scenario up to 2025 decreasing in 2040 to demand levels similar to current demand. Both Global Ambition and Distributed Energy scenarios show a decreasing pattern until 2030, but in the case of Distributed Energy demand recovers existing current demand levels.

For Spain, the demand substantially decreases in all of the scenarios but following different patterns. The Distributed Energy scenario shows a moderate and linear downward trend unlike Best Estimate NT which follows a sharp decrease in 2030 followed by a slight recovery until 2040. The Global Ambition scenario describes a pronounce decrease from 2030 to 2040.

5.5.4.2 Peak demand

The peak demand represents one of the most stressful situations to be faced by the gas infrastructures (1-in-20 year situation for the Iberian Peninsula and 1-in-50 year situation for France). It corresponds to the maximum level of gas demand used for the design of the network in each country, defining the maximum transported energy and ensuring consistency with national regulatory frameworks.

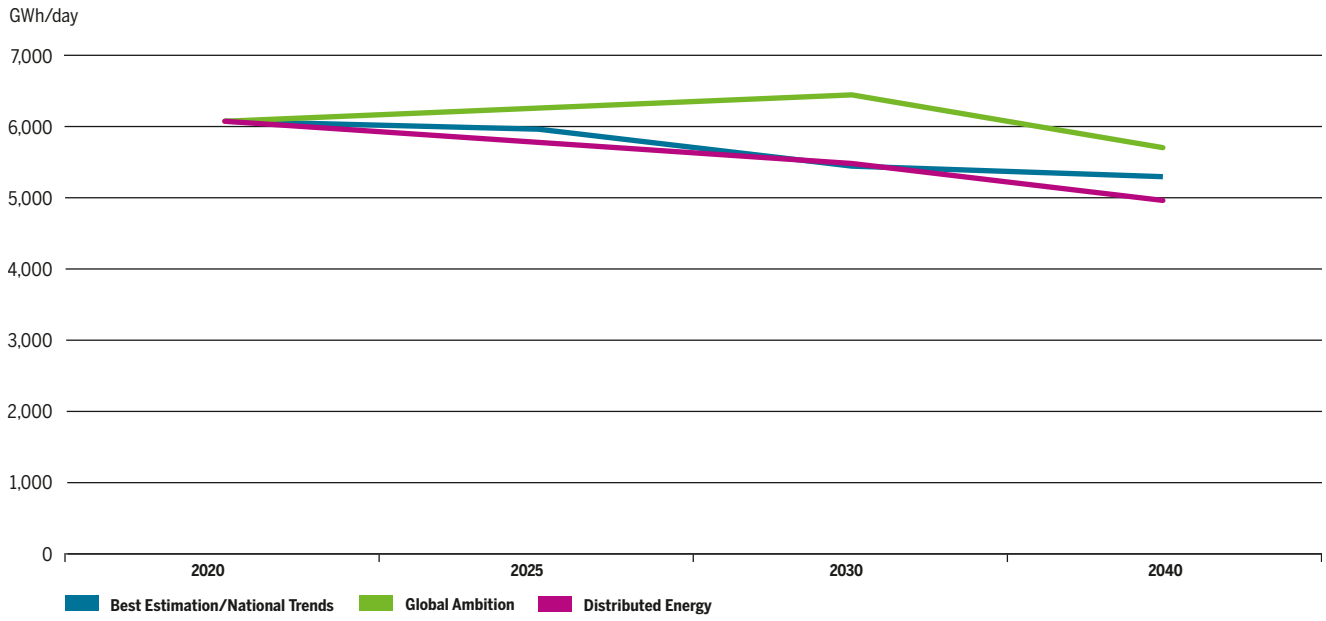


Figure 20. Total peak demand (Source: TYNDP 2020 data, own elaboration).

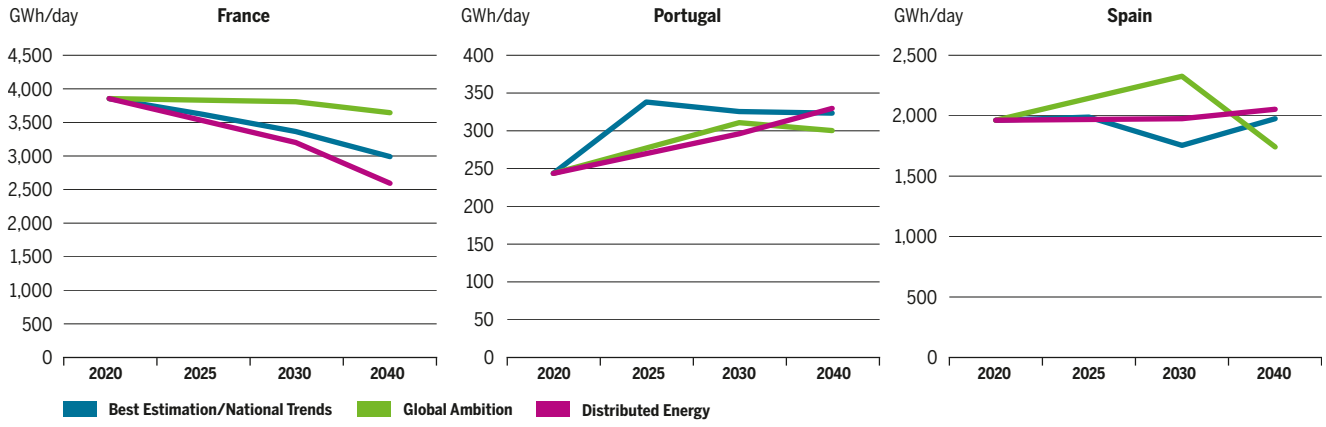


Figure 21. Total peak demand scenarios in France, Portugal and Spain (Source: TYNDP 2020).

For the South Region, the Global Ambition scenario shows an increasing trend in peak demand up to 2030 followed by a downward trend to slightly lower current levels. Both Best Estimate NT and Distributed Energy scenarios follow a steady downward trend.

For France, peak demand generally follows the annual trends, with a decreasing behaviour in the Best Estimate NT and Distributed Energy scenarios. Meanwhile, Global Ambition scenario shows a steady peak demand at current levels until 2030, after which a slight decline is observed.

In Portugal, Global Ambition and Distributed Energy scenarios reverse the downward trend described for yearly average demand, thus showing a steady growth in peak demand until 2030. From this year onwards, Global Ambition outlines a moderate downward trend. As regards Best Estimate NT scenario, peak demand increases until 2025 and then follows a declining path.

For the case of Spain, Best Estimate NT scenario provides similar behaviour to that described for yearly demand, reaching a sharp decrease on peak demand in 2030 followed by a slight recovery until 2040. Meanwhile, Distributed Energy scenario shows a moderate increasing trend whereas Global Ambition scenario first describes a continuous rise until 2030, followed by a steep decrease.

5.6 REGIONAL OVERVIEW OF GAS SUPPLY

Domestic gas production is practically non-existent in Spain and Portugal, as well as in France since the shutdown of the Lacq gas field in 2013. Hence, the South Region imports nearly all of its natural gas consumption. In recent years, the deployment of renewable gases, in alignment with the EU decarbonisation targets, has fostered the injection of biomethane into the natural gas network. Nevertheless, despite the significant development undertaken in recent years, the injection of biomethane in the South Region is still limited.

In 2018, two thirds of the natural gas supply in the South Region were delivered through pipelines, while the remaining third was imported as LNG (see Figure 22). LNG deliveries increased significantly in Portugal to reach an import share of over 90 %. Both Spain and France also received higher LNG deliveries over the last two years, although the LNG import share remained at 60 % in Spain and around 30 % in France. The share of LNG imports in the South Region has also followed an increasing trend in recent years to reach a level of 40 % (see figure 22).

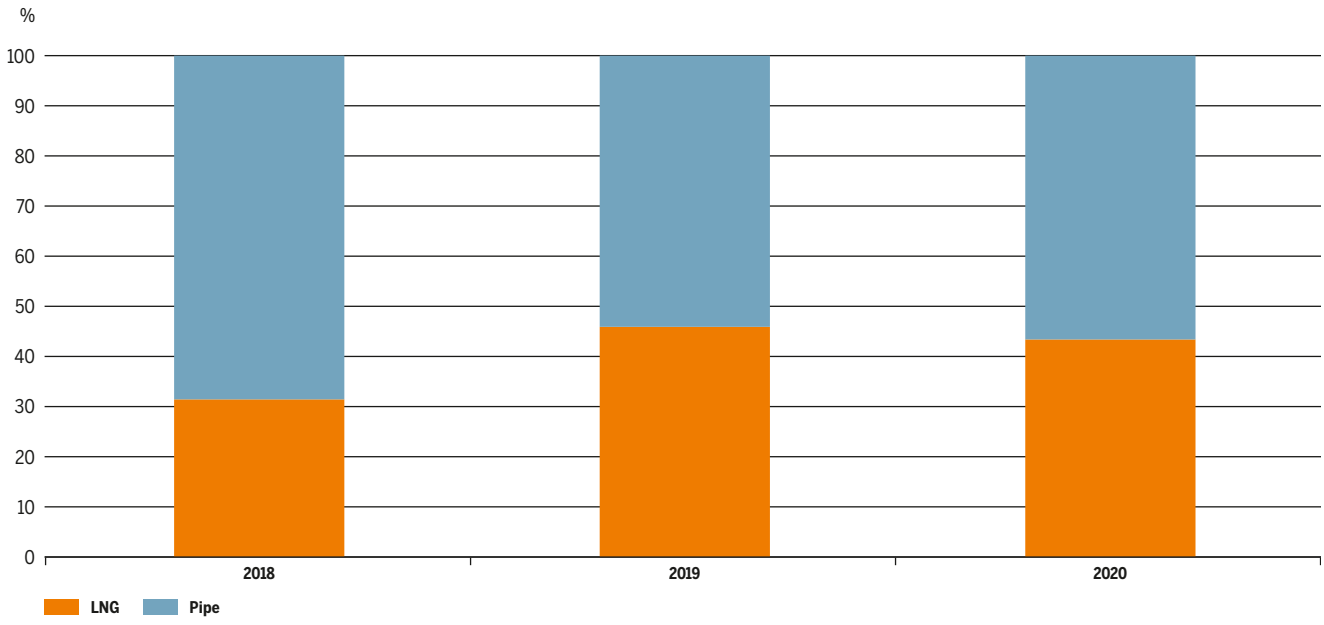


Figure 22. Share between pipeline gas and LNG in the South Region in 2018-2020 period (Source: CRE and AIE (France), Dados Tecnicos REN (Portugal), Annual Gas System Report Enagas (Spain)).

The South Region has traditionally benefited from a highly diversified supply portfolio, in part due to the importance of LNG, which presents the advantage of connecting European markets to the whole world. LNG volumes have increased significantly in recent years with the entrance of new suppliers such as USA.

5.6.1 LNG IMPORTS IN THE SOUTH REGION

LNG can be easily transported over large distances and re-exported towards the most profitable markets, being highly sensitive to variations in global gas demand and prices. Despite a widespread reduction in energy consumption due to lockdowns around the world, LNG trade grew by 0.4 %, reaching 462 bcm in year 2020. 23 % of global LNG imports were delivered to Europe, which was able to absorb uncommitted volumes, especially on the first half of the year. In particular, 40 % of European LNG imports were delivered in the South Region. In the second half of the year LNG trade was increasingly delivered to Asia, since LNG demand in China and India recovered relatively quickly from COVID-19 impact.

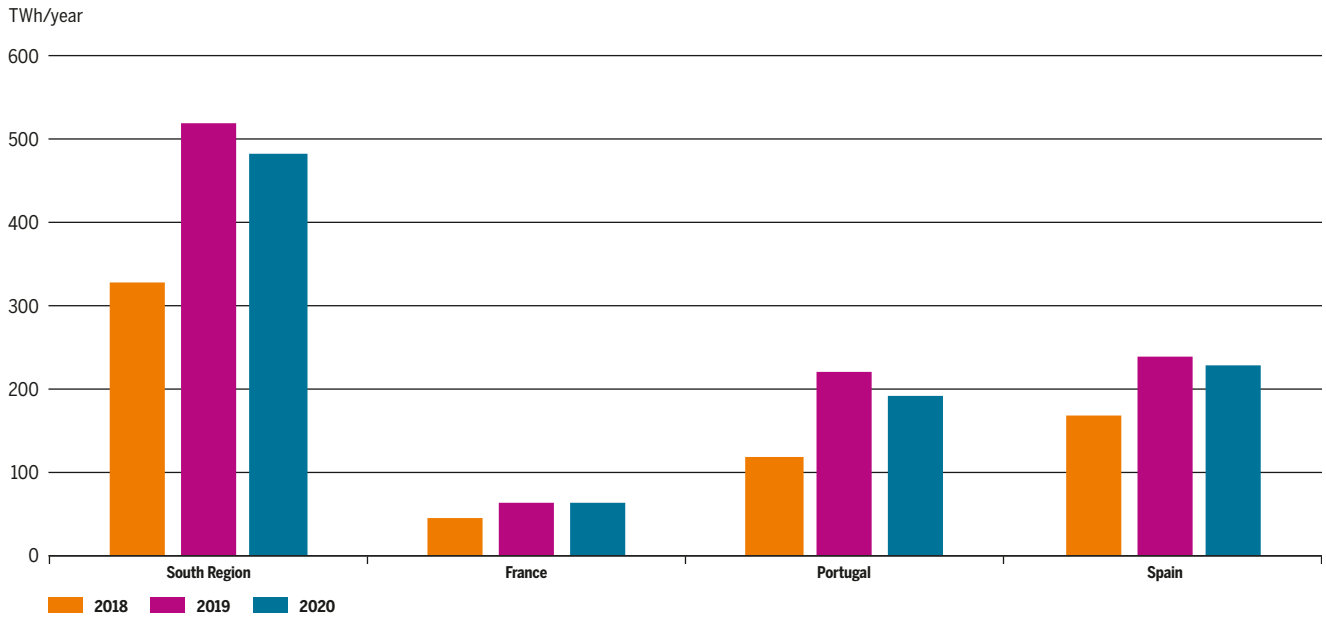


Figure 23. LNG imports in the South Region in 2018-2020 period (Source: CRE and AIE (France), Dados Tecnicos REN (Portugal), Annual Gas System Report Enagas (Spain)).

In 2020, South Region LNG imports came primarily from Russia (22 %) and USA (21 %) closely followed by Nigeria (20 %). Imports from Qatar stood at 13 % and finally Algeria delivered 11 % of the LNG volumes. The remaining 13 % of the LNG imported volumes were imported to a greater extent from Trinidad and Tobago and Angola.

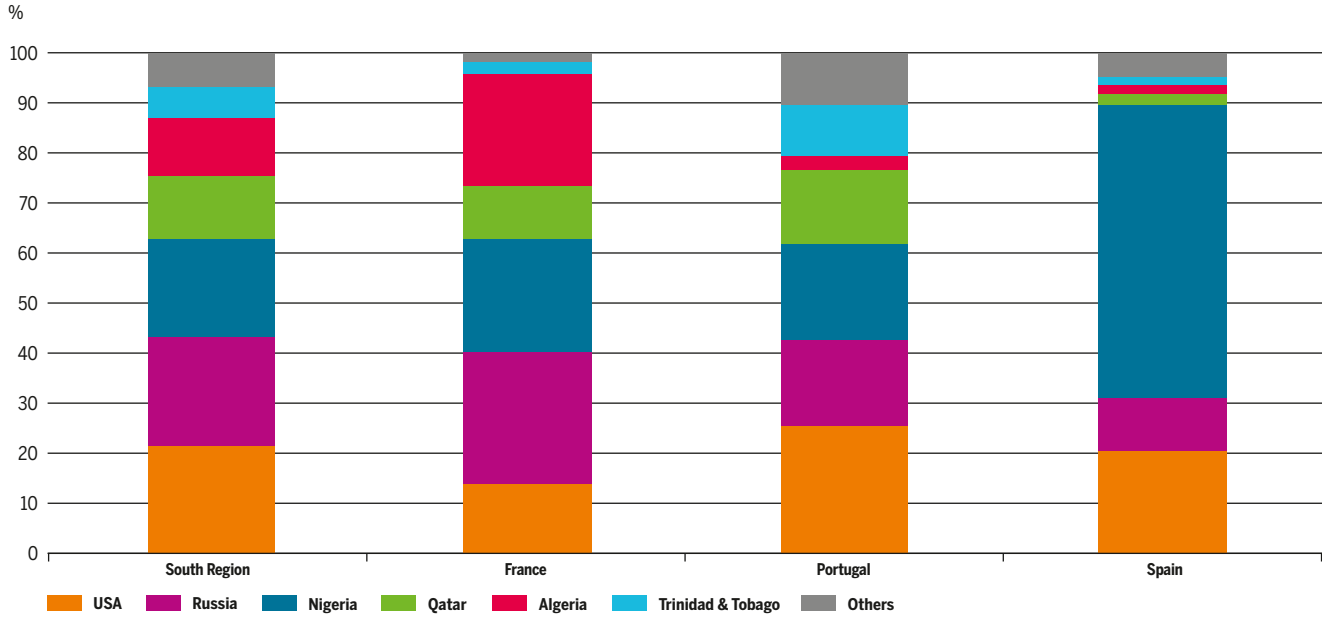


Figure 24. LNG source breakdown in the South Region in 2020 (Source: GiiGNL 2021 Annual Report).

5.6.2 INDIGENOUS PRODUCTION – RENEWABLE GAS

Even though natural gas is a low-carbon fossil fuel, and therefore more environmentally friendly than coal or oil, the EU decarbonisation targets will require a carbon-free energy system. Therefore, natural gas will necessarily be replaced by renewable gas in the long term.

The figure below shows renewable development scenarios as stated in TYNDP 2020, including the combination of Biomethane and Power to Gas (P2G) on its different forms, Power to Methane ($P2CH_4$) or Power to Hydrogen ($P2H_2$). While an ambitious development is foreseen in France, the volumes expected in Portugal and Spain will not reach 50 TWh/y before 2040. Please note that these scenarios were developed in 2019. Nowadays, ENTSOG and its members are developing more ambitious renewable gases scenarios for TYNDP 2022 in alignment with the further commitments of the EU countries to achieve carbon neutrality by 2050.

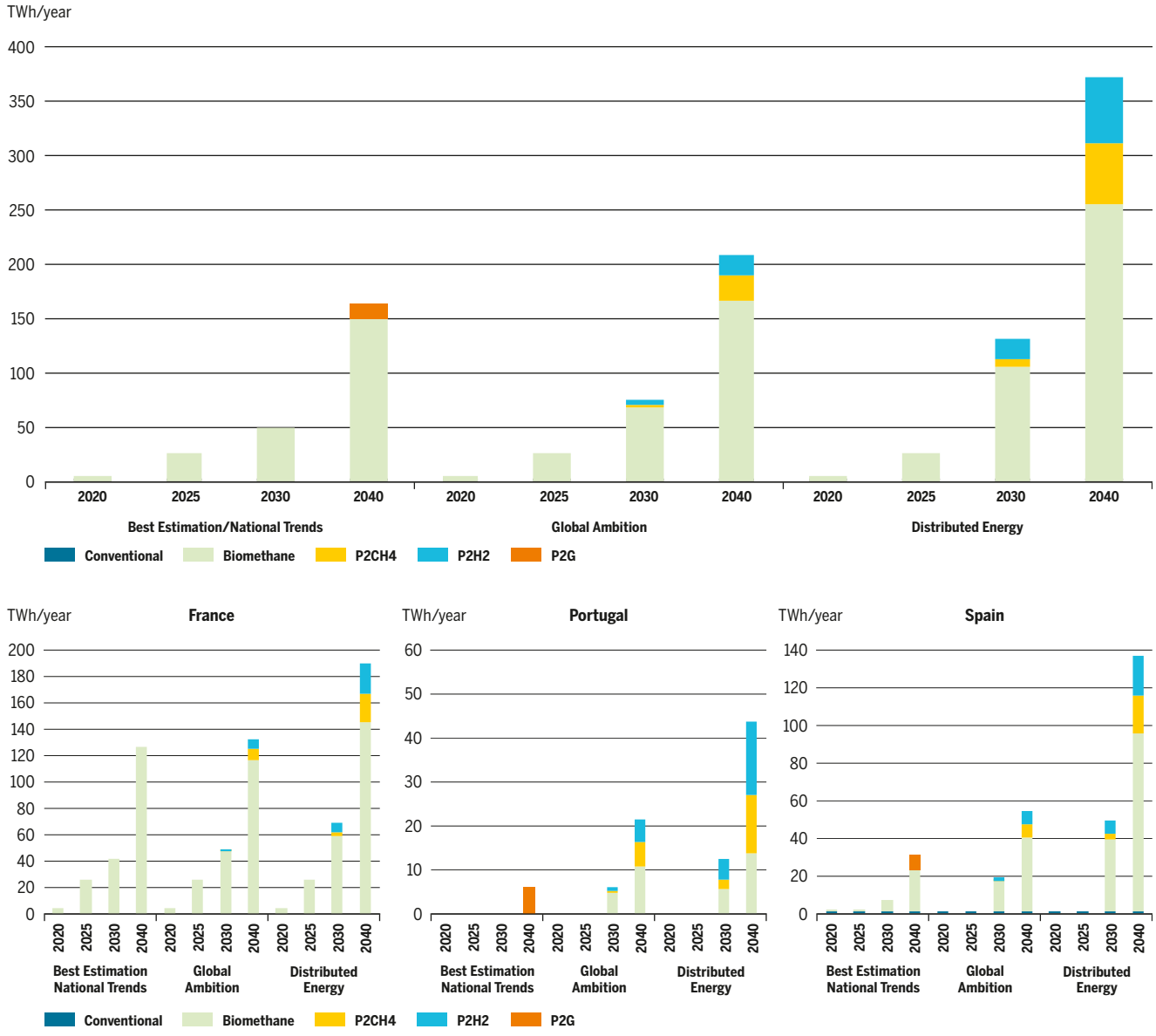


Figure 25. Renewable gases production forecast in the South Region (Source: TYNDP 2020).


Picture courtesy of REN

6 GAS INFRASTRUCTURE: AN EFFICIENT AND RELIABLE ASSET TO DECARBONISE THE SOUTH REGION

6.1 SOUTH REGION TOWARDS NET-ZERO 2050

In response to the roadmap defined in the European Green Deal, Member States of the South Region have launched several national policies and initiatives aimed at underpinning the EU 2030 and 2040 energy and climate targets for reducing greenhouse gas emissions, improving energy efficiency and enhancing renewable energy shares, as well as to pave the way towards fulfilling the overall climate neutrality ambition by 2050.

In particular, the release of the EU Hydrogen Strategy and the Energy System Integration Strategy by the European Commission in July 2020 has shed light on the crucial role that renewable and low-carbon gases will play in the deep decarbonisation of the European Union. In this regard, Member States of the South Region have also sought to align with these expectations and have adopted new measures in support of low carbon gas fuels, albeit to different extents.

Thus, the following paragraphs provide an overview of the main national initiatives put in place in in France, Portugal and Spain envisaging specific ambitions for the gas sector.

6.1.1 FRANCE

In France, the framework for the energy transition is set by the Law on Energy Transition for Green Growth (LTECV) of 2015. It comes with two associated tools:

- The National Low-Carbon Strategy (Stratégie Nationale Bas Carbone, SNBC) describing processes and tools.
- The Multiannual Energy Plan (Programmation pluriannuelle de l'énergie, PPE) defining intermediate targets.

The latter replaces all former energy-specific programs in order to ensure a cross-energy consistency and it tackles each sector (production, consumption, network) and dimension (security of supply, emission reduction, competitiveness). The Integrated National and Climate Plan for France, developed as part of the governance of the Energy Union, also provides a comprehensive overview of French policies in the field of the energy transition, building on both the SNBC and the PPE.[20]

20 Available at: https://ec.europa.eu/energy/sites/default/files/documents/fr_final_necp_main_en.pdf

6.1.1.1 The National Low-Carbon Strategy (Stratégie Nationale Bas-Carbone, SNBC)

The National Low-Carbon Strategy (SNBC), adopted for the first time in 2015 and revised in 2018-2019, is France's roadmap to fight climate change. It provides guidelines for implementing the transition to a low-carbon, circular and sustainable economy, in all sectors of activity. It defines a path for reducing greenhouse gas emissions until 2050 and sets short and medium-term objectives through carbon budgets.

It has two ambitions: achieving carbon neutrality by 2050 (since the 2018-2019 revision) and reducing the carbon footprint of French consumption.

Based on this target trajectory, the SNBC defines, for the French territory, reduction targets for greenhouse gas emissions through carbon budgets for the next fifteen years, broken down by business sectors and by greenhouse gas, including gas as represented in the figure below.

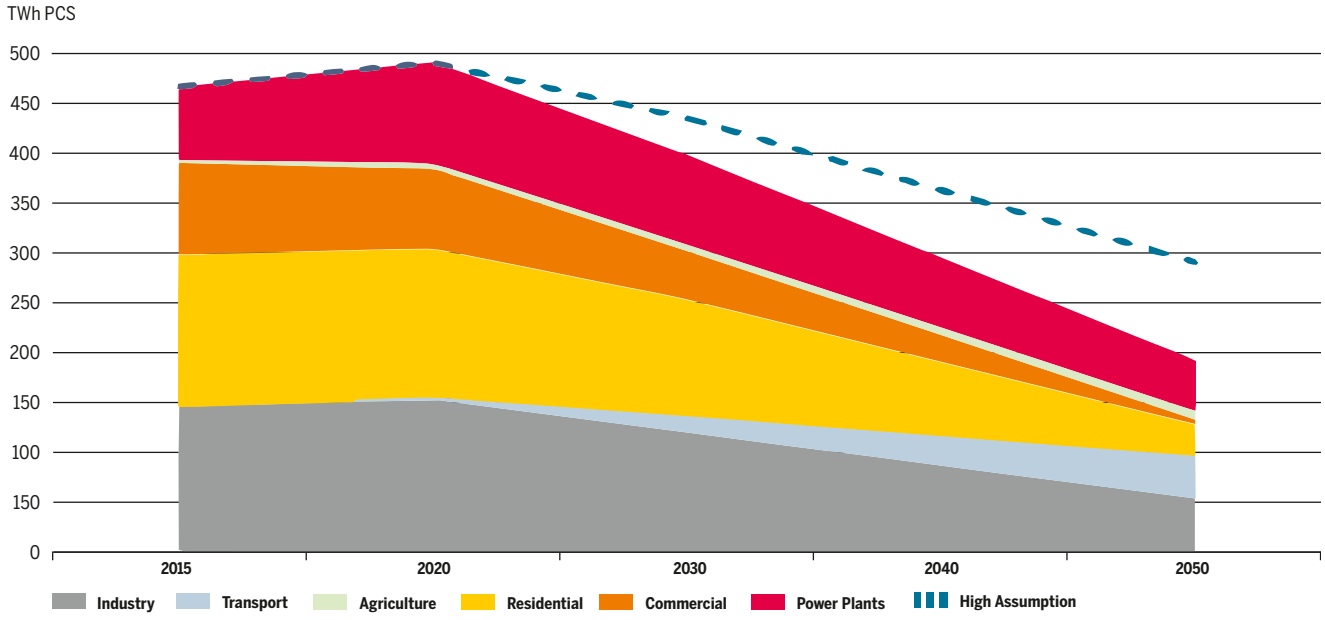


Figure 26. National gas consumption including hydrogen (Source: SNBC).

6.1.1.2 The Multiannual Energy Plan (Programmation plurianuelle de l'énergie, PPE)

The Multiannual Energy Plan (PPE) expresses the orientations and priorities of the public authorities for the management of all forms of energy for metropolitan France. The PPE must outline the orientations and means to achieve the carbon budgets, taking into account the orientations defined in the SNBC.

The PPE includes the following components:

- security of supply: this section defines the safety criteria of the energy system, in particular the criterion of failure of the electrical system;
- improving energy efficiency and reducing primary energy consumption, in particular fossil fuels;
- the development of renewable and recovered energies. The PPE defines in particular the development objectives of renewable energies for the various sectors, for the achievement of which the Ministry in charge of energy can initiate calls for tenders;
- balanced development of networks, storage, transformation of energy and management of energy demand, in particular to promote local energy production, the development of smart grids and self-production;
- the clean mobility development strategy;
- preserving the purchasing power of consumers and competitive energy prices, in particular for companies exposed to international competition;
- assessing the needs for professional skills in the field of energy and adapting training to these needs.

After the first program covering the 2016–2018 and 2019–2023 periods with binding targets for 2023, a second version of the PPE has been published in April 2020, defining new objectives for the periods 2019–2023 and 2024–2028, including:

- A decrease of 7.6 % in 2023 in final energy consumption and of 16.5 % in 2028 compared to 2012;
- A 20 % drop in primary consumption of fossil fuels in 2023 and 35 % in 2028 compared to 2012;
- A 14 % reduction in 2023 in greenhouse gas emissions from energy combustion and a 30 % reduction in 2028 compared to 2016;
- Biogas production of 24 and 32 TWh in 2028 (4 to 6 times the production in 2017)

More specifically for gas, measures to promote energy efficiency should bring gas consumption to 470 TWh by 2023 and 420 TWh in 2028 (compared to 470 TWh in 2018).

As a fossil fuel, natural gas will eventually have to be supplemented by biogas or new syngas produced with carbon-free energies: hydrogen or power to gas. The objectives of the PPE are in line with the prospect that biogas will reach 7 % of gas consumption in 2030 if the cost reductions targeted in the reference path are achieved and up to 10 % in the event of a reduction in costs. Regarding hydrogen uptake, the PPE sets the objective to reach a share of 20 % to 40 % of low carbon hydrogen within the industrial hydrogen consumption by 2028. For hydrogen mobility, the PPE introduces a target of 400 to 1,000 fuelling stations by 2028.

Natural gas for vehicles (NGV) is considered to be an alternative solution to oil-based fuels with the potential to enable the limitation of emissions of atmospheric pollutants. In addition, it can, via bioNGV, become a completely carbon-free fuel. The use of gas as a fuel is set to grow for heavy vehicles. As such, the PPE has NGV prospects in the respective segments of trucks, buses/coaches and light commercial vehicles to develop their respective market shares for new vehicles to respectively 21 %, 9.7 % and 3.7 %. This development has to be accompanied by a coordinated deployment of a network of refuelling stations. The PPE has a target of 140 to 360 refuelling stations in 2023 and 330 to 840 stations in 2028.

6.1.1.3 Law on Energy and Climate (Loi énergie climat)

The Law on Energy and Climate of November 8, 2019 aims to respond to the ecological and climate emergency. It includes this emergency in the energy code as well as the objective of carbon neutrality by 2050, by dividing greenhouse gas emissions by at least six by that date. It sets:

- a 40 % reduction in fossil fuel consumption by 2030 – compared to 2012 (instead of 30 % previously);
- the end of electricity production from coal by 2022 (shutdown of the last four coal-fired power stations);
- support for the hydrogen sector, with a target of 20 to 40 % of hydrogen consumption either from low-carbon or renewable origin.

In February 2021, two renewable and low-carbon hydrogen traceability systems were put in place, coupled with a support mechanism for the production of renewable or low-carbon hydrogen from the electrolysis of water.

The Law on Energy and Climate also gives a right of access to natural gas infrastructures to low-carbon hydrogen producers, subject to preserving the proper functioning and level of safety of natural gas infrastructures.

6.1.1.4 French hydrogen strategy resulting from the French recovery plan

The 2020 health crisis was the trigger for an economic recovery plan in which the French hydrogen strategy has found a significant place. Presented on September 8, 2020, this strategy, built in consultation by the ministries of ecological transition, economy, finance and recovery, education, research and innovation and by the general secretariat for investment, is an ambitious plan of 7.2 billion euros over 10 years to support the scale-up of the hydrogen value chain in 3 priority areas.

- The first axis focuses on the decarbonisation of the industry by creating a French electrolysis sector by setting a target of 6.5 GW of electrolysers installed by 2030, i.e. around 16 % of the European target of 40 GW in the European hydrogen strategy.
- The second axis addresses the development of heavy mobility using carbon-free hydrogen aimed at vehicles with high motive power and long autonomy, including in particular captive fleets, utility vehicles and heavy goods

vehicles. Maritime mobility is mentioned but no objective is stated, while the air seems to be seen as a long-term bet.

- The last axis is intended to support research and innovation, the stake of which lies in new uses of hydrogen as well as transport infrastructure.

The French government is ready to release these important resources quickly, of which 3.4 billion euros are already planned for the period 2020-2023, through the program of investments for the future (PIA Programme d'Investissements d'Avenir - funds ecotechnologies and funds Société des Projects Industriels), ADEME (ADEME investment fund) and BPI (Deeptech fund). It sets up a National Steering Committee under the chairmanship of the Minister of the Economy, Finance and Recovery. Also, French authorities called on the industry to carry out large-scale projects and two calls for projects were launched on 14 October 2020 on the two themes "Territorial hydrogen hubs" and "Technological bricks and demonstrators" for which 275 and € 350 million are already planned respectively. France is also involved in the development of an Important Project of Common European Interest (IPCEI) designed to allow the integration of hydrogen value chains at European level.

6.1.1.5 The energy transition in motion at subnational levels

French regional governments (Régions) are also active in the field of energy transition. Through sustainable development and territorial equality schemes (SRADDET), regional climate, air and energy schemes (SRCAE) in Ile-de-France and Corsica and regional planning schemes (SAR) in Overseas France, as well as territorial climate, air and energy plans (PCAET), many French regions have engaged in extensive discussions around the local dimension of the energy transition. As such, the development of biogas value chains, hydrogen clusters or low-carbon mobility (in the form of NGV or hydrogen) are considered as central building blocks of the support of French regional authorities support to the energy transition.

6.1.2 PORTUGAL

This section is intended to describe the new legislative and regulatory context in Portugal, as well as the prospects for the evolution of the gas sector in line with the energy policy guidelines associated with carbon neutrality, including the incorporation of renewable gases in the Portuguese network. In this way, the contents and objectives related with the four key regulatory/legislative pillars are identified: the 'RNC 2050 – Roadmap for Carbon Neutrality 2050', the 'PNEC 2030 – National Plan for Energy and Climate 2030', the 'EN-H2 – National Strategy for Hydrogen' and the 'Decree-Law nº. 62/2020, organization and legal regime of the National Gas System, incorporating renewable gases'. Some of the texts presented in this subchapter have been translated directly from the Portuguese official documents identified below in the footnotes.

6.1.2.1 RNC 2050 - Roadmap for Carbon Neutrality 2050

Carbon neutrality implies that the balance between carbon emissions and removals from the atmosphere via sinks (e. g. forests) is zero. The Roadmap for Carbon Neutrality 2050 (RNC 2050) points to this goal for 2050, responding to the commitments assumed in the Paris Agreement and positioning Portugal as a leading country in the fight against anthropogenic climate change. The elaboration of the RNC 2050 involved the broad participation of the various actors to define the trajectory for the decarbonisation of the Portuguese economy, considering the contributions of the sectors of energy, transport, waste, agriculture and forests and land use. An important part of this objective is achieved through the reduction of emissions, particularly in the energy sector, namely through the role of electrification.

The implementation of the RNC 2050 is fundamentally based on:

1. Reduction of final energy consumption and increase in energy intensity, via promotion of energy efficiency;
2. Growing electrification of the economy taking advantage of electricity production from renewable sources;
3. Continuation of the investment in the growth of renewable energy sources for the production of electricity;
4. Significant reduction in the consumption of petroleum products, namely in the mobility sector.


Picture courtesy of REN

6.1.2.2 PNEC 2030 - National Plan for Energy and Climate 2030

In 2016, at the Conference of the Parties to the United Nations Framework Convention on Climate Change, Portugal made a commitment to achieve carbon neutrality by 2050. This commitment was materialised on July 1, 2019 with the publication of the RNC 2050 - Roadmap for Carbon Neutrality 2050.

In addition, Regulation (EU) 2018/1999, of December 11, 2018, stipulates that all Member States must prepare and submit to the European Commission an integrated National Energy and Climate Plan for the period 2021-2030 (PNEC 2030). This Plan defines the public policies, the goals, the objectives and the implementation measures in terms of reducing GHG emissions, incorporating renewable energy, energy efficiency, security of supply, internal market and research, innovation and competitiveness.

Once the processes of public consultation and approval of the European Union have been completed, the Resolution of the Council of Ministers nº. 53/2020, of 10 July 2020 has published the PNEC 2030. This document incorporates the first cycle of integrated policies of national energy and climate for the period 2021-2030, with a view to achieving carbon neutrality in 2050.

The goals are ambitious[21] and are based on electrification, the incorporation of renewables, energy efficiency and the reduction of carbon intensity, underlining the importance of developing a complementary strategy for the production of renewable gases, with an emphasis on hydrogen and biomethane.

6.1.2.3 EN-H_2 – National Strategy for Hydrogen

The Portuguese government's goal of achieving carbon neutrality in 2050 requires concerted action between energy, climate, industry and transport policies, as recognised in the PNEC 2030.

In this context, green hydrogen assumes a central role as an efficient option to promote and facilitate the energy transition and, at the same time, constitutes an opportunity for economic, industrial, scientific and technological development within the European framework.

The National Strategy for Hydrogen (EN-H_2), approved by the Council of Ministers Resolution Nº. 63/2020 of 14 August, is an element of incentive and stability for the energy sector, promoting the gradual introduction of green hydrogen as a sustainable and integrated pillar in a comprehensive strategy of transition to a decarbonised economy.

For this purpose, EN-H2 establishes a set of initiatives and goals for the incorporation of hydrogen in various sectors, with emphasis on those in which the technical viability of electrification is not recognised.

21 Some of the goals established in the PNEC 2030 include the reduction of GHG emissions in the range of -45% to -55%; 47% renewables incorporation; and increased energy efficiency by 35%

Of the initiatives included in the National Strategy for Hydrogen document, the following stand out:

- Implement mechanisms to support the production of green hydrogen and investment in projects in this energy vector;
- Create the necessary regulatory framework for the hydrogen value chain;
- Set targets for the incorporation of hydrogen in the various sectors of the economy, to ensure the demand side;
- Establish targets for injecting hydrogen into gas infrastructure.

Regarding the injection of hydrogen into gas networks, the strategy identifies targets with ranges between 1 % to 5 % (by volume) for the year 2025, and 10 % to 15 % (by volume) for the year 2030.

Additionally, the global objectives of National Strategy for Hydrogen for the year 2030 in Portugal are the following:

- Hydrogen representing 5 % of final energy consumption;
- 50 to 100 hydrogen fuelling stations for the mobility sector;
- 6 to 8 Mton CO_2 emissions reduction;
- As mentioned, gas networks hydrogen injection of 10 % to 15 % (by volume);
- 2 to 2.5 GW electrolyser capacity in the country;
- 8,500 to 12,000 new jobs created;
- 400 to 450 M € in support for investment by European funds;
- 380 to 740 M € of reduction in natural gas imports;
- 7,000 to 9,000 M € of investment in new hydrogen projects in the sectors of industry, transport, energy and R&D&I.

6.1.2.4 Decree-Law n°. 62/2020, organisation and legal regime of the National Gas System, incorporating renewable gases

The promotion of clean energy sources assumed in the PNEC 2030 enhances the opportunity for the Portuguese Gas System to accommodate the incorporation of gases from renewable sources and gases with low carbon content.

Decree-Law Nº. 62/2020 transposes Directive (EU) 2019/692 and responds to Hydrogen Strategy, renaming the National Natural Gas System as the National Gas System and redefining its organisation and operation, as well as the respective legal regime. The publication, in addition to incorporating the figure of the producer of renewable gases and the implementation of intelligent systems in the Public Gas Network, promotes the progressive integration of the National Gas System and the National Electricity System.

As the main changes in responsibilities by segment of the value chain, there are the following:

- Transport/Distribution
  - Management of the interconnection of facilities for the production of other gases and design/construction of monitoring and control facilities;
  - Ensure the accommodation of other gases in the infrastructure, safeguarding the quality of operation of the gas system and its technical limits;
  - Ensure that the gas to be transported in the network complies with the technical characteristics and specifications.
- Storage
  - Ensure the capacity of UGS infrastructures and facilities under concession for exploration with other gases.
- Planning/Security of supply
  - The annual Gas Supply Security Monitoring Report (RMSA-G) should incorporate the production of other gases;
  - The elaboration of the national TYNDP (PDIRG) should consider the incorporation of other gases;
  - The planning exercise must consider an integrated management of energy resources and identify the conditions necessary for the security of future supply of gas consumption.
- Traders
  - The establishment of minimum quotas for the incorporation of other gases in the gas supply.

- Production
  - The production of other gases is intended for total or partial injection into gas networks, for self-consumption, individual or collective, and for export;
  - The Government member responsible for the energy sector may establish, by administrative rule, specific regimes for the acquisition of other gases, after consulting the Portuguese energy regulator and the TSO.

Thus, taking into account the framework mentioned in the four regulatory/legislative pieces presented above, in particular Decree-Law Nº. 62/2020, which establishes the organisation and operation of the gas system considering the incorporation of renewable gases, in conjunction with the Hydrogen Strategy, which identifies a set of national goals and objectives for the injection of hydrogen into gas networks, the Portuguese TSO must develop a set of initiatives to ensure the quality and safety of the future operation of gas infrastructures in this new context. In this way, the Portuguese TYNDP have identified the investments associated with transport network and Carriço UGS that require intervention and/or replacement to adapt these infrastructures to the new gas mixtures. Nevertheless, it should be noted that at the time of preparation of the last National TYNDP (in March 2021), some pieces of legal, regulatory and technical nature still need to be developed.

6.1.3 SPAIN

The Spanish government's energy and climate policy framework is mainly driven by three key pillars: the Climate Change and Energy Transition Act (Law 7/2021), the National Energy and Climate Plan (NECP) 2021-2030 and the Just Transition Strategy, all of them intended to keep Spain at the forefront of the energy transition as a reference leader in renewable energies and building on the boost to modernise the Spanish economy.

In this regard, the Climate Change and Energy Transition Act, which came into force on 22nd May 2021, establishes the institutional framework to give regulatory and economic signals to provide stability and set the country's direction towards climate neutrality, facilitating the progressive adaption for the impacts of climate change and preventing its causes by means of anticipation and resilience tools. In parallel, the NECP is a revisable 10-year planning instrument, mandated by EU legislation, that defines the targets and measures for reducing greenhouse gas emissions, encouraging the penetration of renewable energies and energy efficiency. Lastly, the Just Transition Strategy provides for support to ensure that people and regions make the most of the opportunities offered by the transition to a green economy so that nobody is left behind.

Particularly relevant for the gas sector are the Climate Change and Energy Transition Act and the National Energy and Climate Plan 2021-2030. The former states Spanish government's commitment to encourage, through approval of specific plans, the integration of renewable gases, such as biogas, biomethane and hydrogen, by applying annual targets for the penetration of these gases in natural gas sale or consumption, duly monitored and supervised through a certification system, and by putting forward regulatory measures facilitating their consumption in industry, mobility and their injection into the natural gas grid. Likewise, the Act envisages specific annual targets for the supply of alternative fuels in transport, especially with regard to advanced biofuels and other renewable fuels of non-biological origin in air transport.

As for the NECP 2021-2030, it sets out a series of more concrete measures to support the uptake of renewable and low-carbon gases, which are detailed in the following paragraph.

6.1.3.1 National Energy and Climate Plan 2021-2030

The final version of the Spanish Energy and Climate Plan 2021-2030 has been published in the Spanish official gazette, "Boletín Oficial del Estado", on 31st March 2021.

The Spanish NECP lays down the foundations for consolidating a climate-neutral path to 2050, especially by focusing on five priority dimensions: decarbonisation, energy efficiency, energy security, the internal energy market and research, innovation and competitiveness. In particular, the decarbonisation of the energy system constitutes the centrepiece of this Plan, since the energy sector is responsible for three out of four tonnes of greenhouse gases emitted in Spain.

In response to the climate neutrality ambition set out in the European Green Deal for 2050, the Spanish government outlines a series of specific medium-term targets to be accomplished at national level by 2030:

- 23 % reduction in greenhouse gas emissions (GHG) compared to 1990.
- 42 % share of renewables in final energy-use.
- 39.5 % improvement in energy efficiency.
- 74 % share of renewable energy in electricity generation.

Therefore, in order to achieve the above objectives, the Spanish NECP defines a roadmap with specific measures for each of the dimensions. With regard to the decarbonisation dimension, most of the measures aim to promote renewable energy mainly underpinning electricity generation from renewable sources as well as auxiliar instruments to support new renewable capacity through demand management, storage and flexibility. In this regard, the Spanish NECP envisages the development of a legislative framework to support the promotion of storage and sector coupling. In particular, the Plan recognises the role of hydrogen in storing surplus renewable energy, with the possibility of mixing it with natural gas and thus exploiting the potential for coupling the gas and electricity sectors for joint demand management of both sectors.

More specifically in relation to the gas sector, the Spanish NECP states the objective to promote renewable gases, such as biogas, biomethane and renewable hydrogen. Biogas and biomethane are both foreseen as key players, especially with regard to thermal uses in industry, in the short and medium term, due to their technological development, available potential and production costs, offering the same applications and using the same infrastructure as natural gas.

In the long term, the Spanish NECP recognises the role of renewable hydrogen as a flexible energy vector allowing the integration of surplus variable renewable electricity and the use of gas infrastructures. Main applications are foreseen in fuel cell electric vehicles, direct use in industry, energy storage and conversion into synthetic natural gas so as to be introduced into the natural gas grid.

Therefore, the Spanish government commits to develop specific plans to facilitate the penetration of renewable gases, including R&D&I actions both for biogas and hydrogen and for less mature technologies, such as power-to-gas. As part of the elaboration of these specific plans, the following actions are expected:

- Determining and projecting the theoretical production potential by 2030-2050.
- Defining a strategy for determining the most efficient use and the most effective way to take advantage of renewable gases.
- Designing aid mechanisms based on penetration targets that allow an efficient use of the renewable gas, supported by a certification system that makes it possible to oversee and monitor those targets, as well as flexibility mechanisms that encourage maximum efficiency in achieving the targets in competition with other decarbonisation options.
- Determining a system of guarantees of origin for renewable gases providing information on their origin, traceability and the environmental impact associated with their production and use.
- Identifying and removing regulatory barriers that hinder the development of renewable gases, especially power-to-gas.

As a complement to the Spanish NECP 2021-2030, there are other two additional far-reaching initiatives aimed at paving the way towards decarbonisation while recognising the role of the gas sector: the Hydrogen Roadmap and the Long-term Decarbonisation Strategy for 2050.

6.1.3.2 Hydrogen Roadmap: a commitment to renewable hydrogen

In October 2020 the Spanish government approved the "Hydrogen Roadmap: a commitment to renewable hydrogen" as a means to promote the deployment of this sustainable energy vector, envisaged as a key lever for Spain to move towards climate neutrality.

This Roadmap intends to promote the development of technological knowledge and innovative industrial value chains in the country and foster the generation of sustainable employment, thus building a high added value green economy. In particular, the Hydrogen Roadmap defines a vision for 2030 and 2050, establishing ambitious country targets for 2030.

In this regard, it lays out an ambition to reach at least 4 GW of electrolysers installed capacity by 2030, with an intermediate milestone of 300–400 MW to be accomplished by 2024. These key objectives on renewable hydrogen production are also reinforced by a number of specific goals for 2030 in the industrial, mobility and electricity sectors:

- 25 % of the consumption of industrial hydrogen of renewable origin.
- 100–150 hydrogen fuelling stations.
- Fleet of 150–200 renewable hydrogen fuel-cell buses.
- 5,000–7,500 light and heavy-duty hydrogen fuel-cell vehicles for freight transport.
- 2 hydrogen powered commercial train lines.
- Commercial projects already in operation for electricity storage and/or use of surplus renewable energy.

According to the Hydrogen Roadmap predictions, the achievement of the above targets will lead to a mobilisation of investments estimated at 8,900 million euros by 2030.

Therefore, the Roadmap identifies industry and mobility as key sectors with the strongest potential for renewable hydrogen demand growth in the short-term. In particular, for the first phase of deployment, the Roadmap puts forward attention on prioritising renewable hydrogen production projects linked to industrial end-use as well as mobility projects. In this regard, the creation of hydrogen valleys or clusters will play a very significant role as well as the development of pilot projects primarily linked to the transport sector and isolated energy systems.

For 2050, the Hydrogen Roadmap expects a steep increase in renewable hydrogen production accompanied by a major expansion into other applications such as aviation, shipping and high-temperature industrial energy processes, for which electrification is not the most efficient solution or is not technically feasible in the medium term. Similarly, the Hydrogen Roadmap recognises the role of renewable hydrogen as a driver to store energy and decarbonise the heat sector in both industry and households.

Likewise, the Hydrogen Roadmap foresees four main areas of action: regulation, sectoral and transversal instruments and R&D&I. When it comes to regulation, the Roadmap mainly identifies the need for administrative simplification and for facilitating the deployment of direct electricity lines dedicated to renewable hydrogen production as well as hydrogen pipelines for its transport. Also, it lays out the need to develop a system of guarantees of origin for renewable hydrogen to provide appropriate price signals to consumers and to implement tax incentives to enable pilot projects to be scaled up.

With regard to sectoral instruments, the Hydrogen Roadmap foresees measures to promote renewable hydrogen usage in hard-to-abate sectors, such as industry. For that purpose, the government will analyse the introduction of penetration targets for 2025-2030, design financial tools supporting hydrogen-intensive industry adaptations and promote hydrogen valleys and clusters.

On top of this, the Hydrogen Roadmap sets a willing to establish a legal basis for power-to-X, power plants and electrolysis facilities, and to review technical, regulatory and quality requirements for the injection and use of hydrogen in the natural gas grid, with special focus on the use of certain existing facilities for dedicate transport and/or storage of renewable hydrogen. In this regard, it is also planned to assess the need for adaptation of industrial and domestic gas devices to allow gradual integration of renewable hydrogen.

In relation to the transport sector, support will be given for hydrogen fuels development for vehicles and trains, accompanied by specific regulation on hydrogen refuelling stations, as well as for hydrogen usage in maritime transport and deployment of synthetic kerosene and biofuels for aviation. Against this background, the Roadmap also envisages studies on vehicles powered by natural gas and hydrogen enriched mixtures and on hydrogen production from waste.

As regards transversal instruments, the Hydrogen Roadmap acknowledges the role of renewable hydrogen as a key lever to avoid rural depopulation and help achieve the objectives set for demographic challenge, also favouring the re-use of existing infrastructures, as closed thermal power plants. Likewise, the Roadmap foresees support for hydrogen production in the so-called just-transition regions from sustainable biogas coming from agricultural and industrial residues.

Moreover, the Roadmap identifies a need for regional cooperation, especially with neighbouring countries, to make the Iberian Peninsula a key player in renewable hydrogen production and export, and also to provide guidance and institutional support to Spanish renewable hydrogen projects applying for European funding mechanisms.

Finally, the Hydrogen Roadmap defines several measures intended to boost R&D&I, in particular envisaging support for specific technologies advocating for the development of high-power electrolysers, promoting their mass production and the application of new materials, as well as hydrogen-based heat production technologies, including cogeneration and fuel cell cogeneration.

6.1.3.3 Long-term Decarbonisation Strategy for 2050

In November 2020 the Spanish government approved the "Long-term decarbonisation strategy for 2050" which envisages a modern, competitive and climate-neutral economy by 2050.

This strategy aims to comply with the Paris Agreement and the policies included in the National Energy and Climate Plan 2021-2030, establishing an ambitious target for 2050 to reduce total gross greenhouse gas emissions by 90 % compared to 1990, with the remaining 10 % being absorbed by natural sinks. Incidentally, it is foreseen that the implementation of the Long-term Strategy will mobilise up to 300,000 million euros between 2031 and 2050.

The Strategy foresees that the path towards climate neutrality will be mainly driven by the contribution of renewables in energy end-uses, through the combination of direct-use renewable technologies, electrification and renewable fuels. Therefore, it envisions further investments in research and innovation as well as the deployment of innovative technologies such as storage, power-to-X and smart mobility.

In particular, the Long-term Strategy sets out a path towards climate neutrality in 2050 around five main pillars: energy efficiency, renewable energies, natural carbon sinks, adaptation on climate change and sectoral decarbonisation. Concerning the latter, the Strategy that seasonal storage to support renewable electricity generation will be driven by a combination of different solutions, including power-to-gas, thermal storage and hydrogen. Therefore, it recognises the need to put in place appropriate sectoral regulatory framework and mechanisms, such as regulatory sandboxes, to provide sufficient certainty to investors.

In relation to sustainable mobility and transport, a reduction in greenhouse gas emissions of more than 30 % is expected to be achieved by 2030, with a 28 % share of renewable energy via biofuels and electrification. In order to encourage the uptake of advanced biofuels, the Strategy identifies the need to promote R&D&I, encourage investments in production facilities and develop mechanisms to facilitate the recovery of waste and the mobilisation of biomass.

For the 2030-2050 horizon, the Strategy expects that decarbonisation will come hand in hand with the intensification of energy efficiency together with the substitution of fossil fuels by other low-carbon alternatives, including biomethane and, especially, hydrogen, which will play an instrumental role in heavy-duty vehicles by means of fuel cells.

In this regard, the Long-term Strategy recognises the need to develop electrolysis and fuel cell manufacturing at industrial scale as well as to ensure the deployment of the supply infrastructure so as to enable a competitive use of renewable gases in transport. Also, the potential of renewable gases for sector coupling, decarbonising sectors such as energy, transport and industry, will raise the need to look at integrated planning, including regulatory measures and financing support.

Moreover, it is also expected for there to be room for renewable liquid and gaseous fuels in rail, aviation and maritime transport.

Finally, with regard to the industrial sector, intensification of energy efficiency measures and boosting R&D&I to endorse the development of new decarbonised energy vectors, especially by using renewable hydrogen and power-to-X technologies in high and mid temperature processes, are deemed essential for the national industrial sector to move towards sustainability and competitiveness.

Picture courtesy of Reganosa

6.1.3.4 Other initiatives

In addition to the above-mentioned key initiatives launched by the Spanish government to lay the foundations for the sustainable economy and society to come in the next decades, there are other national policies intended to do so, which also envisage support for the uptake of renewable gases.

The Ministry for Ecological Transition and Demographic Challenge initiated last year the drafting of the Biogas Roadmap as an instrument to guide and encourage the deployment of biogas and biomethane in Spain, envisaged as pivotal enablers to integrate circular economy and renewable energy generation, as well as offering diverse usages in sectors such as transport, electricity generation and heat and power systems.

In this regard, in July 2021 the Ministry launched a public consultation on the draft Biogas Roadmap, which sets out the ambition of multiplying the current national production of this renewable gas by 3.8 times by 2030, reaching 10.41 TWh/year. Thus, the draft Biogas Roadmap aims to promote the use of biogas obtained from the anaerobic digestion of organic waste for electricity and thermal generation (mainly in industry) and also for its transformation into biomethane for use in heavy transport or injection into the gas grid. Therefore, the Roadmap plans to boost the biogas value chain in the short-term through the creation of a system of Guarantees of Origin and foresees, for the medium term, the potential implementation of annual targets for biogas penetration in the sale and consumption of natural gas.

Likewise, in February 2021 the Ministry for Ecological Transition and Demographic Challenge published the Energy Storage Strategy that provides a total storage capacity of 20 GW in 2030 and 30 GW in 2050, considering both large-scale and distributed storage. In this regard, the strategy lays out a set of measures to endorse the integration of renewable energies and provide flexibility and stability to the energy system, including the drive for renewable hydrogen and power-to-X, the enhancement of integrated energy planning, the promotion of R&D&I and elimination of administrative barriers to facilitate the start-up of projects.

On 27th April 2021 the Spanish Government approved the Recovery, Transformation and Resilience Plan, which draws up a set of reforms and public investment projects to be eligible to obtain support from the EU Recovery and Resilience Facility, the centrepiece of NextGenerationEU. The main priorities of the Plan to transform the Spanish economic and social fabric include, among others, the promotion of biogas usage, the implementation of R&D sandboxes for renewable energy, the deployment of smart grids, flexibility and storage technologies and the design of a roadmap for renewable hydrogen and its sectoral integration.

In particular, the Plan clearly states the aim to position Spain as a technological benchmark in the production and use of renewable hydrogen, leading a "country project" that promotes the hydrogen value chain through the creation of technology clusters and pilot projects on a regional scale, fostering industrial innovation, supporting just transition areas and making renewable energy available at competitive prices.

In parallel, the Ministry for Ecological Transition and Demographic Challenge launched two calls of interest on lever projects related to renewable hydrogen and energy storage with the purpose of gathering information that will allow the development of the strategic lines of action outlined in the Recovery, Transformation and Resilience Plan.

6.2 FUTURE CHALLENGES AND OPPORTUNITIES TO DECARBONISE THE GAS MARKETS IN THE SOUTH REGION

OPPORTUNITIES AND BARRIERS FOR RENEWABLE AND LOW-CARBON GASES IN THE SOUTH REGION

The gradual renewables and low-carbon gases market ramp-up in Europe, including the South Region, will lead to an increasing need for hydrogen infrastructure to transport, store and import large volumes of these new type of gases, connecting the production and consumptions centres. At the same time, investments in a wide range of transmission, distribution and other infrastructure solutions are key to enable the deployment of a well-functioning and mature gas and hydrogen market. This development requires involvement of both public and private parties and a sound and predictable regulatory framework for required infrastructure which evolves on a flexible manner according to the level of maturity of this new market.

In this context, there is a need to move forward to incorporate the renewable and low carbon gases on the existing infrastructure and, specifically in the case of hydrogen, to develop regional, national and transnational hydrogen network systems as well as non-grid hydrogen transport and storage options (such as hydrogen receiving on-shore terminals), taking into account the European Commission's strategies for both Energy System Integration and Hydrogen development.

Renewables and low carbon gases have the potential to be used in all sectors. Nevertheless, a clear mapping of renewable and low carbon, specifically hydrogen, demand in key sectors could help to prioritise infrastructure investments. In this way, the risk of stranded hydrogen pipeline assets would be minimised due to integrated, efficient and optimised planning processes which adequately design all networks to match priority demand and address public acceptance. Applying a minimum set of sound regulatory principles from the outset (such as an independent operator, transparency, non-discriminatory Third-Party Access, etc.), should ensure that hydrogen investments are done "future proof" and contribute to increasing the liquidity of the future European gas and hydrogen market.

This section identifies and highlights the opportunities for renewables and low carbon gases, and specifically for hydrogen technologies, to contribute to an effective and efficient achievement of the EU climate and energy targets. These opportunities and barriers identified are detailed below.

6.2.1 OPPORTUNITIES

According to the hydrogen strategies launched in France, Portugal and Spain, the South Region aims to reach a hydrogen production capacity via electrolysis of 13 GW[22] in 2030, whereas the estimated overall renewable power potential in the region is 3,587 TWh/y[23]. Therefore, the region has potential not only to decarbonise its own systems but also to export large amounts of hydrogen surplus to the rest of the EU in the medium to long-term. Similarly, the South Region is also in a geographical situation which would allow to import renewable and low-carbon hydrogen from the north of Africa (e.g. Algeria and Morocco), and become a transit route for north-African hydrogen towards Northern Europe.[24]

The development of a robust hydrogen system in the region would contribute, not only to an increase in the resilience and security of supply levels of the overall energy system, but also to reduce dependence on fossil fuel imports and to integrate variable renewable energy (VRE) sources into the energy system.

This deployment of hydrogen also enables an overall optimisation of the electricity and gas system (as envisaged in the EC's Energy Sector Integration strategy) by converting VRE into hydrogen and storing and distributing it via the gas system, while contributing to the stability of the power system. The gas-electricity sector coupling development would enable continued use of existing gas infrastructure, either by blending hydrogen with methane into existing networks, or by repurposing existing gas transmission, LNG terminals or gas storage infrastructures, speeding-up the deployment of hydrogen technologies and demand.

22 Chapter 6.1: 6.5 GW in France, 4 GW in Spain and 2-2.5 GW in Portugal

23 Source: Opportunities for hydrogen energy technologies considering the national energy & climate plans – trinomics: Table D-1 Reference data for Scenario Assessment per Member State, page 121

24 Source: Opportunities for hydrogen energy technologies considering the national energy & climate plans – trinomics

In terms of large-scale seasonal storage, the region has several salt cavern layers and other types of storage such as aquifers where new hydrogen storage facilities can be developed. Moreover, the existing underground storages can be retrofitted or repurposed as hydrogen storage infrastructure.

Hydrogen infrastructure to transport, store, distribute and import hydrogen will also reduce the amount of investments needed to reinforce and expand the power grid, facilitating the integration of renewable electricity into the energy market and reducing curtailment of renewable electricity production.[25]

Regarding hard-for-electricity-to-abate sectors, hydrogen could be used to decarbonise long-distance and heavy-duty transport, high temperature heat processes in the energy-intensive industry, and the use of fossil fuels as feedstock in the steel and (petro-) chemical industries, among others.

Concerning investments and financing opportunities, hydrogen related activities such as repurposing and retrofitting, would fit into the new EU sustainable finance taxonomy, which will allow companies to align their portfolios and get easy access to sustainable financing. There is also a relevant opportunity with the revision of the TEN-E Guidelines regulation, which is expected to include hydrogen infrastructures as eligible projects for obtaining grants and subsidies under the revised Connecting Europe Facility (CEF) program.

The revision of the TEN-E regulation can help deliver on sustainability objectives while building on TSOs experience around energy infrastructure planning. The future TEN-E framework and the associated PCI selection process could incentivise the transition towards the decarbonisation, support sectorial integration and respond to the energy system needs. This framework could also help create a framework for an efficient hydrogen infrastructure planning which is currently lacking. In that regard, TSOs have long term experience of coordination at European level through the TYNDP process. Building on that legacy would allow for an efficient and future-proof network planning.

Moreover, hydrogen projects can be supported by other EU financial instruments under the Next Generation EU Program (including the Recovery and Resilience Facility), the InvestEU, the Regional Funds, the ETS Innovation Fund, Horizon Europe, IPCEIs...

Cross-border cooperation and dialogue is also key to identify the future opportunities associated with the energy transition. For instance, the European Hydrogen Backbone initiative proposes a vision for a dedicated hydrogen transport infrastructure across Europe. A group of 23 European gas TSOs from 21 countries envisions a hydrogen network of 39,700km by 2040. The report also describes how gas infrastructure can contribute to decarbonisation targets and bring benefits to the hydrogen economy ramp up as a cost-effective option for long-distance hydrogen transportation.

6.2.2 BARRIERS

Regulatory and operational barriers for hydrogen transmission, distribution and storage:

Renewable and low-carbon gases are still uncompetitive, so customers do not have a business case to switch. There are many elements still missing in the EU regulatory framework which act as a barrier to the development of these new gases. Main regulatory and operational barriers include:

- Lack of clarity on future evolution of the EU Emissions Trading System.
- Uncertainty over taxation rules not only for fossil fuels but also for energy used in electrolysers, and whether these taxation rules will reflect those electrolysers act as a conversion facility, and not as an end-user.
- Lack of robust certificates/guarantees of origin framework for renewable and low-carbon hydrogen to allow efficient trade "across borders and sectors" and for proving reliable sustainability standards (climate value) of hydrogen.
- Non-existence of an agreed framework to calculate and declare the levelised cost of hydrogen (LCoH) for hydrogen projects
- Absence of a carbon border adjustment mechanism to protect the international competitiveness of European industry using renewable and low-carbon hydrogen.

The European and national hydrogen strategies need to clarify their operationalisation since the announced targets need to be translated into clear volumes and concrete support. So far, there is still a lack of clear region-specific mapping of hydrogen demand in priority sectors undertaken by the European Commission.

25 Source: Opportunities for hydrogen energy technologies considering the national energy & climate plans – trinomics

Beyond the demand dimension, the infrastructure development is facing several challenges. Today there is no regulatory basis for planning, construction and operation of hydrogen infrastructure, developed through retrofitting, repurposing or newly built processes. There is neither a framework for a coordinated infrastructure planning at national level and EU level between hydrogen, gas and electricity both for pipes and underground storage, preferably under TEN-E regulation. In that regard, as mentioned previously, TSOs have long term experience of coordinated long term infrastructure planning for natural gas through the TYNDP process. This experience could be leveraged and translated in the field of low carbon gases.

In this regard, ensuring an efficient, integrated and optimised planning of energy infrastructure, leveraging all energy carriers and technologies offering GHG emissions reductions in a transparent and non-discriminatory way, will be paramount to achieve a cost and time efficient decarbonisation of the entire energy system. On top of this, it is essential to allow for a flexible and dynamic infrastructure planning, with regular revisions, that properly follows the evolution of the integrated energy system to come, which will gradually incorporate new energy carriers and technologies, such as hydrogen, renewable energy storage and P2G.

Moreover, the non-existence of a European regulatory framework for P2G facilities including siting, sizing, constructing and operation, ownership, taxation, etc., brings additional difficulties. The barriers associated to the development of infrastructure are followed by barriers linked to the operation of those infrastructures. The EU has not adopted neither principles for access to infrastructure and operation nor regulatory solutions for hydrogen blending. From an operational perspective, the technical challenges for blending exist and there is no clarity on technical requirements on how to deal with them. This absence of technical standards and requirements are equally applicable to repurposing and newly built hydrogen pipelines.

In terms of infrastructure, the transport and distribution infrastructure (pipelines and storage) are relevant, but also the refuelling points and end-use points. Nowadays, there is still a lack of availability of sufficient hydrogen refuelling stations to accelerate the change from fossil to zero-carbon fuels.

Other relevant barriers for hydrogen projects are related to the R&D process. The EU has not developed yet a framework for EU Regulatory-Sandbox, supporting R&D and new business models to promote innovation, scaling up, system adaptation and optimisation for technology.

Additionally, other regulatory and operational barriers are related to the land access management (and whether priority can be given to energy infrastructure), the missing framework for capturing the benefits for integrated projects involving different modes of transport and energy vectors, or the barriers related to the various hydrogen carriers available in the market (e.g. ammonia, LOHC, methanol, etc.). The lack of coordination between TEN-E and TEN-T can pose serious difficulties, as well as the non-existence of clear regulations and higher incentives for shipping hydrogen over long distances.

Standards and technical regulations related to safety, certifications, transportations, are important too and can hinder market development if not implemented on a timely and effective manner.

Finally, barriers can be also found when doing the technological scale up, or when finding the right staff to operate the new hydrogen assets. The lack of training and competence for staff in charge of logistics, maintenance, etc., can represent a serious problem in the growth and expansion of the hydrogen industry if not addressed well in advance.

Financing barriers:

The EU financing framework lacks specific regulation for hydrogen infrastructure financing, subsidy schemes application and allocation of financial support. This brings doubts on where within the supply chain is worthy to co-invest, and on how to attract financing from the financial markets and get bankable projects. There is certainly a need for renewable hydrogen dedicated chapter in EU State Aid Guidelines revision which is favourable for the development of hydrogen transport and storage infrastructure as well as other hydrogen related infrastructure.

Project promoters also face uncertainty about the regulatory treatment of financing R&D activities which depend on arrangements approved by the market regulator. The absence of a coherent strategy and prioritisation for the allocation of R&D hydrogen funding during the next 5 years prevents market players from optimising their business plans.

When it comes to hydrogen infrastructure, it should be noted that hydrogen infrastructure per se does not reduce GHG emissions, but enables the GHG emissions reductions for other market players located in other parts of the hydrogen value chain (e.g. consumers). Having EU funding instruments which do not acknowledge this reality and do not allow for public grants/subsidies to be allocated to participants outside a given project (e.g. at the beginning and/or end of the value chains) represent a barrier to the market development.

7 ENERGY TRANSITION PROJECTS IN THE SOUTH REGION

7.1 OVERVIEW OF ETR PROJECTS IN THE SOUTH REGION

As part of the South Region's engagement to EU climate and energy ambitions, several stakeholders, including gas TSOs, are currently proactively involved in diverse projects and initiatives aiming to materialise those efforts to advance towards climate neutrality.

In particular, gas TSOs in the South Region are fully committed to ensure that sustainable gas and gas infrastructures play a central role in decarbonising the EU economy and society. In this regard, Table 7 provides a list of some of the energy transition projects in which gas TSOs are currently involved, classified according to the categories set out in TYNDP 2020.

Picture courtesy of Teréga

Project Name	Promoter	Status	Commissioning Year
Biomethane development			
Circular Economy	Reganosa	Feasibility	2024
Biomethane development & Reverse flow project			
Biomethane production units connection and reverse flow units	Teréga	Planned	–
Biomethane: reverse flow project	GRTgaz	Planned	–
West Grid Synergy	GRTgaz	Planned	2020
CCS/CCU			
Pycasso	Teréga	Feasibility	2028–2030 (expected)
CNG/LNG for transport			
CORE LNGas hive and LNGHIVE2	Enagas Transporte S.A.U.	FID	2023
Small Scale LNG at Sines Terminal	REN Gasoductos	Planned	–
Railway Roadmap	Enagas Transporte S.A.U.	FID	2022
Hydrogen & synthetic methane project			
Green Crane	Enagás Renovable S.L.U.	Less-Advanced	2024–2026
H2Pole	Reganosa	FEED/Permitting	2024
H2RENGRID - AS CarriÇo	REN Armazenagem	Planned	2022–2031
H2RENGRID - RNTG	REN Gasodutos	Planned	2022–2031
Hygeo	Teréga	Pre-feasibility	–
Jupiter 1000: 1st industrial demonstrator of Power to Gas in France	GRTgaz, Teréga	Commissioned	2020–2021
Lacq Hydrogen	Teréga	Pre-feasibility	2026
LNG to Decarbonised Gas (L2DG)	Reganosa	Under consideration	2026
MosaHYc (Mosel Saar Hydrogen Conversion)	GRTgaz, CREOS Deutschland	Commissioned	2020
R&D for hydrogen production			
Sun2Hy	Enagás Renovable S.L.U.	Less-Advanced	2024
Smart multi energy system			
Impulse 2025	Teréga	Planned	2025

Table 7. Energy transition projects in the South Region promoted by gas TSOs (Source: TSO own elaboration).

As can be seen in figure 27, the vast majority of ETR projects promoted by gas TSOs in the South Region relate to hydrogen and biomethane developments intended to scale-up production capacities of these renewable gases. In particular, some of these projects comprise power-to-gas technologies and reverse flow.

In addition, there are other developments that are being carried out in the South Region, mainly focused on Carbon Capture and Storage/Utilisation of CO_2 emissions (CCS/CCU), R&D for hydrogen production, smart multi energy system and compressed natural gas (CNG)/liquified natural gas (LNG) for transport.

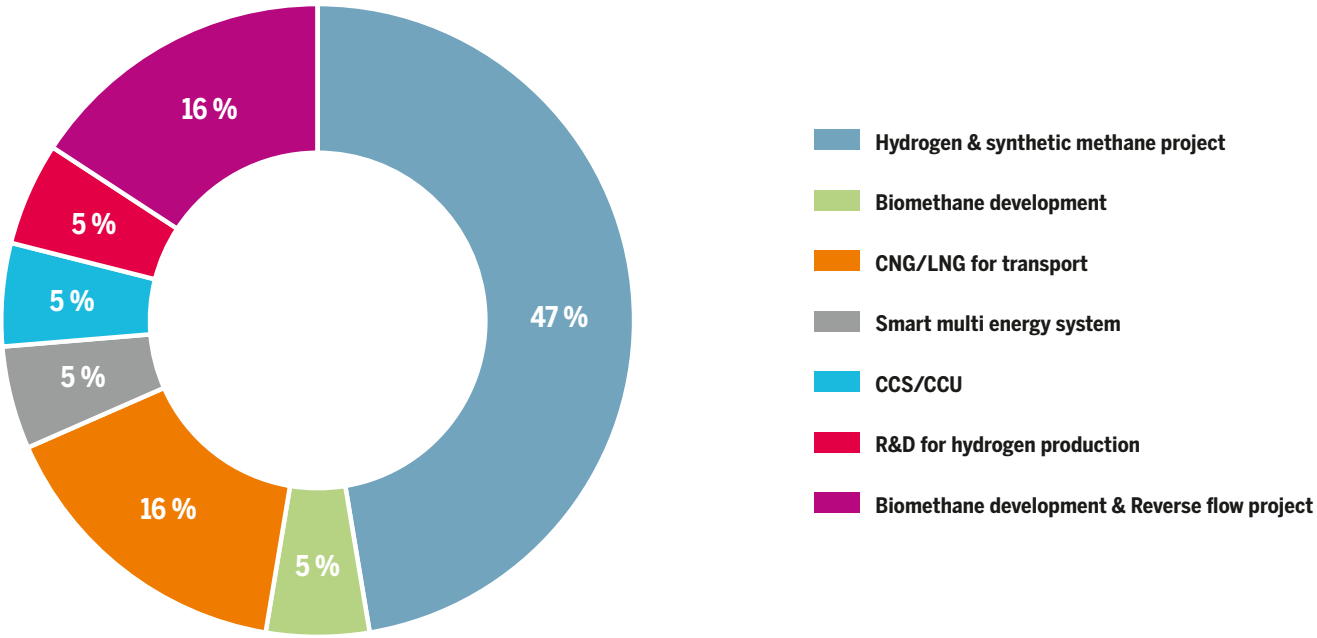


Figure 27. Energy transition project categories in the South Region (Source: TSO own elaboration).

The data included in the map represents the number of ETR projects in which gas TSOs are working on in France, Portugal and Spain together with the breakdown by project category. In this regard, while developments in Portugal are mainly focused on hydrogen projects, France and Spain are more diversified.

In France, the country of the South Region with the highest number of projects being developed by gas TSOs, most of the initiatives focus on hydrogen and synthetic methane (44 % of total) followed by biomethane and reverse flow developments (33 %). There are also further activities aimed at creating a CCUS hub and fostering a smart multi-energy system. Meanwhile, Spanish gas TSOs concentrate 43 % of their projects on hydrogen, with the remaining fraction being dedicated to a variety of areas, such as biomethane development and sustainable mobility. In Portugal, the energy transition projects are focused on hydrogen and synthetic methane (67 %).

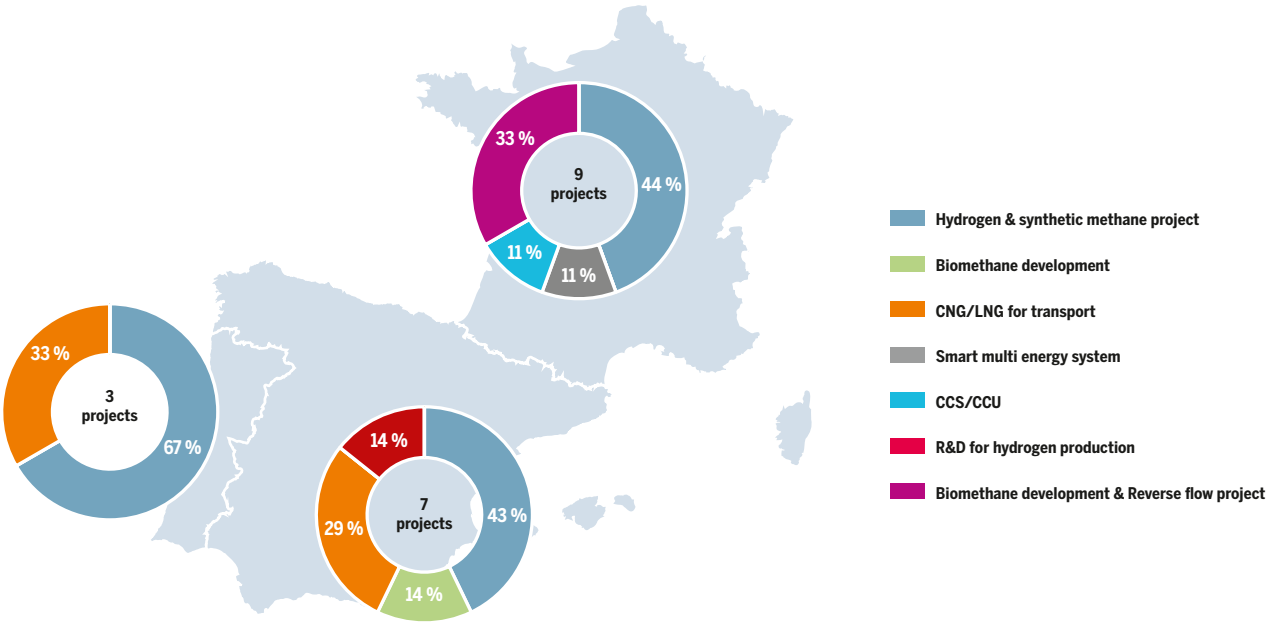


Figure 28. Number of ETR projects per country and breakdown by project category (Source: TSO own elaboration).

The following paragraphs provide a closer look at the energy transition projects which are currently being assessed by gas TSOs in the South Region.

7.2 ETR PROJECTS IN FRANCE

Biomethane: reverse flow projects

General information			
Project Code	ETR-N-624	**Project Category**	Biomethane development & Reverse flow project
Promoter	GRTgaz	**Host Country**	France
Maturity Status	Planned	**Commissioning Year**	–

Description

The scattered production of renewable gas will take an increasing part in the gas mix. Grid extensions will be required to collect this generation and backhaul facilities will allow the excess energy to be absorbed when supply exceeds local demand.

These network adaptations will enable to maximise the volume of biomethane injected into the gas system and reach national target for renewable gas (10 % of gas consumption in 2030). Three backhaul facilities have been under operation on GRTgaz's network since 2020. 9 other backhaul facilities have been validated by the NRA and will be commissioned by 2022, while studies have been launched for 11 other projects. By 2023, GRTgaz expects to commission around 30 backhaul facilities.

In order to reach 30 TWh of biomethane injection into the network, it can be estimated that around 70 backhaul installations and mutualised compressors would be required, ie a financial envelope of 200 M €. A higher target reaching 50 TWh would require around 132 backhaul facilities, corresponding to a 370 M € investment.

Jupiter 1000: 1st industrial demonstrator of Power to Gas in France

General information			
Project Code	ETR-F-546	**Project Category**	Hydrogen & synthetic methane project
Promoter	GRTgaz	**Host Country**	France
Maturity Status	Commissioned	**Commissioning Year**	2020/2021

Description

The Jupiter 1000 project is the first industrial demonstrator of Power to Gas with a power rating of 1 MWe for electrolysis and a methanation process with carbon capture. Green hydrogen will be produced using two electrolysers involving different technologies, from 100 % renewable energy. The installation will be based on an innovative methanation technology and CO_2 will be captured on a nearby industrial site. In the light of the performance levels shown by the demonstrator, GRTgaz and its partners will work on future technical and economic standards of a full-sized installation of this type. Over the longer term, the idea is to launch the Power to Gas activity in France. More than 15 TWh of gas could be produced each year using the Power to Gas system by 2050.

Located in Fos-sur-Mer, near Marseille, the project is being commissioned. Production and injection of hydrogen into the network have begun in 2020, the methanation process with carbon capture is expected to be commissioned by the end of 2021.

MosaHYc (Mosel Saar Hydrogen Conversion)

General information			
Project Code	ETR-N-899	**Project Category**	Hydrogen & synthetic methane project
Promoter	GRTgaz, CREOS Deutschland	**Host Country**	France/Germany
Maturity Status	Commissioned	**Commissioning Year**	2020

Description

GRTgaz in France and CREOS in Germany work together towards a cross-border 100 % hydrogen transportation network via the reuse of existing gas infrastructures, connecting Saarland (Germany) and Lorraine (France) and arriving at the border of Luxembourg.

The ambition of the mosaHYc project is to provide a 70 km regional-size hydrogen infrastructure where various hydrogen producers and consumers in Saarland, Lorraine and Luxemburg can access on a non-discriminatory basis and interact freely to develop hydrogen applications in the industry and especially in the mobility sector. Indeed, the project aims at supplying first future hydrogen filling stations, in line with green cross-border mobility ambitions of Saar federal State in Germany, Grand Est Region in France and Luxemburg. Thus, the project could contribute decarbonising mobility uses and address major environmental and societal challenges including the topic of improving air quality in the Saar-Lor-Lux region.

For GRTgaz, this project would also be the first demonstrator in France for the adaptation of an existing pipeline from natural gas to the transport of pure hydrogen. It would allow the emergence of technical and regulatory provisions allowing the conversion of existing networks to the transport of hydrogen energy.

West Grid Synergy

General information			
Project Code	ETR-F-587	**Project Category**	Biomethane development & Reverse flow project
Promoter	GRTgaz	**Host Country**	France
Maturity Status	Planned	**Commissioning Year**	2020

Description

In many cases, the injection capacity of biomethane production into the local distribution system is limited by local consumption. At a larger scale, decentralised production has significant impacts on the gas infrastructure operation (monitoring, maintenance, coordination with the stakeholders...). In order to adapt the distribution and transmission system to those structural changes, GRTgaz has launched a demonstrator and a major industrial program.

3 gas utilities (GRTgaz, GRDF and SOREGIES) investigate this issue together with public actors through an operational demonstrator named West Grid Synergy and located in the West of France, in territories with important biomethane production projects and very high target integration rates for green gas (from 35 to 120 %). The objective is to design technical and organisational solutions based on a comprehensive understanding of the gas system

The demonstrator will focus on the following topics:

- Design and implement smart infrastructures: design and test various technical solutions (reverse flow unit, dynamic and remote control of the gas pressure, communicating units, production and consumption forecast...).
- Design smart organisations: define the relevant information stakeholders (biomethane producer, industrial


Picture courtesy of Teréga

consumer, transmission and distribution system operators) should share and the resulting organisation and protocols for operating the new gas system in order to optimise the global system.

- Integrate and optimise the global system: identify the best mix of infrastructures and the appropriate dynamic settings for those interoperable infrastructures from the injection to the consumption point.
- Support local actors: test and collect best practices regarding communication and consultation around local biomethane plant setups and to promote the shift towards new practices (organic waste collection, NGV mobility, etc.) to support energy transition.

By 2023, 260 GWh/year will be produced in the West Grid Synergy territories and injected into the transmission and distribution gas network.

Biomethane production units connection and reverse flow units

General information			
Project Code	ETR-F-728	**Project Category**	Biomethane development & Reverse flow project
Promoter	Teréga	**Host Country**	France
Maturity Status	Planned	**Commissioning Year**	–

Description

The scattered production of renewable gas will take an increasing part in the gas mix. Grid adaptations and extensions will be required to connect these production units to the transmission network. Backhaul facilities will also be needed to allow biomethane injected in the distribution to flow back to the transmission grid when the biomethane injected locally exceeds local demand.

These network adaptations will enable to maximise the volume of biomethane injected into the gas system and reach the national target for renewable gas (10 % of gas consumption in 2030).

Teréga expects 2 or 3 connection projects per year (around 25/30 completed by 2030) for an estimated production between 0.2 TWh/y (2021) and 1.1 TWh/year (2030), and 1 backhaul project every 2/3 years (around 4 completed by 2030) for an estimated reverse flow of 0.4 TWh/year.

One of the backhaul facilities has been validated by the NRA in the "Délibération de la Commission de régulation de l'énergie du 27 mars 2019 relative à l'examen des plans décennaux de développement de GRTgaz et Teréga."

One of the backhaul facilities is at the stage of feasibility study. The biomethane connection projects are 50 % at a pre-feasibility study level and 50 % at a feasibility study level.

Hygeo

General information			
Project Code	ETR-N-901	**Project Category**	Hydrogen & synthetic methane project
Promoter	Teréga	**Host Country**	France
Maturity Status	Pre-feasibility	**Commissioning Year**	–

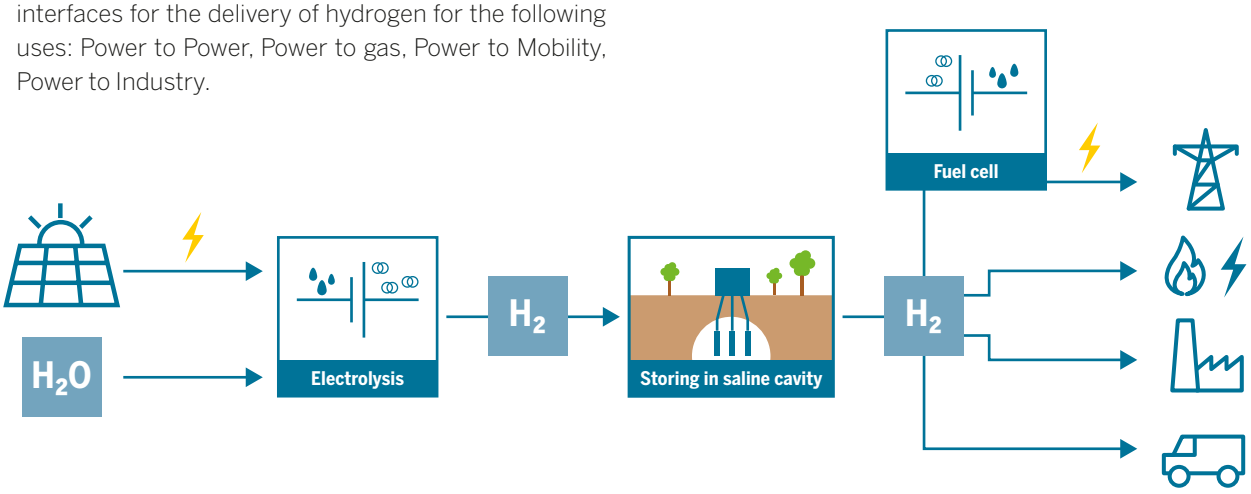
Description

HYGEO project aims to develop a geological renewable energy storage installation in the form of the green hydrogen (H_2). The project includes:

- an electrolyser and compression unit,
- a Fuel Cell of at least 1 MW,
- the saline cavity, storing up to 68 tonnes of hydrogen so the equivalent of 900 MWh of electricity,
- interfaces for the delivery of hydrogen for the following uses: Power to Power, Power to gas, Power to Mobility, Power to Industry.

Hygeo will offer flexibility to the electricity grid, providing a source of supply of electricity (P2P), as well as the possibility of providing H_2 for direct consumption or for injection in the gas network.

The pre-feasibility study regarding technical, economic, environmental, regulatory and societal aspects is in progress (2020–2021).



Project promoters

Impulse 2025

General information			
Project Code	ETR-F-743	**Project Category**	Smart multi energy system
Promoter	Teréga	**Host Country**	France
Maturity Status	Planned	**Commissioning Year**	2025

Description

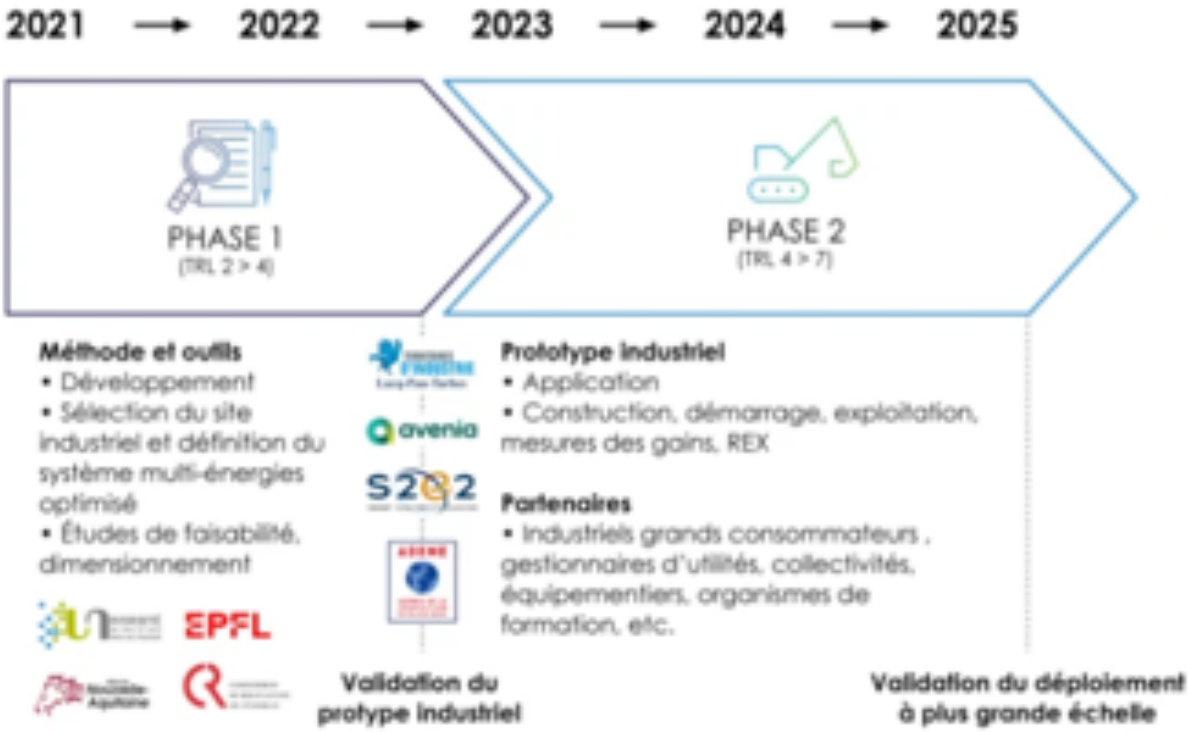
IMPULSE 2025 project aims at implementing a « smart multi-energies system » to interconnect different energy networks (gas, power, heat) to create synergies and improve energy efficiency. It includes studies and the building of a pilot demonstrator in 2 phases:

Phase 1 (2019–2022)
Development of a model and optimisation tool to identify the optimal configuration of a smart multi-energies system. Many technological components will be studied and meaningful or priority design studies will be conducted.

Phase 2 (2022–2025)
Study of the operational feasibility to confirm estimated gains. Several partners are associated. This phase aims at improving the demonstrator through the implementation of the technological components identified in phase 1.

The phase 1 of the project was approved by the French regulator (CRE) on the 11th June 2019. The outcome of the phase 1 will provide the indications to proceed with the operational phase 2.

Website of the project.



Lacq Hydrogen

General information			
Project Code	ETR-N-942	**Project Category**	Hydrogen & synthetic methane project
Promoter	Teréga	**Host Country**	France
Maturity Status	Pre-feasibility	**Commissioning Year**	2026

Description

LACQ HYDROGEN will be a first-of-a-kind vertically integrated "at-scale" value chain and business model, driven by the growing market demand for green power. It is a perfect demonstration of four key European policy imperatives:

(i) energy decarbonisation, displacing coal and natural gas in dispatchable power generation;

(ii) industrial revitalisation, bringing investments and jobs across the hydrogen value chain (including electrolyser and turbine manufacturing) to conversion areas;

(iii) European integration, fostering the development of a European Hydrogen Backbone of transmission and storage from Spain to France and other countries, and

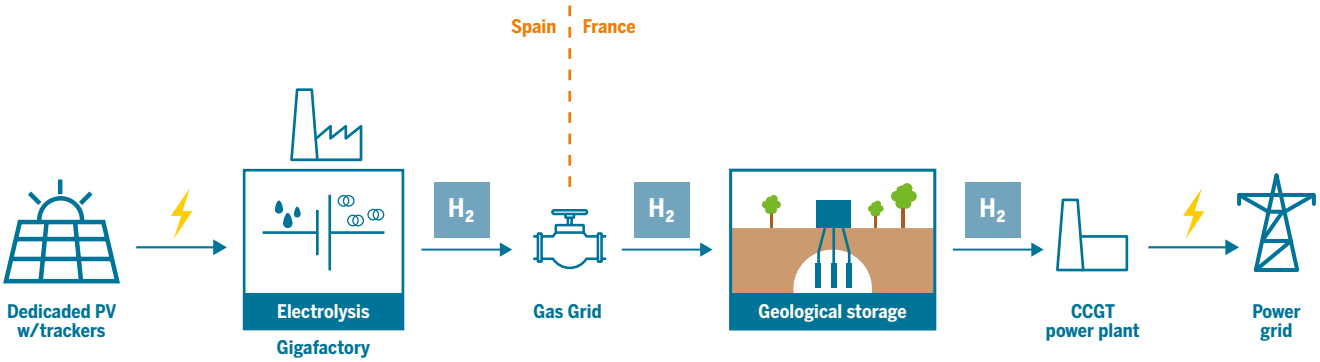
(iv) European sovereignty, reducing fossil fuel imports.

Lacq Hydrogen ("LH") includes a 800-MW renewable hydrogen combined-cycle gas turbine (CCGT) power plant system project promoted by Teréga and GazelEnergie with the support of Soladvent acting as coordinator.

The business case for LH is not driven by regulatory measures, long-term subsidies or feed-in tariffs, but by tangible demand for 100 % renewable power.

LH aims to become a global pioneer in the production of fully dispatchable renewable power from the combustion, in properly designed gas turbines, of hydrogen produced from solar power by water electrolysis, at competitive prices.

The upstream part of the project will leverage the unique competitive advantage of Spain, whereas the downstream part will exploit an ideal configuration in South Western France for the storage of hydrogen at the required scale and the production of dispatchable power.



Pycasso

General information			
Project Code	N/A	**Project Category**	CCS/CCU
Promoter	Teréga	**Host Country**	France
Maturity Status	Feasibility	**Commissioning Year**	2028–2030 (expected)

Description

The objective of this project is to create a CCUS hub based on a shared vision as well as a coherent, integrated and optimised territorial approach for Occitanie, Nouvelle Aquitaine and the Spanish Basque Country regions. It relies on the decarbonisation plans of local communities to consider emissions reduction as a set of solutions, of which CO_2 storage would only be one component. However, the complexity of such a project requires that we start studying it now, in co-construction with the local regions to reach a certain level of appropriation.

In summary, this project is based on the region undeniable assets:

- Significant storage capacities (in depleted and deep gas fields for several decades: 500 Mt of CO_2, which represents 100 years of emissions from the Aquitaine area or 40 years of emissions from both the Aquitaine area and the Spanish Basque Country).
- The Lacq/Meillon area, where the largest storage capacities are located, is the ideal barycentre of North Spain/South-West France (Bordeaux-Bilbao-Toulouse triangle).
- A regionally and internationally interconnected gas pipeline transport network, of which some sections are potentially usable.
- The Rousse pilot project (2013–2014 – 50 Kt of CO_2 injected over 2 years) demonstrated the technical and environmental feasibility of this type of storage: depleted reservoir from an old field gas.
- Pooling transport and storage infrastructure would significantly reduce costs, which are already among the lowest for onshore storage (69 €/t CO_2 – ADEME 2020).
- A modular project over time and space.

7.3 ETR PROJECTS IN PORTUGAL

In the ETR projects category, REN Gasodutos is in charge of preparing its entire gas infrastructure for the transport of natural gas and hydrogen mixtures, as well as a small-scale LNG project at Sines terminal.

In order to allow for the fulfilment of the hydrogen injection targets imposed by the National Strategy for Hydrogen (EN-H_2), investments in transport and storage infrastructures, as well as in associated equipment, are mandatory.

For the period between 2022 and 2031, the Portuguese National Development Plan, PDIRG 2021, foresees a global investment of 41.0 M € in the RNTG and Carriço UGS, associated to the hydrogen blending. At RNTG, the total investment announced is 15.6 M €, and at Carriço UGS, the total investment announced is 25.4 M €.

In the last PDIRGN proposal, a small-scale LNG project at the Sines LNG terminal was considered, in order to offer natural gas as an alternative fuel for the maritime and port transport sectors, in a context of energy transition.

H2RENGRID - AS Carriço

General information			
Project Code	N/A	**Project Category**	Hydrogen & synthetic methane project
Promoter	REN Armazenagem	**Host Country**	Portugal
Maturity Status	Planning	**Commissioning Year**	2022–2031

Description

H2RENGRID – Enabler for Decarbonisation, the project is intended to retrofit the Portuguese gas network for blending of hydrogen into the natural gas streams. According to the current national legislation, the network has to be able to receive gas mixtures of hydrogen and natural gas with hydrogen content of 1 to 5 % v/v until 2025 and, 10 to 15 % v/v until 2030, 40 to 50 % v/v until 2040 and 75 to 80 % v/v until 2050.

To achieve the thresholds defined by national politics, investments in the gas storage facilities are mandatory. The Portuguese TSO, REN Gasodutos, has published a plan of investments (in its NDP 2021) which considers both the national gas transmission network and the underground gas storage at Carriço.

For Carriço UGS facility, investments are split into caverns, surface equipment, high pressure motor/compressor groups and electricity and control, for a total of 25.4 M €.

- **Caverns:** It is necessary to undertake a set of deep studies, such as inspection and bacteriological, materials behaviour, geomechanical and capacity analysis. The project also includes the reinforcement of the intrusive inspection programs and Integrity Management Programs currently in place. The total investment projected for caverns is 2.2 M €.
- **Surface equipment:** Underground gas storage pipelines, heating devices, analysers and metering equipment have to be replaced or retrofitted to admit gas mixtures of natural gas and hydrogen. For the UGS facility, it will also be necessary to assess the impact on the gas dehydration system. The total investment expected for these enhancements is 2.2 M €.
- **High-pressure motor/compressor groups:** Currently working engines at Carriço UGS facility are OTTO cycle, natural gas driven engines, which do not accept mixtures of hydrogen with natural gas. Hydrogen blending into natural gas, as well as operating regime at Carriço, with frequent starts and stops, favour the replacement of current engines by electric motors, with an associated investment of 12 M €.
- **Electricity and control:** With the replacement of the current compressor engines for electric motors, it will be necessary to adapt and repower the existing electric installation. The project includes two new transformers, variable speed equipment, 60 kV substation and power line, for a total investment of 9 M €.

The Portuguese NDP 2021 puts the global project investment to be reached by 2031, with about 94 % achieved by 2026, amounting to almost 24 M €.

H2RENGRID - RNTG

General information			
Project Code	N/A	**Project Category**	Hydrogen & synthetic methane project
Promoter	REN Gasodutos	**Host Country**	Portugal
Maturity Status	Planning	**Commissioning Year**	2022–2031

Description

H2RENGRID – Enabler for Decarbonisation the project is intended to retrofit the Portuguese gas network for blending of hydrogen into the natural gas streams. According to the current national legislation, the network has to be able to receive gas mixtures of hydrogen and natural gas with hydrogen content of 1 to 5 % v/v until 2025 and, 10 to 15 % v/v until 2030, 40 to 50 % v/v until 2040 and 75 to 80 % v/v until 2050..

To achieve the thresholds defined by national politics, investments in the gas transmission network are mandatory. The Portuguese TSO, REN Gasodutos, has published a plan of investments (in its NDP 2021) which considers both the national gas transmission network and the underground gas storage at Carriço.

For the national transmission network (RNTG), the investments are split into pipelines, control systems, surface equipment and analysers, and metering equipment, for a total investment of 15.6 M €.

- Pipelines: The project includes specific studies to confirm and certificate the network to be used with mixtures of natural gas and hydrogen. These studies will verify, among others, the impacts on mechanical properties of steel, as well as the amplitude and frequency of pressure cycles. Hydrogen content increases the crack propagation speed in steel. New technologies for pipelines interior inspection are considered, as well as the increase of the inspection activities frequency. The total investment associated to pipelines is 6.75 M €.
- Control systems: Different compositions of the gas will happen at different locations of the network, because of the heterogeneous distribution of the hydrogen injection points along the grid. As a consequence, it is necessary to better control the mixture composition along the network, with investments in SCADA system, simulation software and others, in a total of 4.2 M €.
- Surface equipment: Flame speed varies with the content of hydrogen in the gas. This phenomenon reduces thermal efficiency of existing boilers, which have to be replaced in order to properly work with mixtures of natural gas and hydrogen. Other equipment such as valves, reservoirs and heat exchangers have also to be prepared. Total investment foreseen for surface equipment is 2.85 M €.
- Analysers and metering: Currently installed chromatographs use helium as the transport gas, resulting in the inability to detect hydrogen, which is a gas with similar conductivity. This situation can be overcome by converting current chromatographs with a specific column for hydrogen and changing the transport gas to argon, installing a hydrogen analyser in series with current chromatographs or replacing these with certified chromatographs for mixtures with hydrogen. The adopted solution will be decided on a case-by-case basis. Some metering devices, such as vortex flowmeters are not compatible with gas/H_2 mixtures and have to be replaced as well. The investment foreseen for these equipment is 1,8 M €.

The Portuguese NDP 2021 puts the global project investment to be reached by 2031, with about 77 % achieved by 2026, amounting to about 12 M €.

Picture courtesy of REN

Small-Scale LNG at Sines terminal

General information			
Project Code	N/A	**Project Category**	CNG/LNG for transport
Promoter	REN Gasodutos	**Host Country**	Portugal
Maturity Status	Planning	**Commissioning Year**	–

Description

Two possibilities were contemplated, the adaptation of the current LNG carriers unloading dock and the construction of a new berth, dedicated exclusively to the supply of LNG to smaller ships.

In the last edition of the PDIRGN, REN Gasodutos favoured the option of adapting the current berth, given the reduced investment cost compared to the other option.

In its sight on the PDIRGN 2020–2029 proposal, ERSE (Portuguese NRA), while recognising maritime transport as a potential new way of using LNG and its importance as a milestone for the decarbonisation of the economy, recommended the development of independent and more in-depth studies on the identified solutions.

In the present edition of the PDIRG (2022–2031), given the still lack of definition of an energy policy that would clarify the necessary guidelines for investment decisions at Sines LNG terminal, regarding the supply of LNG under the SSLNG, there are no concrete proposals on this matter and are not presented for decision under this Plan.

Thus, it was considered that at the date of preparation of the current PDIRG proposal, the conditions were not met for REN to propose again, as a possible solution, the adaptation of the current unloading berth of Sines, proposing such decision for future plans exercises, taking into account a better national regulatory and legislative framework.

7.4 ETR PROJECTS IN SPAIN

Green Crane

General information			
Project Code	ETR-N-537	**Project Category**	Hydrogen & synthetic methane project
Promoter	EnaGás Renovable S.L.U.	**Host Country**	Spain
Maturity Status	Less-Advanced	**Commissioning Year**	2024–2026

Description

Green Crane is a joint initiative by Enagás and SNAM to deploy renewable hydrogen value chains at scale. It aims to develop local hydrogen demand as well as export routes to NW and Central Europe. In Spain, it comprises the regional hubs of Madrid, Tarragona, Castellón, Mallorca (Green Hysland), Algeciras, País Vasco, Aragon, Asturias and Castilla y León. The latter foresees exporting green hydrogen to The Netherlands by using LOHC's. The hydrogen will be produced from new dedicated solar PV and wind farms and will be used directly in industry and mobility projects. All hubs foresee a certain amount of hydrogen to be blended in the natural gas grid (up to 2 or 5 %).

CORE LNGas hive and LNGHIVE2

General information			
Project Code	ETR-A-541	**Project Category**	CNG/LNG for transport
Promoter	Enagas Transporte S.A.U.	**Host Country**	Spain
Maturity Status	FID	**Commissioning Year**	2023

Description

CORE LNGas hive project, led by Puertos del Estado and coordinated by Enagas, is part of institutional strategy to deploy LNG supply fuelling in ports in the Iberian Peninsula and develop the associated market, is a step in the career of reduced emissions.

This project aims to develop an integrated, safe and efficient logistics chain for the supply of liquefied natural gas, LNG (small scale and bunkering) as a fuel in the transport sector, especially maritime, in the Iberian Peninsula. In this way, the CORE LNGas hive project contributes to the decarbonisation of the European Mediterranean and Atlantic corridors and is a further step in the race to reduce emissions, promote clean energy for transport and care for the environment promoted by the European Union.

In the initial project, 25 initiatives have been developed, carried out by the partners for the adaptation of infrastructure and logistics, and their commercial development in order to offer small-scale supply and refuelling services. Among the initiatives included in the project are the following:

- Adaptation of the infrastructures of all regasification plants for small-scale bunkering and/or fuelling services.
- Development of LNG distribution barges in Barcelona and northern Spain.
- Use of LNG as fuel in tugboats, port cranes and land transport (rail transport).
- Estimation of the potential demand for LNG and the logistics chain necessary for its supply.
- Development of technical and safety standards.
- Social acceptance of LNG.

- Study of training needs for the use of LNG and its deployment.

In addition, the CORE LNGas hive project offers know-how to other European countries for the development of procedures, legislation and the establishment of training activities. The project also promotes the international expansion of the LNG sector, integrating initiatives within a coherent and global project by combining public and private efforts.

As a continuation of the initial project, the LNGHIVE2 strategy has been developed as a roll-out of the initial project for the commercial deployment of LNG as a fuel, with 50 partners (Public Partners, Port Authorities, Industrial Partners (NG operators, ship owners, external services)) and with a total budget of 246 M € and 58 EU Fundig. This roll-out includes different initiatives co-funded by the EU for the development of LNG fuel supply and demand.

- LNGHIVE2: Infrastructure and logistics solutions, Coordinated by Enagás.
- LNGHIVE2: Vessels demand: green and smart links – LNG solutions for smart maritime links in Spanish Core ports. Coordinated by Baleària.
- LNGHIVE2 Santander: Development of LNG bunkering infrastructure in Santander, a strategic port in the North of Spain. Coordinated by Repsol LNG Holding.
- LNGHIVE2 Algeciras: A Flex LNG bunkering vessel in the port of Algeciras Bay. Coordinated by Enagás.
- LNGHIVE2 Barcelona: An efficient LNG bunker barge in the port of Barcelona. Coordinated by Enagás.

Railway Roadmap

General information			
Project Code	ETR-F-632	**Project Category**	CNG/LNG for transport
Promoter	Enagas Transporte S.A.U.	**Host Country**	Spain
Maturity Status	FID	**Commissioning Year**	2022

Description

Development of the roadmap of Railway transformation from Diesel to LNG/BioLNG and H_2 with national Railway Operator (RENFE).

Automotive Pilot of passengers consists of the development of the necessary studies to develop the engineering of the first commercial line of passengers with LNG in the vicinities of Asturias and the tests of the same one for its extrapolation to commercial lines, 4 units S2600.

Project raiLNG is developed by the consortium (RENFE, Enagás, Naturgy and Bureau Veritas) and consists of the transformation of the S1600 locomotive to generate the hybrid Diesel/GNL tractor composition. The resulting composition will establish a comparison of performance between the two in the same service conditions.

- Project to transform locomotives from manoeuvres to LNG that currently use diesel fuel in port areas, 6 S310 units.
- LNGhive2: transformation of a heavy haul locomotive 333 Model in the Huelva-Sevilla corridor. The integral project will include a gas station.
- BIORAIL Project: Project of R+D+ì to promote disruptive technologies and alternatives to the traditional "motor-fuel" binomial that cover the shortcomings of the current platform.
- H2RAIL project to pilot Fuel Cell solution for low powertrain DMU vehicles.
- Development of a transformation Plan for at least 20 % of the Renfe Fleet.

Picture courtesy of Enagás

Sun2Hy

General information			
Project Code	ETR-A-504	**Project Category**	R&D for H_2 production
Promoter	EnaGas Renovable S.L.U.	**Host Country**	Spain
Maturity Status	Less-Advanced	**Commissioning Year**	2024

Description

Photoelectrochemical hydrogen production and hydrogen injection into the gas grid. This project is considering the production of green hydrogen by PEC technologies and includes the scaling up, the production and the real case application/demonstration project. Here below some of the key features:

- Clean and renewable technology.
- The solar radiation is converted directly into hydrogen (without external electricity).
- Low cost materials and high availability.
- Innovative project, increase on efficiency and cost reduction compared to a traditional PV- electrolyser plant.

Circular Economy: Waste to Biomethane

General information			
Project Code	ETR-N-951	**Project Category**	Biomethane development
Promoter	Reganosa	**Host Country**	Spain
Maturity Status	Feasibility	**Commissioning Year**	2024

Description

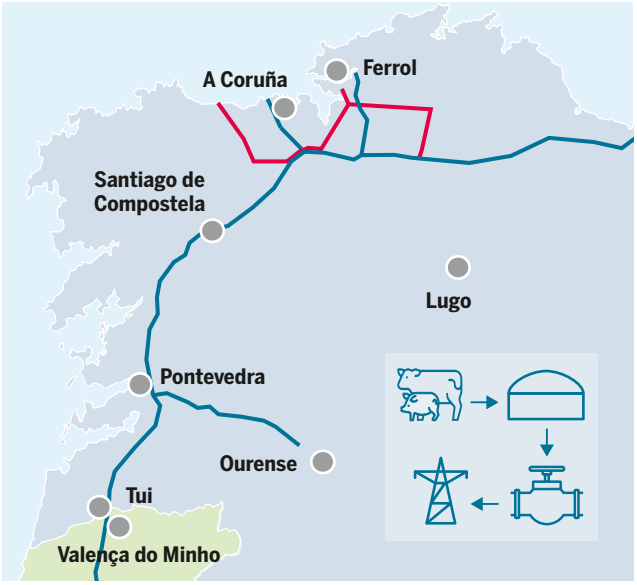
The Project "Circular Economy: Waste to Biomethane" is promoted as an energy transition project for biomethane injection into the Reganosa gas grid. The main objective is to develop an environmental neutral project for the injection of 1 TWh/year of biomethane into the natural gas network by recovering different residues, such as farming and agricultural, among others.

Particularly, the Project is based on the recovery of waste such as livestock manure (cattle, pig and poultry manure), organic fraction of urban solid waste, WWTP sludge and organic industrial waste (mostly from the agri-food sector) through anaerobic digestion, resulting in the production of biogas. At a later stage, this biogas will be refined to obtain biomethane in the subsequent upgrading module. Biomethane has similar properties to natural gas so it can be injected into the gas network. In addition, fertilisers will be obtained as by-products of the digestion by the concentration of nutrients that remain in the digestate. Therefore, the scope of the Project envisages the development of a biomethane network that will connect the biomethane plants to the Spanish gas grid. In this regard, this initiative empowers diverse benefits by handling current challenges such as:

- The use of slurry and muck as organic fertiliser: livestock manure is an important source of nutrients but can also adversely impact the environment if not handled correctly. This Project ensures the responsible management of nutrients related to this resource. Thus, the Project will contribute to the compliance of current EU targets on the recycling and landfill activities.

- Decarbonisation target in the gas sector: biomethane also meets the purpose of resource efficiency and use of local resources like organic household waste to obtain a renewable gas that can significantly contribute to achieving decarbonisation goals in the gas market.

Hence, the Project provides an outstanding contribution to circular economy, which constitutes not only a fundamental pillar of the energy and climate policy at European and national level, but also at regional level. In this regard, Galicia's regional government has drafted the Galician Circular Economy Strategy 2019-2030, which defines specific targets and measures for sectors such as food production and waste management, recognising, among others, the need to promote the efficient treatment of livestock waste through biodigesters to produce biogas. Likewise, the Galician Climate Change and Energy Strategy 2050 states a clear commitment to support the development of renewable energies, including biogas, synthetic gas and hydrogen, as well as to encourage the use of Galician forests as natural carbon sinks and the improvement of energy efficiency in all sectors.



Galician natural gas network and Circular Economy simplified scheme.

Therefore, to ensure and facilitate the promotion of Circular Economy initiatives, it would be convenient to promote a system of guarantees of origin (GO) for all types of renewable and low-carbon gases that demonstrates emissions savings, provides traceability and guarantees equal conditions for the different types of fuel and technologies used in their production to ensure reliable information for consumers.

In relation to the project timing schedule, commissioning and operation dates are expected to take place in 2024. In this regard, a Pre-Feasibility Study has already been completed and a Feasibility Study is currently under development.

H2Pole Project

General information			
Project Code	ETR-N-427	**Project Category**	Hydrogen & synthetic methane project
Promoter	Reganosa	**Host Country**	Spain
Maturity Status	FEED/Permitting	**Commissioning Year**	2024

Description

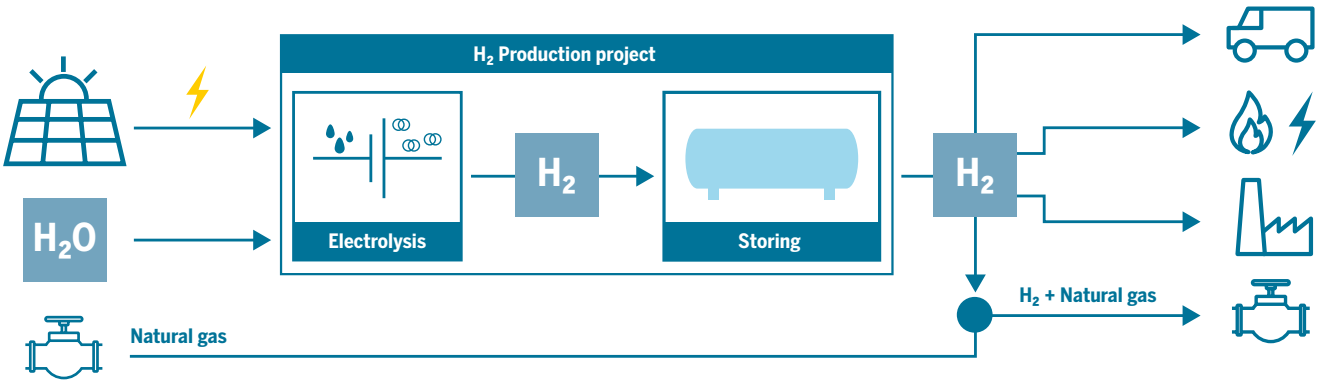
The H2Pole Project is a First Industrial Deployment Project that will install, in a first phase, a 50 MW demonstration plant for the production of renewable hydrogen by electrolysis. The plant is expected to be operative in 2024 and to allow for further scaling up the current electrolysis hydrogen facilities from experimental pilots to an industrial scale. The installation of additional 50 MW is planned by 2030, reaching an annual production of 14,400 t of renewable hydrogen. Also, the H2Pole Project aims to validate the hybridisation of hydrogen production with several renewable energy sources, such as wind, solar photovoltaic and hydro.

Thus, the objective of the Project is to develop the value chain of hydrogen in northwest Spain, providing the region with its first stable and accessible liquid market of renewable hydrogen. It intends to promote the use of hydrogen in a variety of sectors, outstanding its value as an energy vector through the injection into the natural gas grid and leveraging the existing infrastructure to facilitate the immediate use of hydrogen.

This initiative will encourage the decarbonisation of different sectors (mainly gas, mobility or industry), increasing the renewable energy uses and providing a circular energy ecosystem for the region and the surrounding companies. It is estimated that the Project will avoid 146 kt CO_2/year.

Therefore, the project will help to realise the ambitions set by the EU Hydrogen Strategy and the Spanish Hydrogen Roadmap. But, in particular, it will constitute a key enabler in the regional context to support the objectives of the Galician Climate Change and Energy Strategy 2050, which states a clear commitment to support the development of renewable energies, including biogas, synthetic gas and hydrogen, as well as to encourage the use of Galician forests as natural carbon sinks and the improvement of energy efficiency in all sectors. Against this background, Galicia's regional government launched in May 2021 a call of interest on projects related to renewable hydrogen in order to gather valuable information to allow the development of the strategic lines of action and define the necessary support mechanisms to promote the development of the hydrogen value chain in Galicia.

In this regard, the Project will allow to demonstrate the real effect of the hydrogen injection into the natural gas network (currently limited to 5 % in volume) and validate the predicted assumptions of the simulation models. Therefore, integrating renewable gases into the gas grids would also require exhaustive revisions and updates of quality, safety and other technical standards to facilitate the new hydrogen market.



The Project also includes the facilities to allow the distribution of renewable hydrogen for different users and markets:

- Newly built hydrogen pipeline and an injection station which will connect the electrolyser plant to high-volume consumers.
- Truck loading facility to transport hydrogen by road.
- Hydrogen Refuelling Station (HRS) to enable deployment of hydrogen as fuel for heavy duty vehicles.

In relation to the status of the Project, a Feasibility Study has already been completed and the Front Engineering Design (FEED) and permitting activities are currently under development. The Final Investment Decision will be taken in May 2022.

LNG to Decarbonised Gas (L2DG) Project

General information			
Project Code	ETR-N-483	**Project Category**	Hydrogen & synthetic methane project
Promoter	Reganosa	**Host Country**	Spain
Maturity Status	Under consideration	**Commissioning Year**	2026

Description

The L2DG Project is an energy transition project based on a methane pyrolysis plant for hydrogen production and injection into Reganosa gas grid. Its main objective is the adaptation of the terminal to achieve the decarbonisation of LNG entries from the regasification plants, while also complying with efficiency targets.

The pyrolysis plant will be located at the existing facility of Mugardos LNG terminal and will consume the natural gas from the LNG regasification vaporisers to turn it into hydrogen at a rate of about 4 t/h, which represents 5 % of the technical send-out capacity of the terminal. This hydrogen will be injected into the natural gas grid owned by Reganosa.

In this regard, the Project aims to provide end-users connected to the gas grid with access to low-carbon hydrogen as a means to facilitate sectoral decarbonisation while leveraging the existing gas infrastructure, in line with the roadmap set out in the EU Hydrogen Strategy launched by the European Commission in July 2020 and the resolution adopted by the Committee on Industry, Research and Energy of the European Parliament on 19 May 2021, which recognise the role of low-carbon hydrogen, especially in the short and medium term, to rapidly reduce emissions from existing hydrogen production and support the parallel and future uptake of renewable hydrogen. According to ENTSOG estimations, the L2DG Project will reduce GHG emissions in about 291 kt CO_2/year.

Thus, in order to enable the deployment of this type of projects in the decarbonised gas market it is essential to recognise and support the role of existing gas infrastructure and gas operators to accommodate renewable and low-carbon gases. At the same time, it is paramount to provide adequate incentives for production and foster R&D in sustainable gas-related technologies.

In relation to the status of the Project, the project is "Under Consideration". The Prefeasibility Study are currently under development. The project commissioning is expected to be completed by 2026.

GLOSSARY

AVB	Spanish Virtual Balancing Underground Gas Storage
bcm	Billion Cubic Meters of natural gas
CCS/CCU	Carbon Capture and Storage/Utilisation
CNG	Compressed Natural Gas
Enagás	Spanish TSO
ENTSOG	European Network of Transmission System Operators for Gas
ETR projects	Energy transition projects
EU	European Union
FEED	Front End Engineering Design
FID	Final Investment Decision
GRIP	Gas Regional Investment Plan
GRTgaz	French TSO
GWh	Giga Watt hours
IP	Interconnection Point
LNG	Liquified Natural Gas
LOHC	Liquid Organic Hydrogen Carrier
NECP	National Energy and Climate Plan
OTC	Over-the-counter
P2G	Power-to-gas
PEG	French acronym for Gas Trading Points
PVB	Spanish Virtual Balancing Point
Reganosa	Spanish TSO
REN	Portuguese TSO
South GRIP	Gas Regional Investment Plan for the South Region (ES, FR and PT)
Teréga	French TSO
TRF	Trading Region of France
TSO	Transmission System Operator
TVB	Spanish Virtual Balancing Tank
TWh	Tera Watt hours
TYNDP	Ten-Year Network Development Plan
UGS	Underground Gas Storage
VIP	Virtual Interconnection Point
VTP	Portuguese Virtual Trading Point

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