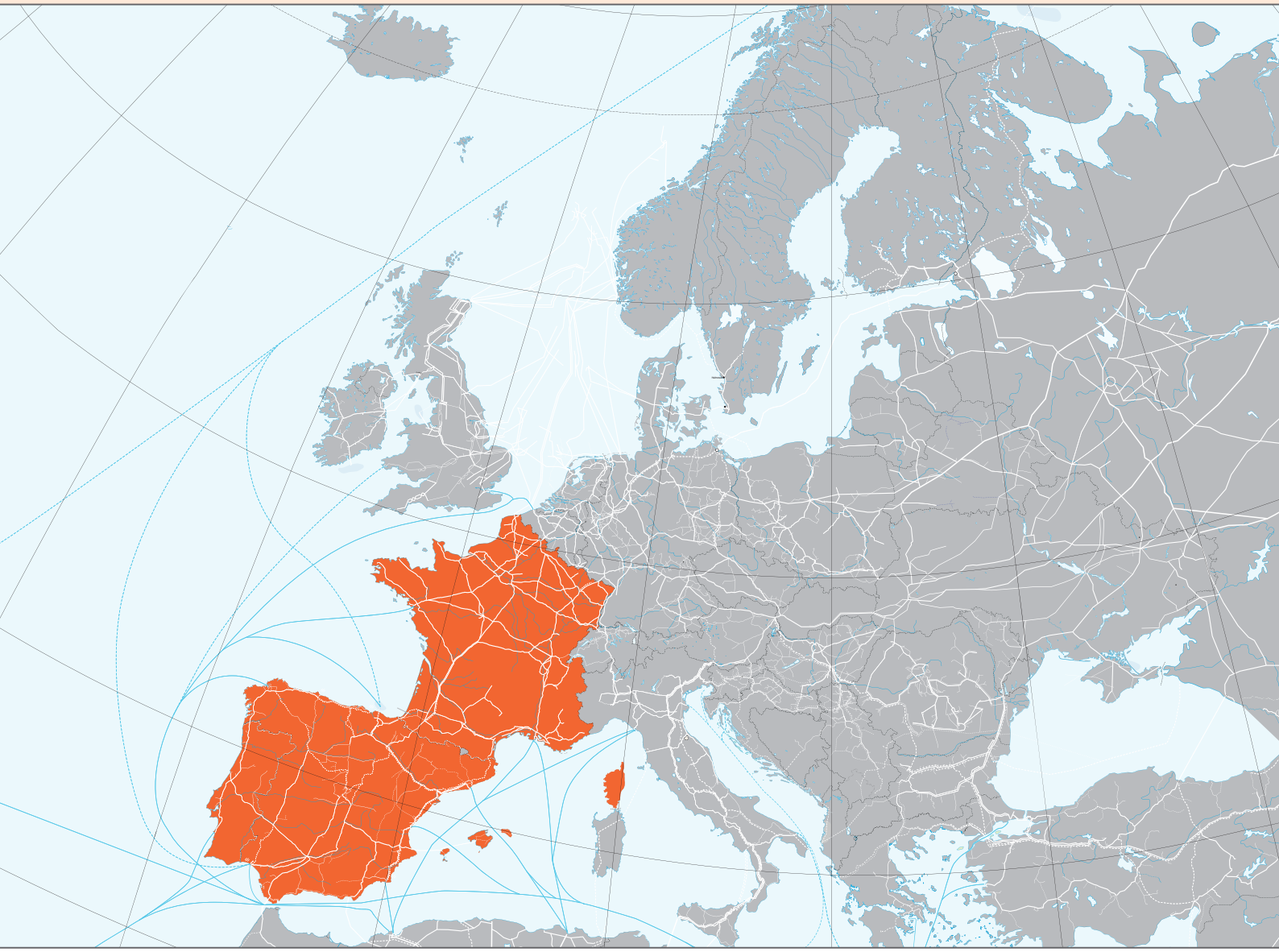
enagas GRTgaz REN TIGF



South Gas Regional Investment Plan

2011 - 2020

entsog
european network of transmission system operators for gas

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1. Executive Summary

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Major efforts are needed to modernise and expand Europe's gas infrastructure and to interconnect networks across borders to increase competitiveness, sustainability and security of supply into the Union creating the European Internal Gas Market.

Transmission System Operators (TSOs) in the South Region developing this first *Gas Regional Investment Plan (GRIP)*, **REN Gasodutos, GRTgaz**, **TIGF** and **Enagas**, understand theirs vital role to play achieving these Energy European objectives assuming the challenge of interconnecting and adapting the gas infrastructure to the new future needs.

The **South Region GRIP** report, in closer consistency with EU-wide and national TYNDPs, investigates how the cross border projects in the South Region, **3RD IP PORTUGAL-SPAIN** and the I**BERIAN-FRENCH CORRIDOR**, will cooperate to achieve the European Energy objectives for 2020 and beyond, stressing their value building the North-South Corridor in Western Europe.

"The Energy Infrastructures Priorities for 2020 and beyond" has identified the North-South Corridor in Western Europe as a priority corridor focusing its priority on "*Removing internal bottlenecks, increasing short-term deliverability, making full use of possible alternative external supplies, including from Africa, and optimizing the existing infrastructure, notably existing LNG plants and storage facilities.*"[1]

At national level, each TSO as expert on its networks characteristics, has designed individual developments on infrastructures directly linked to increasing cross border capacity, and also the core network infrastructures that are needed for the improvements of interconnection capacity. Additionally, TSOs in the South Region as ENTSOG members, have had intensive and closer collaboration developing the ENTSOG TYNDP 2011-2020 capturing a pan-European view. At this stage, the **South Region GRIP** report integrates both perspectives, coordinating at regional level these national developments, assuring the coherence and convergence with the data, methodology, rules and general assumptions determined for the elaboration of the EU TYNDP.

The **South Region GRIP** report has followed a BOTTOM UP APPROACH complementary with a TOP DOWN APPROACH, focusing in the impact of the cross border developments on:

- Interconnection level,
- Sustainability,
- Diversification of Gas Sources,
- Diversification of Gas Routes,
- Regional Cooperation to face "Disruptions": Resilience Assessment
- Market Integration

[1] Energy Infrastructure Priorities for 2020 and beyond (Brussels, 17/11/2010)

The **South Region GRIP** report describes the current gas market into the South Region, highlighting the diversified portfolio of supplies and of physical gas routes, showing strong differences in both seasonal and daily gas demand modulation among the three gas systems, stressing the complementary role played by LNG Terminals and Underground Storages providing flexibility in order to enable the Combined Cycle Gas Turbines (CCGTs) intermittent consumption due to renewable energies intermittency.

The first conclusion, from the TOP DOWN APPROACH, highlights the synergies found between the three countries gas systems, indicating the value of increasing interconnection cross border capacity helping not only the South Region, but also the rest of Europe in order to create the internal gas market.

Focusing on the Regional Cooperation to face "Disruptions", considering the special characteristics of the Region, the report shows how the **IBERIAN-FRENCH CORRIDOR** and the **3RD IP PORTUGAL-SPAIN** remove cross-border congestion providing remaining flexibility to face the worst disruptions detected for the South Region under extreme gas demand situations. It should be also noticed that the rest of non-FID infrastructure projects have benefits from a security of supply point of view, stand out as essential the development of new cross-border interconnection.

Because Transmissions System Operators in the South Region believe that the challenge for the following years are to create a well-meshed network, enabling the access to different supply sources, the **South Region GRIP** report investigates what the contribution is of the **3RD IP PORTUGAL-SPAIN** and the **IBERIAN-FRENCH CORRIDOR** to interconnect the Mediterranean Area and North West Europe.

Key conclusions are obtained under this market integration analysis, stressing the benefit of developing the **3RD IP PORTUGAL-SPAIN** and the **IBERIAN-FRENCH CORRIDOR**:

- FROM A REGIONAL PERSPECTIVE, highlighted is the better integration of these three countries into the South Region, developing the new cross border interconnection capacities. Removing cross-border capacity bottleneck (as identified by market integration tests) between France and Spain will bring the European gas market closer, making possible the development of large scale energy trade between countries.

- FROM AN EUROPEAN PERSPECTIVE, creating a new *Corridor from South to North* developing the **IBERIAN-FRENCH CORRIDOR**, opens a path to transport gas from Algeria to central Europe through France, increasing the European diversification of supply by reducing the dependence of the incumbent gas source jointly with the risks linked to security of supply.

  Additionally, creating a new *Corridor from North to South*, opening the access gas from Russia to the customers and shippers operating in the South of Europe, contributes to the increase of the liquidity in the market, allowing possibilities of arbitrage between the different European gas sources, making the transmission system a powerful contributor to the security of supply and to the achievement of the single market.

Transmissions System Operators of the South Region, having extended experience in working together since 2006 improving Regional Cooperation into the Region, wish that this first **South Region GRIP** report, showing the role played by developing the **3RD IP PORTUGAL-SPAIN** and the **IBERIAN-FRENCH CORRIDOR** in order to create the **North-South Corridor in the Western Europe**, provides useful information to all stakeholders and will support fruitful discussions when assessing the ability of investment projects to answer regional market needs.

2. Introduction

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2.1 General Preamble

Europe is importing gas in a very significant way and Transmissions Systems Operators have been cooperating for decades in order to enable cross border transmission. This cooperation is crucial for supporting market integration and developing the security of supply of all Member States. The need to promote regional cooperation is underlined by the European Directive 2009/73/EC in Article 7 and further detailed by the European Regulation n° 715/2009 in Article 12.

Pursuant to Article 12 (1) of the European Regulation, Transmission System Operators of the Region will publish every two years, a regional investment plan, which contributes to the fulfilment of tasks listed Article 8 (1)-(3), thereof the elaboration of the European Ten-Year Network Development Plan published by ENTSOG.

Transmission System Operators have worked together within ENTSOG in order to elaborate the European Ten-Year Network Development Plan (TYNDP 2011-2020) published on 17 February 2011 and available at www.entsog.eu/publications/TYNDP.html.

This Gas Regional Investment Plan provides updated information on the regional investment projects the TYNDP 2011-2020 was based upon.

Transmissions System Operators of the Region wish that this document will provide useful information to all stakeholders and will support fruitful discussions when assessing the ability of investment projects to answer the regional market needs.

2.2 Specific Preamble

2.2.1 Objectives

GRIPs are created as a regional zoom of TYNDP, progressing towards the implementation of the Energy European priorities (EIP). Based on the afore mentioned, the added value of GRIP South Region should be to highlight the value of each of the cross border projects included in the TYNDP, to achieve the European Energy objectives for 2020 and beyond. TSOs in the South Region want to use this GRIP to give a clear picture of the different infrastructures projects so far identified, focusing on the interconnection projects, showing the capacity created by development on its. Additionally, GRIP South Region should propose some indicators to establish a priorisation for the different projects, focusing in the criteria proposed by EC:

- Diversification of sources and routes and counterparts
- Increase interconnection level
- Increase of market integration
- Reduction of market concentration

2.2.2 Methodology

For the objectives above mentioned, the GRIP South Region has defined a double approach:

Bottom-Up Approach

Concerning the Bottom-Up Approach, the GRIP South Region has been focused on cross-border projects, stressing its role creating the internal European market. In line with that, TSOs envision the GRIP "integrating and coordinating at regional level the individual developments on infrastructures needed for increasing cross border capacity elaborated by TSOs at national level".

GRIP has provided an update on the current cross border IP projects, and a specific further analysis on non-FID cross-border projects included in TYNDP.

Top-Down Approach

Concerning the Top-Down Approach, the GRIP South Region has developed a complete analysis on:

- Demand: Gas market composition, role of gas-fired for power generation, peak vs. average.
- Supply: Share of LNG/NG, diversification
- Security of Supply: Using the ENTSOG tool used for TYNDP, the GRIP South Region includes a resilience network assessment considering the special characteristics of the Region and under specific risk scenarios.
- Market Integration: The GRIP South Region investigates the contribution of the Iberian-France Corridor to the European internal market focus on interconnect the Mediterranean Area and the Northern supply Corridor.

2.2.3 Previous experiences

Regional cooperation is not a new issue for South Region. In effect, TSOs from France, Spain and Portugal have been working since 2006 under Gas Regional Initiatives (GRIs) established by ERGEG in order to develop integration and convergence into a single European market.

The South Gas Regional Initiative (S-GRI), led by the Spanish Energy Commission (CNE), has identified three key priorities: interconnection capacity, interoperability and transparency.

Interconnection capacity

In 2008, a coordinated Open Subscription Procedure (OSP) was launched for the coordinated allocation of interconnection capacity between France and Spain that either exists or is under development. As a consequence, Spanish national legislation (a Royal Decree and a Ministerial Order) had to be modified and harmonized with the French laws. This mechanism is planned to be developed yearly to allocate short-term capacities at the border.

Once the existing capacity was allocated, the region focused its efforts on developing two Open Season procedures at the Spanish-French border in order to develop future capacity by upgrading existing interconnections (at Larrau and Biriatou) and creating a new gas corridor to the Eastern Pyrenees.

As a result of the first Open Season, launched in July 2009 and closed in January 2010 with the French TSOs' positive decision to invest, interconnection capacity will be increased by up to 5.5 bcm/year at Larrau as of March 2013. The second Open Season, which closed in July 2010, triggered the development of 2 bcm/year of interconnection capacity at Biriatou in the direction of Spain to France by 2015. The Open

Seasons were a success in identifying clear market interest in the proposed interconnection projects where investments decisions need to be taken. These results will significantly improve the integration of the Iberian and European gas markets as well as the security of supply, and they are a good example of regional cooperation by regulators, governments, TSOs, the European Commission and shippers.

Interoperability

On the interoperability side, a proposal to modify the network code was made by the Spanish regulator in order to implement EASEE-gas' Common Business Practices (CBPs) on harmonization of units, nomination and matching processes. At the same time, Portugal and Spain developed a study on the legal changes that are required in both countries when implementing a common trading licensing process.

Transparency

According to the Action Plan of the S-GRI, in line with Reg. EC 715/2009, the main objective would be to identify what information is needed by the market players to operate efficient and effectively, how this information should be provided by TSO's (and by other stakeholders when appropriate) on a fair and non-discriminatory basis, and what regulatory arrangements are necessary to ensure proper monitoring and enforcement. It is important to assess whether information provision, management and update of this information, are adequate to support the functioning of an effective gas market.

In this sense, an interconnection status record is published since December 2007 to make public the development of the new infrastructures. Information is updating each six months.

2.3 North-South Corridor in the Western Europe (Summary of EIP 2020)

The Energy Infrastructures Priorities for 2020 and beyond define the main lines of energetic strategic to follow in Europe for next years.

The Communication on Energy Infrastructure Priorities for 2020 and beyond highlights several issues that specifically deal with natural gas:

- Gas is set to continue to play a key role in the EU's energy mix and will gain importance as the back-up fuel for variable electricity generation;
- Conventional natural gas resources require additional, diversified imports. Gas networks face additional flexibility requirements in the system, and the need for bidirectional pipelines, enhanced storage capacities and flexible supply, including liquefied (LNG) and compressed natural gas (CNG);
- A diversified portfolio of physical gas sources and routes and a fully interconnected and bidirectional gas network are needed.

One of the proposed corridors deal directly with gas and the South Region: "**The North-South Corridor in Western Europe**."

As defined by the European Commission in the Energy Infrastructures Priorities "the strategic concept of the North-South natural gas interconnections in Western Europe is to better interconnect the Mediterranean area and thus supplies from Africa and the Northern supply Corridor with supplies from Norway and Russia.

There are still infrastructure bottlenecks in the internal market which prevent free gas flows in this region, such as for example the low interconnection level to the Iberian peninsula, preventing the use of the well-developed Iberian gas import infrastructure to its best. The Spain-France axis has been a priority for over a decade, but is still not completed. However, progress has been achieved in recent years, thanks to the better co-ordination of the national regulatory frameworks – taken up also as a priority by the South-West Gas Regional Initiative – and the active involvement of the European Commission. Another indication for imperfect market functioning and the lack of interconnectors are the systematically higher prices on the Italian wholesale market compared to other neighbouring markets."

Considering the current situation and the future objectives for Europe, the main points proposed for our Region in the Communication are the following:

OBJECTIVE

North-South Corridor in Western Europe to **remove internal bottlenecks** and **increase short-term deliverability**, thus making full use of possible alternative external supplies, including from Africa, and **optimising the existing infrastructure, notably existing LNG plants and storage facilities**.

Proposed Way Forward..

The **main infrastructure bottlenecks** preventing the correct functioning of the internal market and competition **need to be identified** in this corridor **and** stakeholders, Member States, NRAs and TSOs, shall work together **to facilitate their implementation**.

Secondly, an **integrated analysis** between the **electricity and gas system** - taking into account both generation and transmission aspects - should lead to the assessment of the gas flexibility needs and the identification of projects with the objective to back-up variable electricity generation.

By following criteria...

- **GAS: diversification**, giving priority to diversification of **sources**, diversification of supplying **counterparts** and diversification of **routes**; as well as increase in competition through **increase in interconnection level**, **increase** of **market integration** and **reduction** of **market concentration**

The North-South Corridor in Western Europe is intended to break the quasi isolation of the Iberian Peninsula through a large-size gas bridge across the Pyrenean range.

This Communication is also fairly specific and concrete with regards to modalities. It proposes to replace the TEN-E procedure with its long and rigid project lists, by a more flexible approach focusing on a limited number of European priorities and the identification of concrete facilities labelled "projects of European interest". It also proposes a "toolbox" aiming at speeding up the programme's implementation:

- Further development of regional cooperation via regional clusters,
- Establishment of a contact authority ("one-stop shopping") for each project of European interest, serving as a single interface between project developers and the competent authorities involved at national, regional, and/or local level;
- The introduction of a time limit for a final positive or negative decision to be taken by the competent authority will be explored.

3. SUPPLY: Regional overview

© Image courtesy of Enagás

The South Region is highly dependent on natural gas imports: national gas production is currently negligible in both Portugal and Spain, and only accounts for 2% of the natural gas consumption in France.

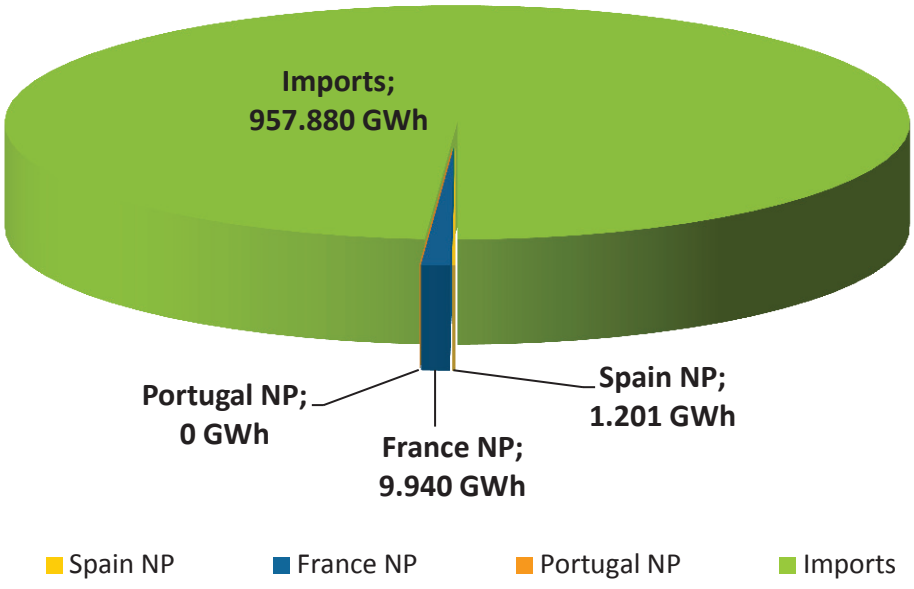


FIGURE 3 - 1: SUPPLY OF THE SOUTH REGION OF EUROPE

From a global point of view, 54% of natural gas imports in the South Region has been delivered as liquefied natural gas (LNG), while the remaining 46% was imported through pipelines. These figures are not homogeneously distributed among the three countries of the South Region, as shown in the **FIGURE 3 - 2**.

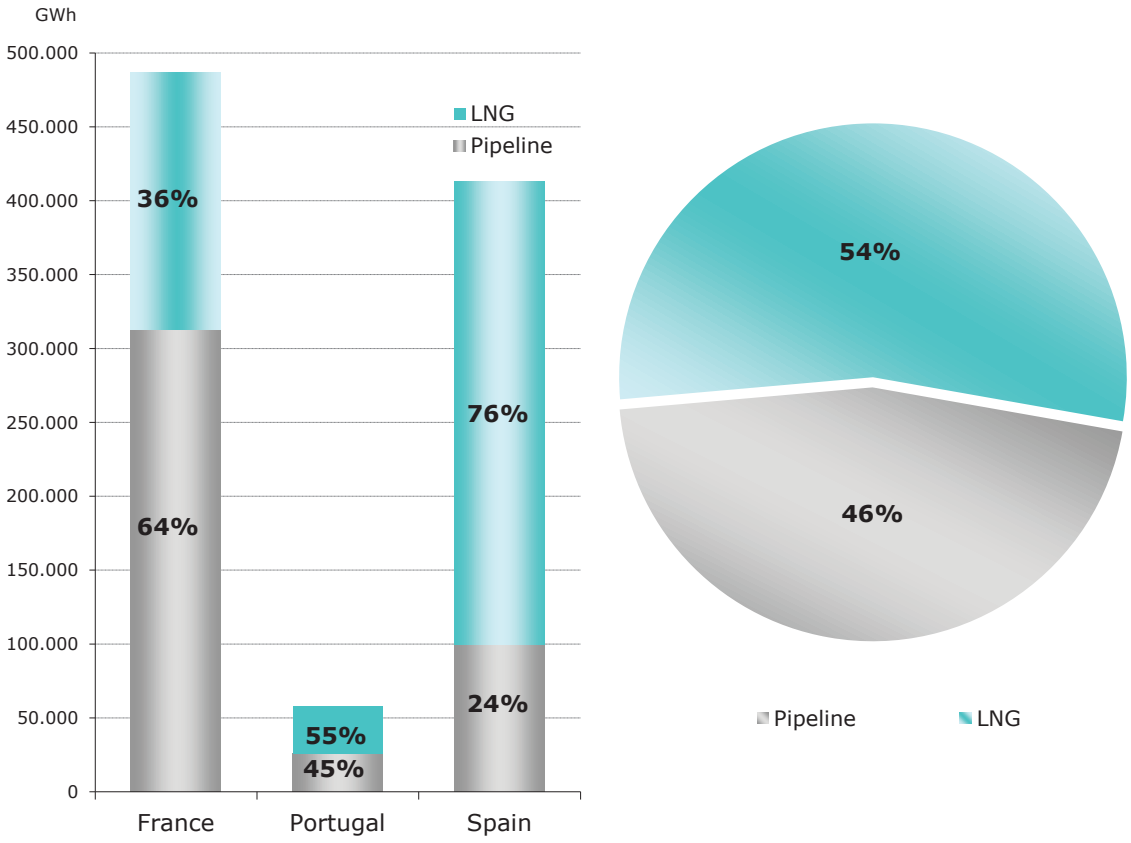


FIGURE 3 - 2: PERCENTAGES OF LNG AND NG IN FRANCE, PORTUGAL AND SPAIN (LEFT) AND IN THE SOUTH REGION (RIGHT)

The South Region is characterized by a highly diversified supply portfolio with imports from over 14 different origins. The diversification of supply differs from one country to another and between pipeline and LNG entries.

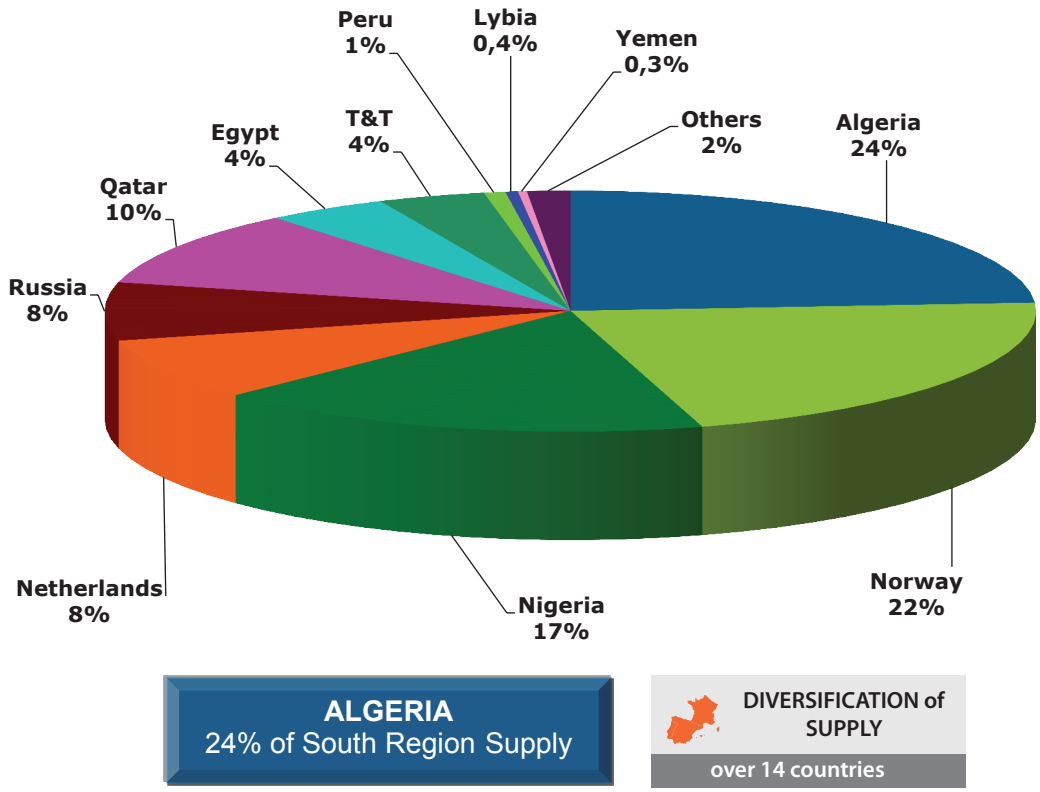


FIGURE 3 - 3: ORIGIN OF THE SUPPLY TO THE SOUTH REGION IN 2010

Pipeline Imports

Four different origins compose the pipeline gas import portfolio: Norway (41%), Algeria (24%), Netherlands (18%) and Russia (17%).

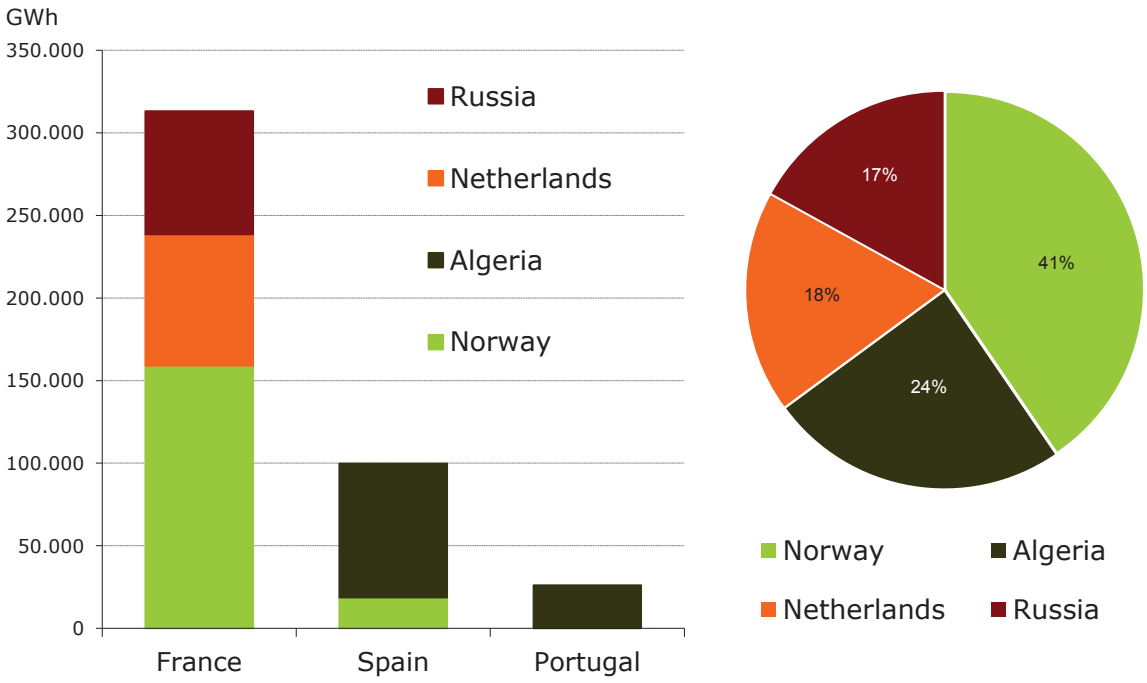
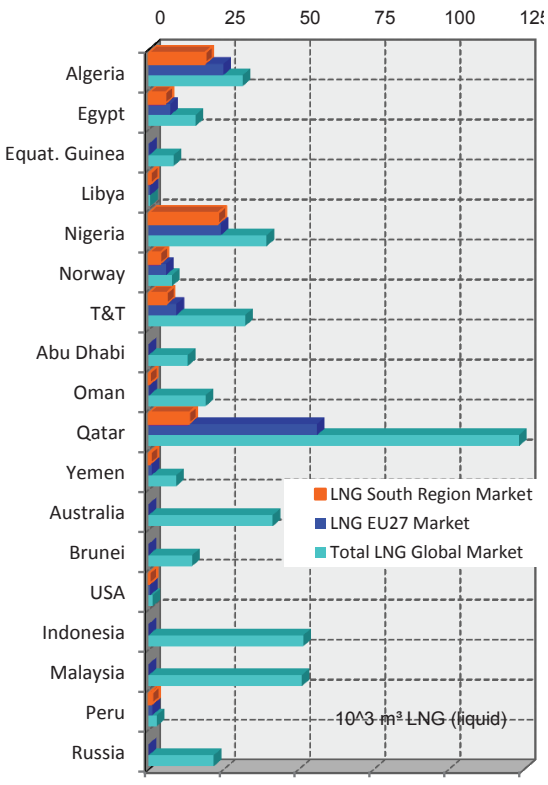


FIGURE 3 - 4: THE ORIGINS OF THE GAS IMPORTED BY PIPELINE TO THE SOUTH REGION

The LNG Market in the South Region [2]

In 2010, the world LNG trade accounted 483,1 Mm^3 (in liquid form), of which 131 Mm^3 (in liquid form), i.e., 27%, was destined to the EU27. The South Region received more than 55% of the total LNG destined to Europe, with Spain in the first place in the ranking, receiving 35% of the total LNG destined to Europe.

FIGURE 3 - 5 shows the percentages of LNG imported by source, making a comparison among the Global LNG Market, the European LNG Market and stressing the South Region Market role in the LNG global business.



SOURCES OF IMPORTS		% LNG Global Market	% EU27 on LNG Global Market	% South Region on LNG Global Market
Atlanntic Basin	Algeria	6%	5%	4%
	Egypt	3%	1%	1%
	Equat. Guinea	2%	0%	0%
	Libya	0%	0%	0%
	Nigeria	8%	5%	5%
	Norway	2%	1%	1%
	T&T	7%	2%	1%
Middle East	Abu Dhabi	3%	0%	0%
	Oman	4%	0%	0%
	Qatar	**26%**	**12%**	3%
	Yemen	2%	0%	0%
Pacific Basin	Australia	9%	0%	0%
	Brunei	3%	0%	0%
	USA	0%	0%	0%
	Indonesia	**11%**	0%	0%
	Malaysia	**11%**	0%	0%
	Peru	1%	0%	0%
	Russia	4%	0%	0%
			27%	**15%**

FIGURE 3 - 5: THE PERCENTAGES OF LNG IMPORTED BY SOURCE, FOR THE GLOBAL LNG MARKET, FOR THE EU27 AND FOR THE SOUTH REGION

[2] Based on information included on the report "The LNG Industry 2010" GIIGNL

15% of LNG traded during 2010 was destined to the South Region; **FIGURE 3 - 6** indicates its distribution by country:

	FRANCE	PORTUGAL	SPAIN
% South Region on LNG Global Market	5%	1%	9%

FIGURE 3 - 6: DISTRIBUTION BY COUNTRY OF LNG TRADED DURING 2010 IN THE SOUTH REGION.

From the point of view of the origin basin to highlight that the majority of the LNG received in the South Region came from the Atlantic Basic:

- 43 % of the Total Export from Atlantic Basin was destined to the South Region
- 9 % of the Total Export from Middle East was destined to the South Region

From the country perspective:

	FRANCE	PORTUGAL	SPAIN
Atlantic Basin	82%	97%	76%
Middle East	18%	3%	22%
Pacific Basin			3%

FIGURE 3 - 7: PERCENTAGES OF THE ATLANTIC BASIN, MIDDLE EAST BASIN AND PACIFIC BASIN IN THE LNG SUPPLY OF EACH COUNTRY OF THE SOUTH REGION

The LNG market has experienced big changes in recent years, trending towards increasing flexibility:

- the globalization allows finding alternatives sources and cargoes,
- rerouting LNG ships between LNG Terminals,
- the short-term and spot market has increasing and it is possible to access to multiple sources of supply.

An indicator of that new flexibility is the increase of LNG traded no linked to Long Term contracts. Spot and short-term imports (defined as contracts with duration of 4 years or less) recorded a very strong increase, (+40.0%, compared with 2009) and up to 91.3 Mm^3 in liquid form. The rise of spot and short-term operations was particularly significant in Europe (+50.9%), due to the attractiveness of their LNG prices compared to long-term prices and to the availability of uncommitted LNG supply from the Middle East.

type of contract	World	EU27	South Region
Long Term	81%	80%	83%
Short Term /Spot	19%	20%	17%

FIGURE 3 - 8: PERCENTAGES OF SHORT AND LONG TERM CONTRACT IN THE WORLD, IN EU27 AND IN THE SOUTH REGION

Although the Short Term and/or Spot percentage in the South Region is lower than the global and European values, analysing the South Region in detail, we can observe different levels of Short Term and/or Spot contracts depending on the country, with values varying from 19% in Spain to 8% in Portugal.

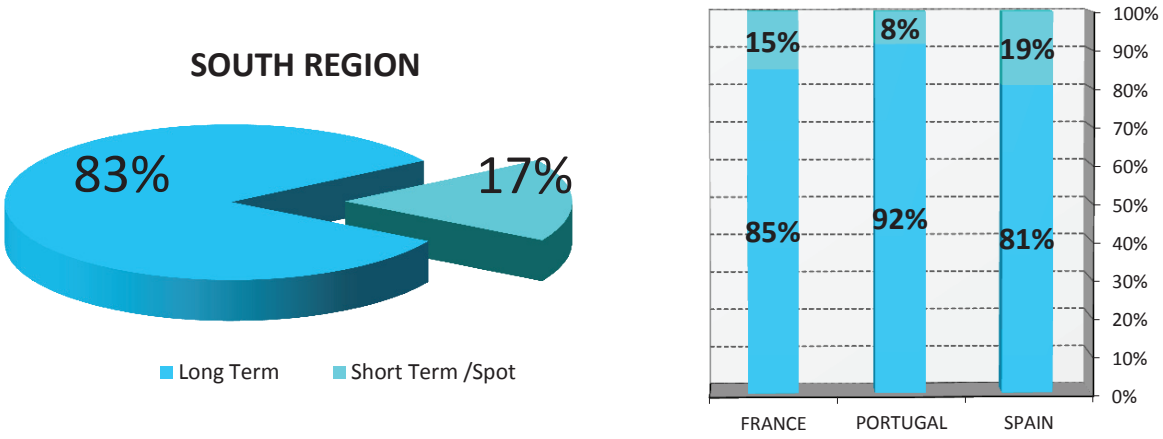


FIGURE 3 - 9: DISTRIBUTION OF THE SHORT AND LONG TERM CONTRACT, FOR THE OVERALL SOUTH REGION (LEFT) AND FOR EACH COUNTRY (FRANCE, PORTUGAL, AND SPAIN) (RIGHT).

The LNG business is a way to increase the diversification of supply sources. **FIGURE 3 - 10** shows the high level of diversification reached in the South Region in 2010: LNG tankers came from 12 different countries.

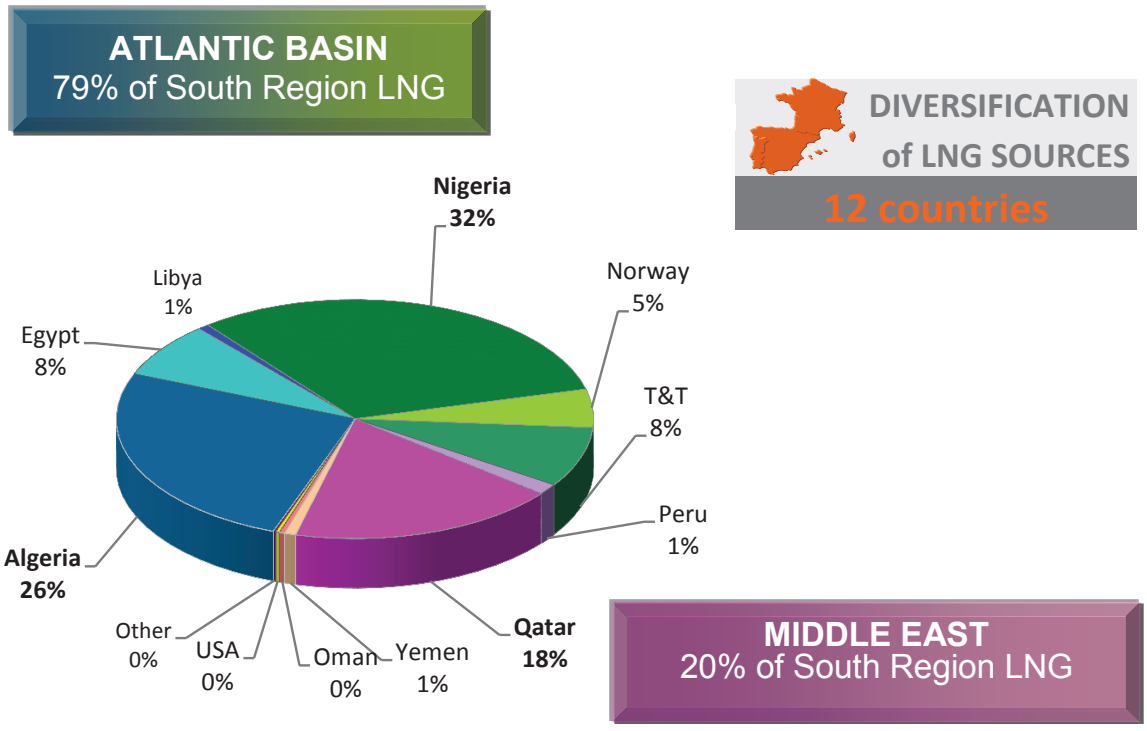


FIGURE 3 - 10: ORIGIN OF LNG IMPORTS IN THE SOUTH REGION IN 2010

Analysing the diversification of LNG sources by country, the Spanish LNG Terminals received supplies from 12 countries, followed by French LNG Terminals that received LNG from 7 different countries. We also note that in addition to the usual LNG cargoes from Nigeria, the LNG Terminal in Portugal received some spot cargoes from a different origin.

FIGURE 3 - 11 also highlights that the Spanish LNG market represented 62% of the total LNG market in the South Region, followed by France with 31% and 6% in Portugal.

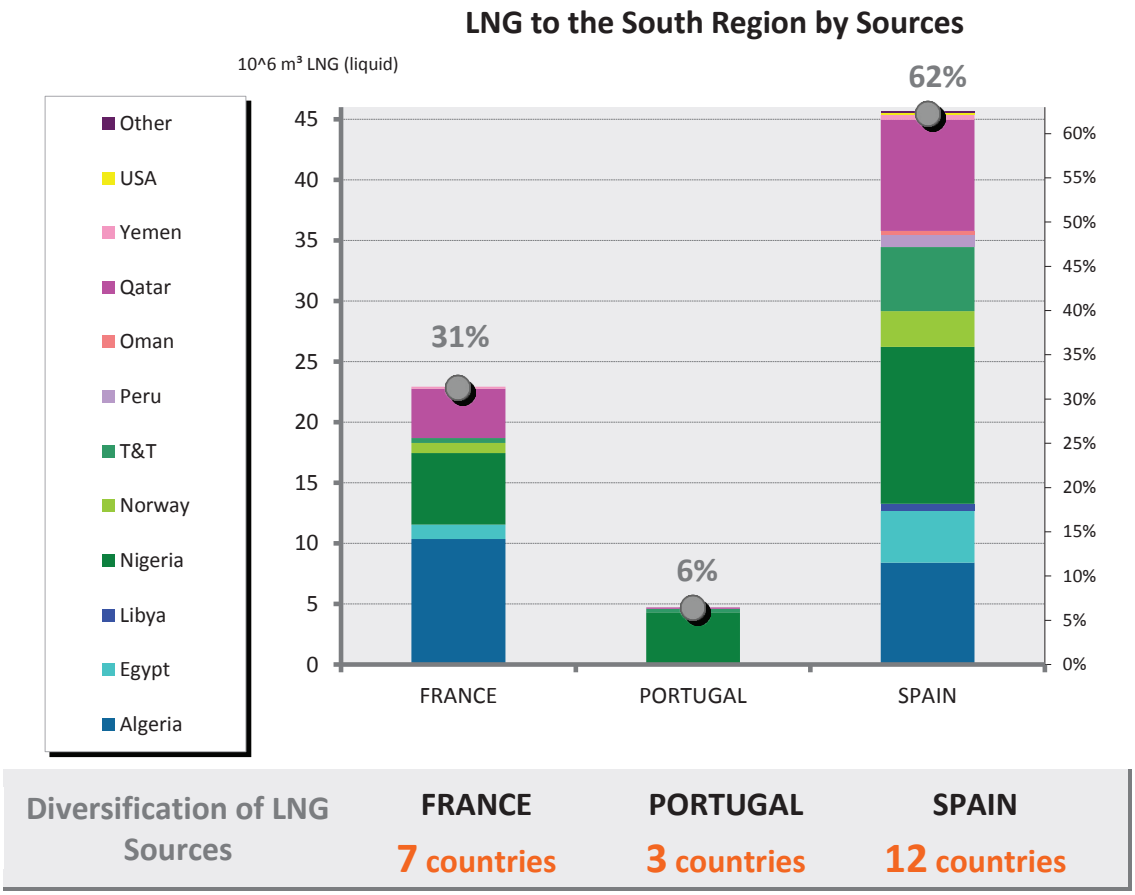


FIGURE 3 - 11: PERCENTAGES OF LNG ORIGIN FOR EACH COUNTRY IN THE SOUTH REGION

Key conclusions on Regional Overview of the Supply

As key conclusions, we must highlight:

- The South Region is highly **dependent on natural gas imports.**
- From a global point of view, **54%** of natural gas imports in the South Region has been delivered as liquefied natural gas **(LNG)**. This figure is not homogeneously distributed among the three countries of the South Region, representing more than 75% in Spain and 36% in France .
- The South Region is characterized by a **highly diversified supply portfolio** with imports from over **14 different origins**.

4. DEMAND

© Image courtesy of Enagás

4.1 Regional overview : South Region

In 2010[3] , the primary energy consumption in the South Region was 429 MTOE (Million Tonnes of Oil Equivalent), 18% of it was Natural gas (78 MTOE), being the third energy source after Oil (40%) and Nuclear (26%).

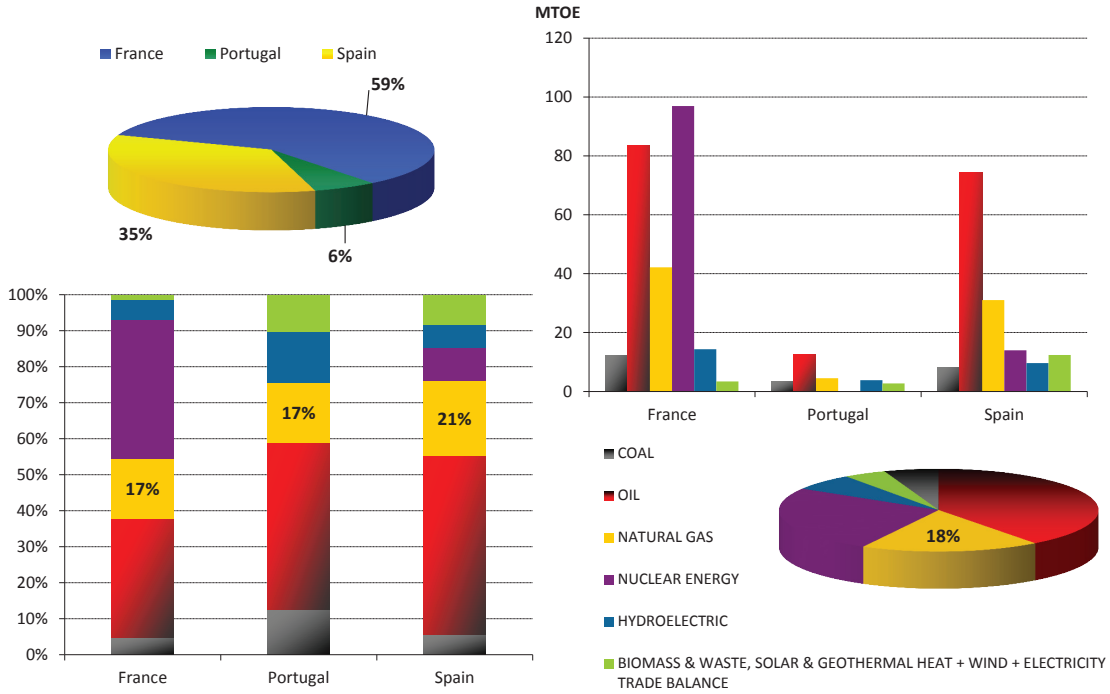


FIGURE 4 - 1: PRIMARY GAS CONSUMPTION IN THE SOUTH REGION

The highest natural gas demand in Europe is in the UK, followed by Italy, Germany and France in the 4th position. In 2010 Spain occupied the 6th position in the ranking while Portugal was the 15th as shown in **FIGURE 4 -2**. The annual gas demand is highly dependent on the population size, the industrial intensity, the power generation mix and the access to cheap supplies.

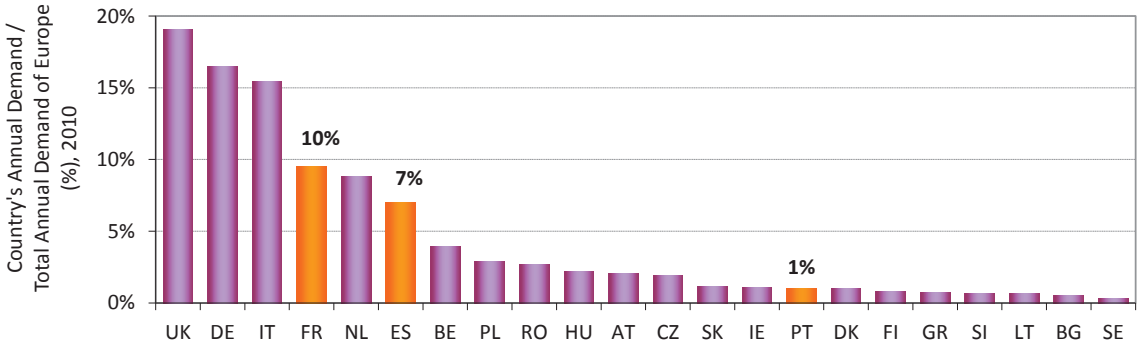


FIGURE 4 - 2: EUROPEAN GAS DEMAND BY COUNTRY

[3] BP Statistical Review of World Energy, June 2011

The annual demand in the South Region represents approximately 18% of the total gas demand in Europe, where France accounts for 10%, Spain 7% and Portugal the remaining 1%.

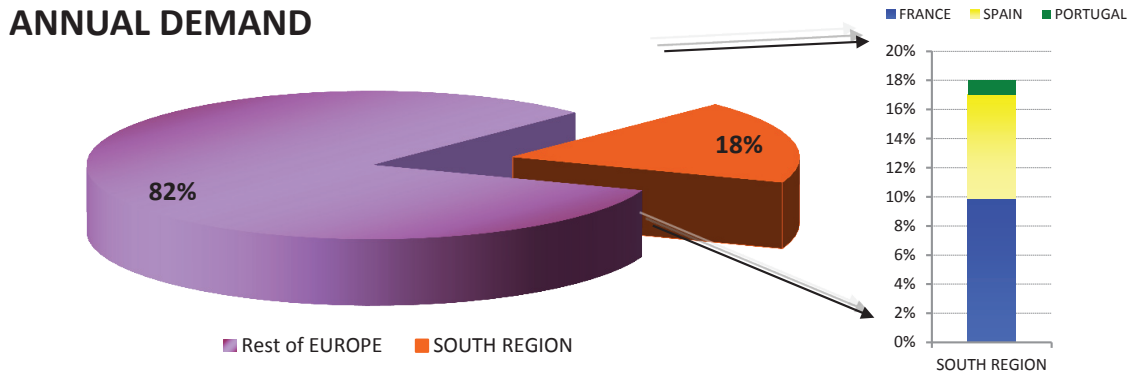


FIGURE 4 - 3: ANNUAL DEMAND IN EUROPE

Focusing in the South Region, the French gas market represents close to 55% of the total gas market, followed by Spain at 40%.

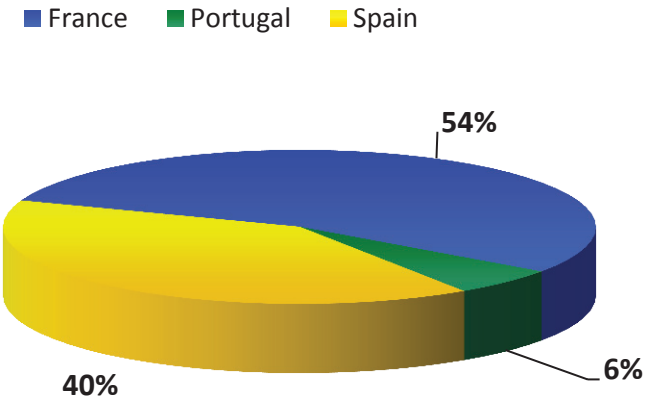


FIGURE 4 - 4: ANNUAL DEMAND IN THE SOUTH REGION

FIGURE 4 - 5 summarizes the annual gas demand per capita for Europe by country in the South Region.

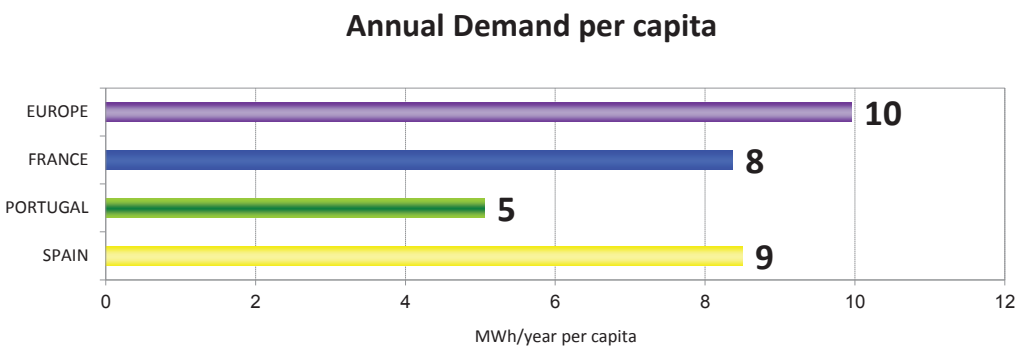


FIGURE 4 - 5: ANNUAL DEMAND PER CAPITA IN EUROPE, SPAIN, PORTUGAL AND FRANCE (IN MWH/YEAR PER CAPITA)

The natural gas demand is divided into two sectors:

- The demand of the conventional sector (Residential-commercial and industrial sector, where natural gas is used in production processes, including cogeneration), and
- The demand for power generation.

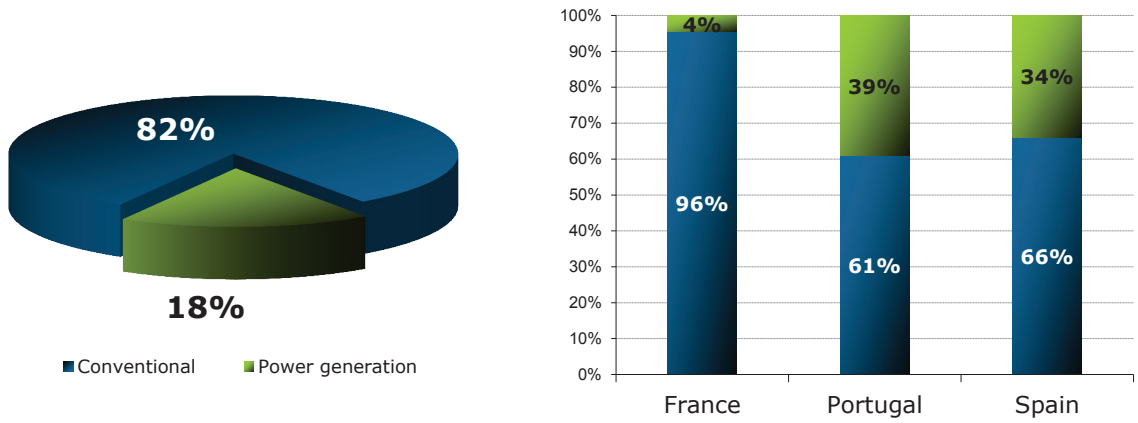


FIGURE 4 - 6: PERCENTAGE OF DEMAND FOR THE CONVENTIONAL SECTOR AND FOR POWER GENERATION, IN THE SOUTH REGION (LEFT) AND FOR EACH COUNTRY IN THE SOUTH REGION (RIGHT).

The relevance of gas demand for power generation is strongly dependant on the role played by natural gas in the electricity mix, not only being determined by the share of CCGT's on installed power but also by the proportion of renewable energies (mainly wind energy), which are intermittent.

FIGURE 4 – 7 shows the installed power capacity followed by **FIGURE 4 – 8** showing the annual net production in the South Region. We can observe that there are huge differences between countries in the South Region both in installed power capacity and annual power net production.

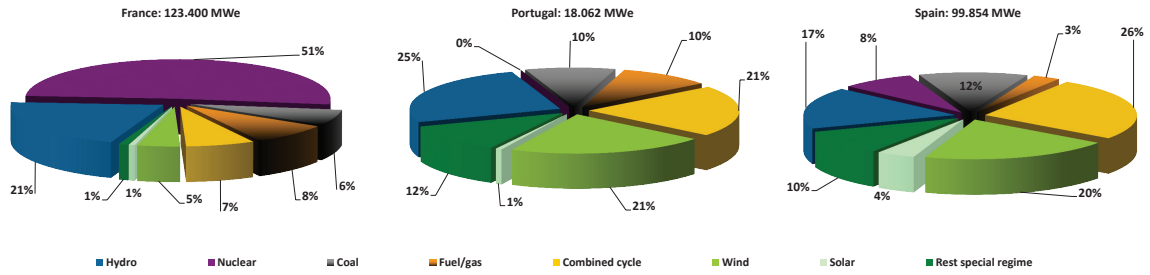


FIGURE 4 - 7: INSTALLED POWER CAPACITY (31ST DECEMBER 2010) IN FRANCE, PORTUGAL AND SPAIN

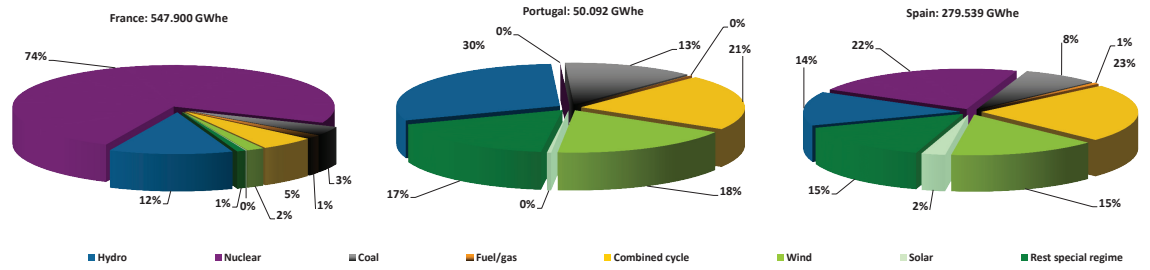


FIGURE 4 - 8: ANNUAL POWER NET PRODUCTION 2010 IN FRANCE, PORTUGAL AND SPAIN

Gas demand varies over time, through years, seasons, weeks, and at different times of the day. The demand fluctuations can be categorised by the period over which the variation in supply is required – that is, seasonal, weekly, daily and hourly. These different kinds of demand modulation are a consequence of the composition of the energy market.

The following graph, **FIGURE 4 -9**, shows the daily demand of the South Region during the year 2010. The modulation that the gas demand showed throughout the year is highly dependent on the gas demand composition, but not only due to the distinction between conventional demand of gas and gas demand for power generation, but also due to the different shares of residential-commercial demand and industrial uses in the conventional demand.

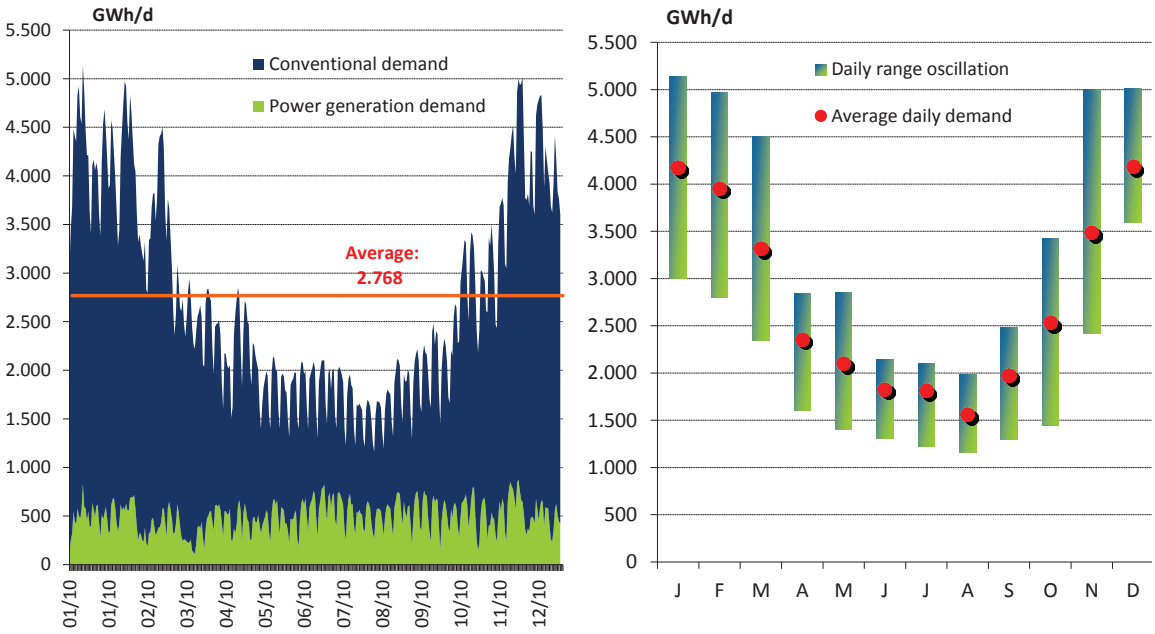


FIGURE 4 - 9 DEMAND MODULATION IN THE SOUTH REGION: SEASONAL MODULATION AND DAILY OSCILLATIONS (2010)

As shown in the followings graphs, there are huge differences between the demand behaviour through the year for these three countries. In order to compare the profiles of each one, the following graph **(FIGURE 4 -10)** shows the ratio "daily demand over annual demand" (in percentages) for each country.

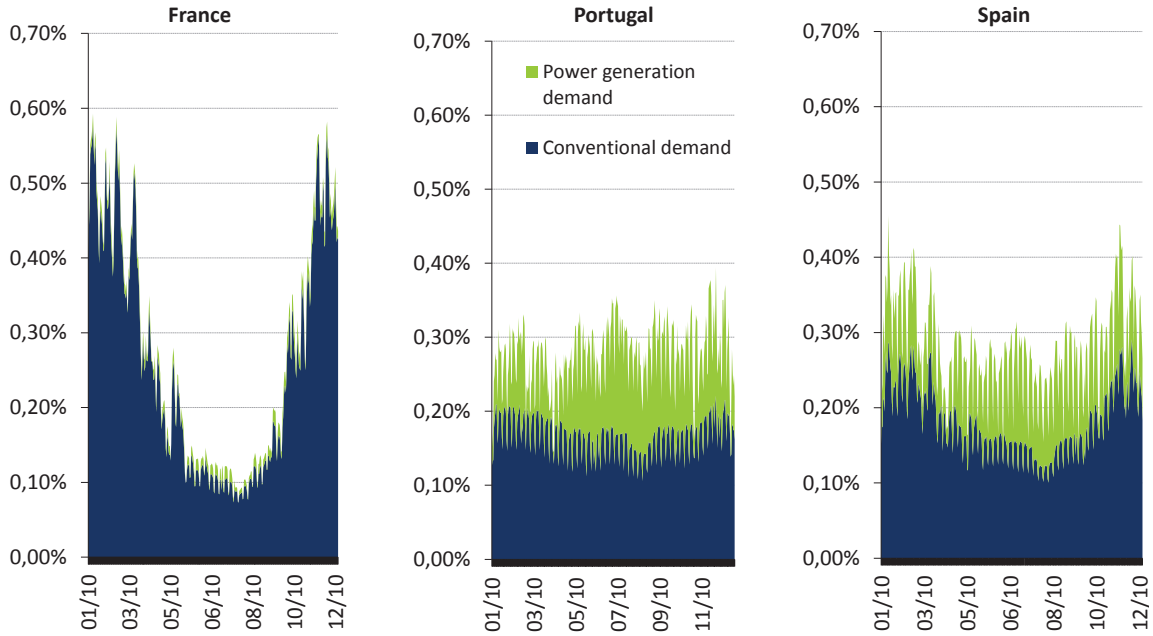


FIGURE 4 - 10 RATIO (DAILY GAS DEMAND / TOTAL ANNUAL GAS DEMAND) FOR CONVENTIONAL AND POWER GENERATION GAS DEMAND, IN FRANCE, PORTUGAL AND SPAIN (2010)

As there is no relationship between the seasonal behaviour of the two demand sectors considered, conventional demand and power generation demand modulation are analysed separately.

The conventional demand has a stressed seasonal profile. In the following graph, we can observe a stressed seasonal elasticity, i.e., a big difference between the maximum conventional demand and the minimum conventional demand. **FIGURE 4-11** shows the modulation of conventional demand through the year in the South Region:

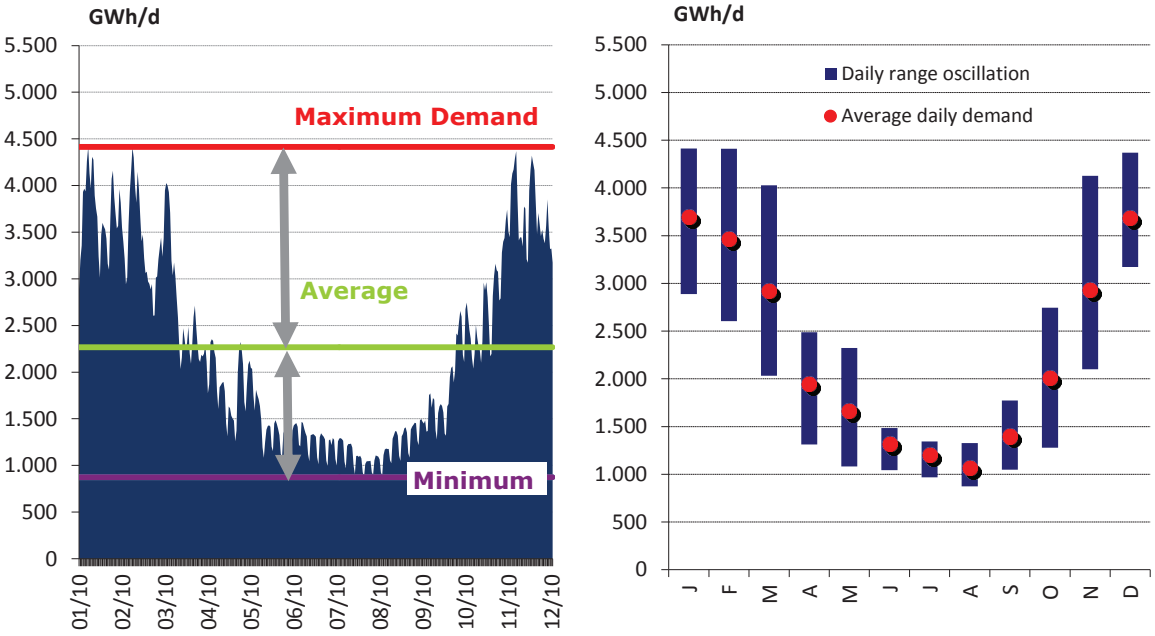


FIGURE 4 - 11 CONVENTIONAL DEMAND MODULATION IN THE SOUTH REGION: SEASONAL MODULATION AND DAILY OSCILLATION (2010)

FIGURE 4 - 12 shows the modulation of the conventional demand of gas in the countries of the South Region and highlights the stressed seasonal modulation of the conventional gas demand in France, due to a high share of residential consumption. Spain and Portugal have less seasonality during the year.

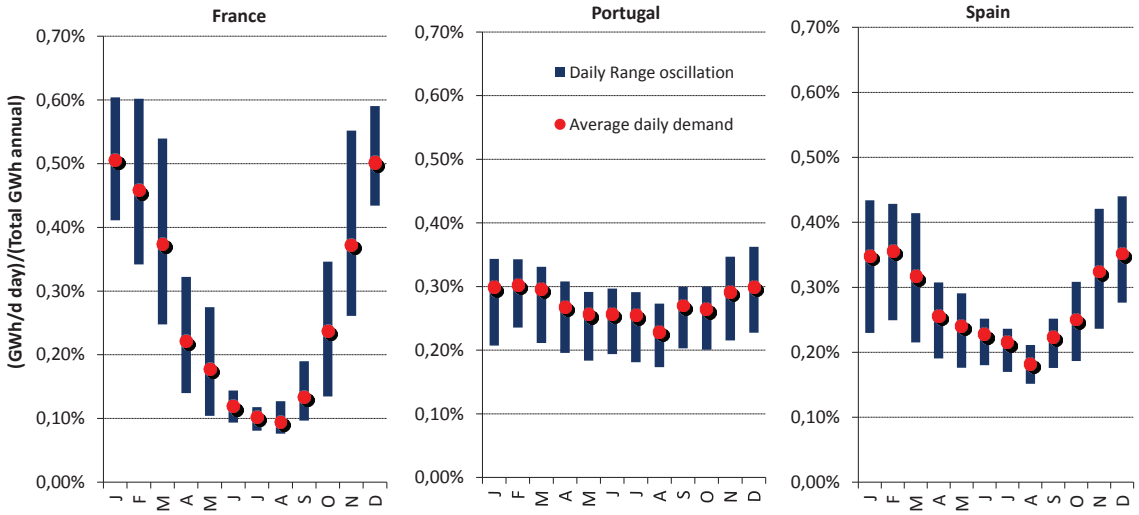


FIGURE 4 - 12 RATIO (DAILY GAS DEMAND / TOTAL ANNUAL GAS DEMAND) FOR CONVENTIONAL DEMAND IN FRANCE, PORTUGAL AND SPAIN (2010)

It is very different to analyse the patterns of gas demanded for power generation. **FIGURE 4-13** shows the daily modulation of the gas demand for power generation in the South Region during 2010.

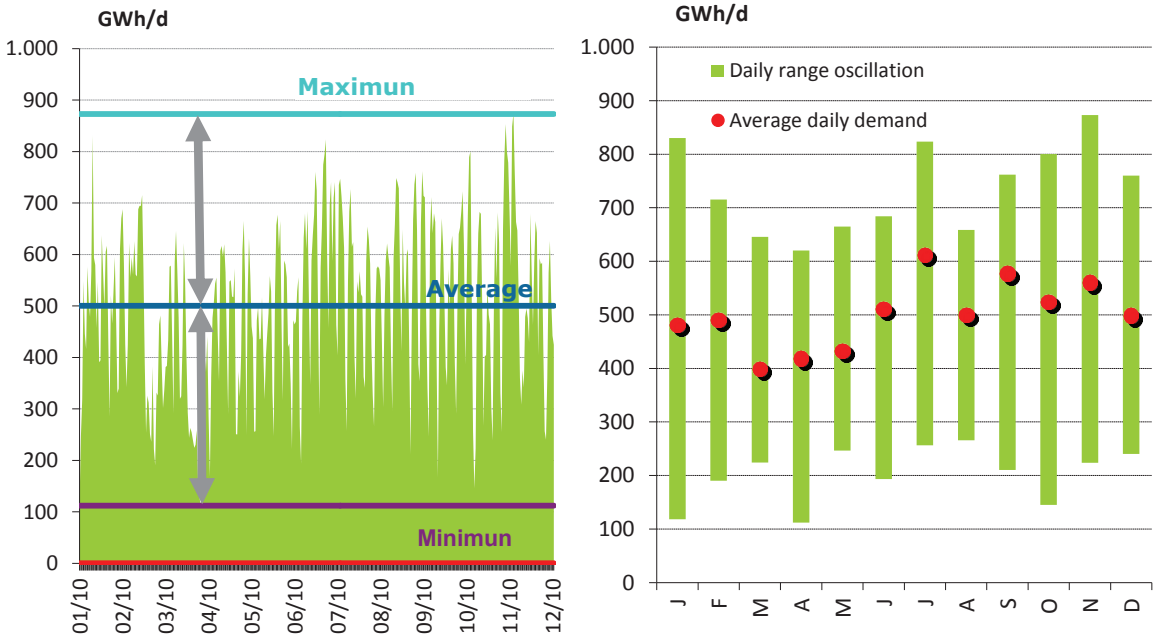


FIGURE 4 - 13 POWER GENERATION DEMAND MODULATION IN THE SOUTH REGION: SEASONAL MODULATION AND DAILY OSCILLATIONS (2010)

We can observe that the gas demand for power generation does not follow a yearly defined pattern, as it depends not only on the electricity demand, but also on the contribution of renewable technologies to the electricity generation mix.

Once more, we can observe, in **FIGURE 4 - 14**, the different role played by gas for power generation in each country in the South Region.

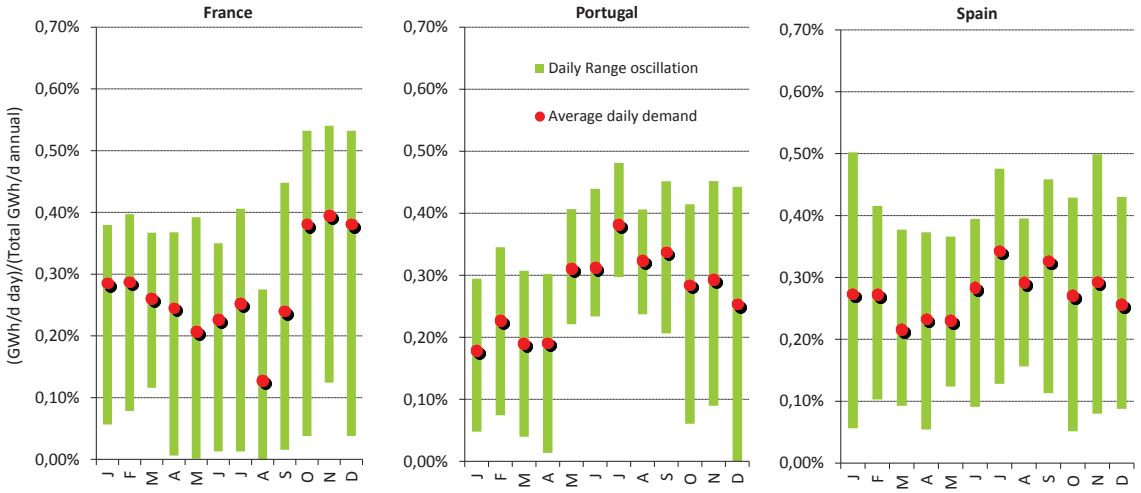


FIGURE 4 - 14 RATIO (DAILY GAS DEMAND / TOTAL ANNUAL GAS DEMAND) FOR POWER GENERATION GAS DEMAND IN FRANCE, PORTUGAL AND SPAIN (2010)

Figure 4 - 15 summarizes the main parameters describing daily demand oscillation in the South Region and in each country of the South Region.

		GWh/d		Daily Range Oscillation			Peak CCGT simultaneity*
		Average daily demand	% of the Total demand	Upper	Under	Total	
South Region Aggregation	2010 Total demand	2.768		86%	-58%	144%	95%
	Conventional demand	2.268	82%	95%	-61%	156%	
	Gas for power generation	500	18%	74%	-78%	152%	
France	2010 Total demand	1.514		116%	-73%	190%	64%
	Conventional demand	1.446	96%	121%	-72%	193%	
	Gas for power generation	68	4%	97%	-100%	197%	
Portugal	2010 Total demand	157		44%	-49%	93%	92%
	Conventional demand	95	61%	32%	-37%	69%	
	Gas for power generation	61	39%	76%	-100%	175%	
Spain	2010 Total demand	1.098		66%	-44%	111%	100%
	Conventional demand	726	66%	61%	-45%	105%	
	Gas for power generation	372	34%	83%	-81%	164%	

* Peak CCGT simultaneity means the share of consumption of CCGTs during the peak day of the gas system in relation with their maximum consumption.

FIGURE 4 - 15 DAILY DEMAND OSCILLATION IN 2010

To Highlight:

- **The demand for power generation in the South Region, which represented 18%** of the total demand in an "average day", being used in Spain and Portugal more than the 30 % of the total demand, for power generation whereas France only 4% of the gas was used for it.

- It is important to note the level of **simultaneous** consumption for **gas-fired for power generation** during the days of peak demand for the total system, reaching more than **90 %** in countries that have a high share of CCGTs.

In addition to replacing coal fired power plants reducing CO_2 emissions, the combined cycle gas turbines (CCGT) are playing an important role as a support in the development of renewable energy production. Intermittency and unpredictability of renewable energy sources like wind and solar require a flexible back-up. The combined cycle gas turbines (CCGT) can provide efficient flexibility and therefore makes the CCGT as an enabler to introduce the development of renewable energies.

The "annual load factor" is another parameter used to describe the demand modulation. It is defined as the relation between daily peak demand and average gas demand. **FIGURE 4 - 16** shows the current load factor values for each country in the South Region.

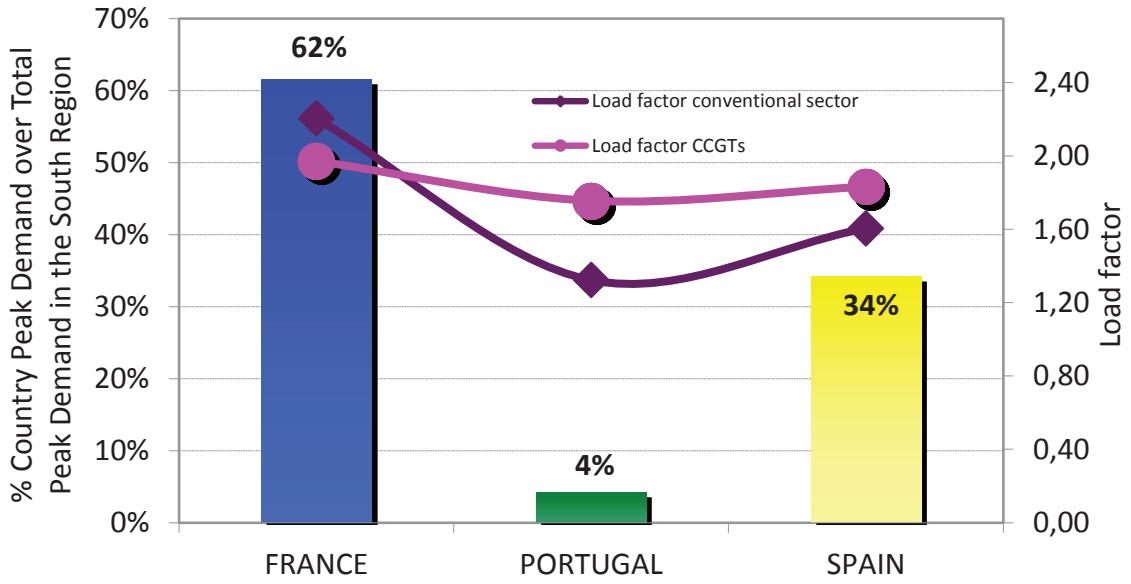


FIGURE 4 - 16 SHARE OF PEAK DEMAND AND LOAD FACTOR

In 2010 the load factor for the conventional demand in the South Region was 1.95, while the load factor for each country varied between [1.32; 2.21]. The gas demand for power generation in the South Region had a load factor of 1.74, while the load factor in the countries in the South Region varied between [1.76; 1.97].

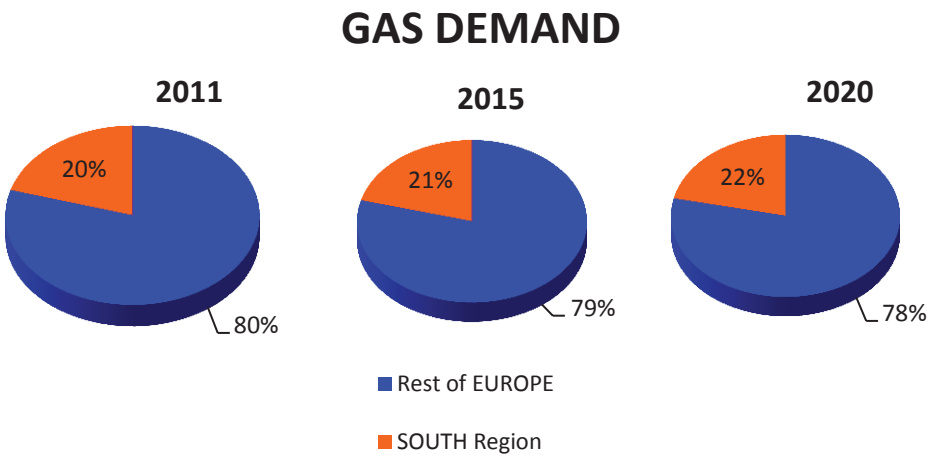
Key conclusions on Regional Overview of the Demand

As key conclusions, we must highlight the different behaviours of gas demand in each country of the South Region:

- Both seasonal and daily gas demand modulation show strong differences among the three gas systems.
- The **conventional demand** presents a **stressed seasonal modulation in France**, whereas **in Portugal and Spain the seasonal modulation is less**.
- **The role of gas for power generation is different in each country**, which represents more than 30% of the daily average demand in Spain and Portugal, and only 4% in France.
- **The gas demand for combined cycle gas turbines has an important variation in the load factor** associated to the intermittency of the renewable energy sources. As a consequence, **gas fired power plants require a high level of flexibility from the gas system**.

4.2 10-Year Demand in the South Region [4]

The gas demand in the South Region achieves more than 20% of the total gas demand of Europe.



Source: TYNDP 2011-2020 and own elaboration

FIGURE 4 - 17 GAS DEMAND IN EUROPE

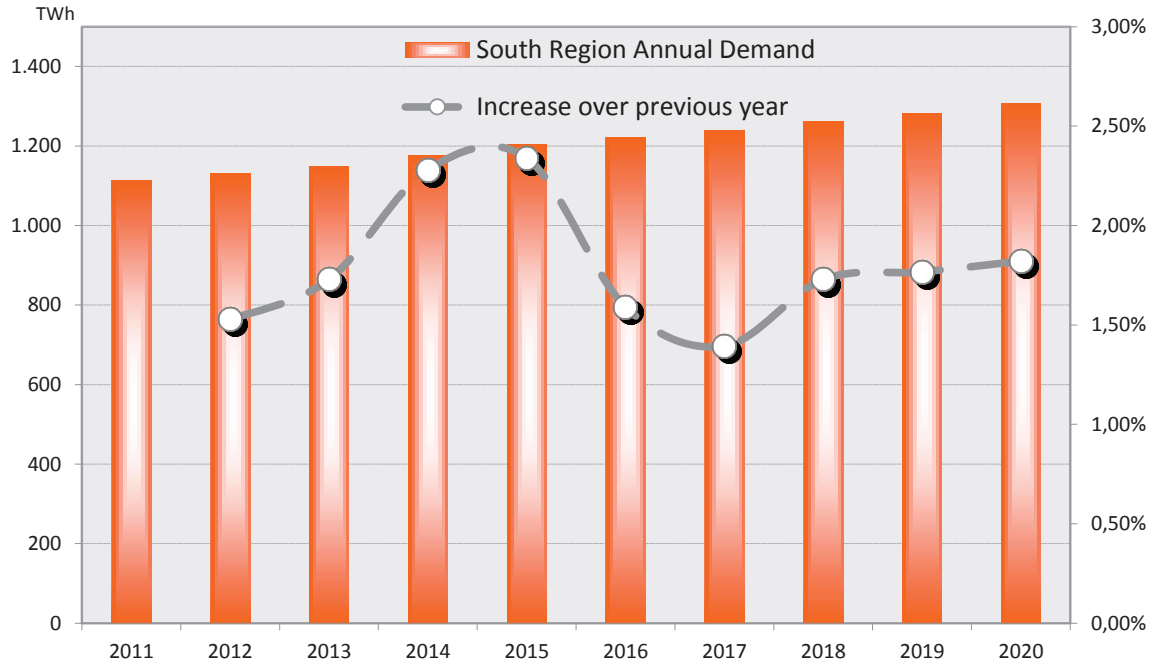
Natural gas in the South Region is used mainly for residential and commercial heating, industrial processes and electricity generation. Its advantages include competitive pricing, constant availability, flexibility of use and environmental benefits. Particularly with regard to electricity production, the power plants using combined-cycle gas technology (CCGT) are relatively inexpensive and quick to build, have lower CO2 emissions than oil or coal-fired power plants (approximately -30% and -50%, respectively), and due to their responsiveness and flexibility, provide an appropriate addition to solar and wind power generation, which by nature are both unpredictable and irregular.

The need to increase electricity production capacity will offer considerable prospects for growth with regards to the demand for gas. The gas demand in the South Region is essentially driven by electricity production. In addition to the rest of the advantages previously highlighted, natural gas ensures a continuous supply of electricity. The conjunction Gas System & CCGTs represent a good backup to the development of electricity production from renewable energies, where output is very intermittent.

As a consequence of the economic crisis, natural gas consumption in the South Region fell in 2009 in comparison with the previous year. However, during 2010, there has been a recovery of the gas consumption mainly due to the coldest winter experienced in the Region.

[4] Source of data: ENTSOG TYNDP 2011-2020

In **FIGURE 4-18** we can see the evolution of the gas demand in the South Region. Projections by 2020, adjusted to take into account the reduced consumption during the crisis, state an average annual growth of approximately +1.80% in the Region during the period between 2011 and 2020, while for the rest of Europe will only achieve 1.05%.



Source: TYNDP 2011-2020 and own elaboration

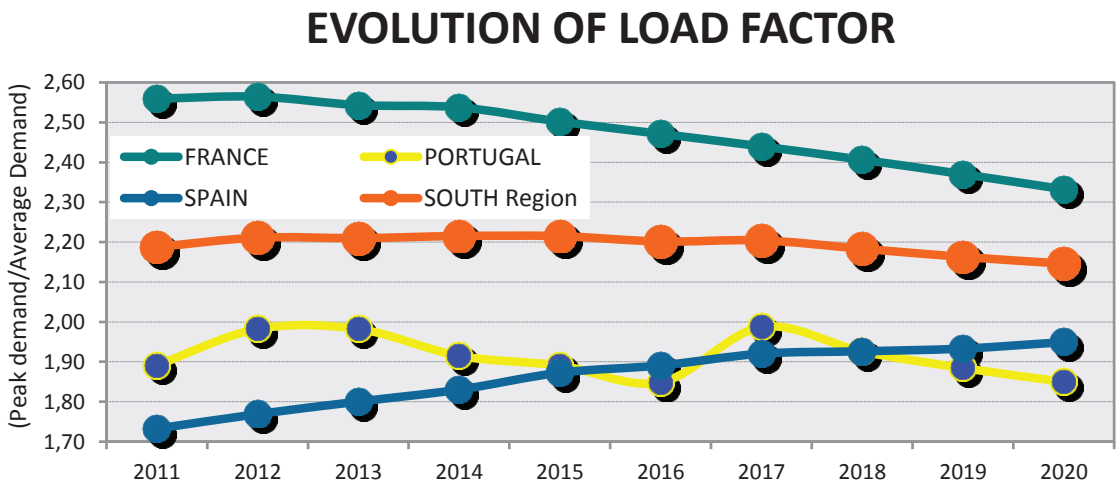
FIGURE 4 - 18 EVOLUTION OF GAS DEMAND IN THE SOUTH REGION

FIGURE 4-19 shows the evolution of the load factor in the Region, i.e., the relation between peak demand and average demand.

The estimated load factor increases in Portugal and Spain due to the increase of residential and commercial sector and the installation of CCGTs which will have a big variability in the gas demand, functioning as a back-up to renewable energy sources. This circumstance implies that higher flexibility in the Gas System will be needed in the future.

In France, the demand of the residential and commercial sector will slightly decrease, due to the results of the environmental regulations (building isolations, etc.), and the industrial sector will greatly increase, due to the power generation development (with projects of combined gas cycle turbine power plants, CCGTs). The load factor of the residential and commercial sector is far higher than the load factor of the industrial sector and, consequently, the global evolution of the load factor is a decrease.

We can observe in **FIGURE 4-19** that the Regional load factor remains stable. This fact indicates the positive synergies that would result from increasing interconnection capacity in the Region, helping to optimize the use of entry facilities and providing flexibility to the Gas System.



Source: TYNDP 2011-2020 and own elaboration

FIGURE 4 - 19 EVOLUTION OF THE REGIONAL LOAD FACTOR IN THE SOUTH REGION

5. Instrument of Flexibility: UGS and LNG Terminals

© Image courtesy of Enagás

The gas demand in the South Region is covered by Import Pipelines, UGSs, LNG terminals and EU-IPs.

In **FIGURE 5 - 1** we can see the importance of the LNG Send-Out over the total entries to the South Region: the LNG Send-Out, on an annual average, represents 45% of the total entries to the South Region, whereas the addition of shares of the Import Pipelines (Import pipelines and EU-IP) only represents the 41 %.

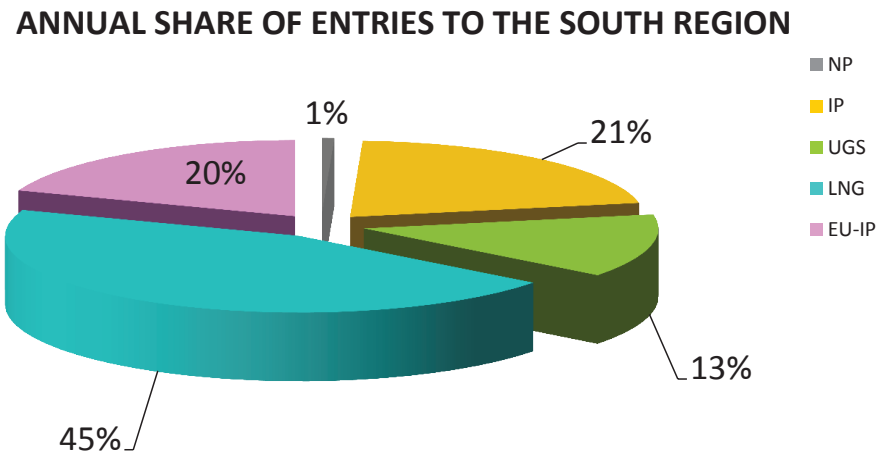


FIGURE 5 - 1 ANNUAL SHARE OF EACH ENTRY TO THE TOTAL ENTRIES TO THE SOUTH REGION

FIGURE 5 - 2 shows the different contributions of each entry with regard to the South Region's total annual entries, in order to know the importance of each entry. In the y-axis (left) the daily quantity for each entry (in GWh/d) is plotted, whereas the y-axis (right) reflects the daily share of each entry with regard to the total annual entries.

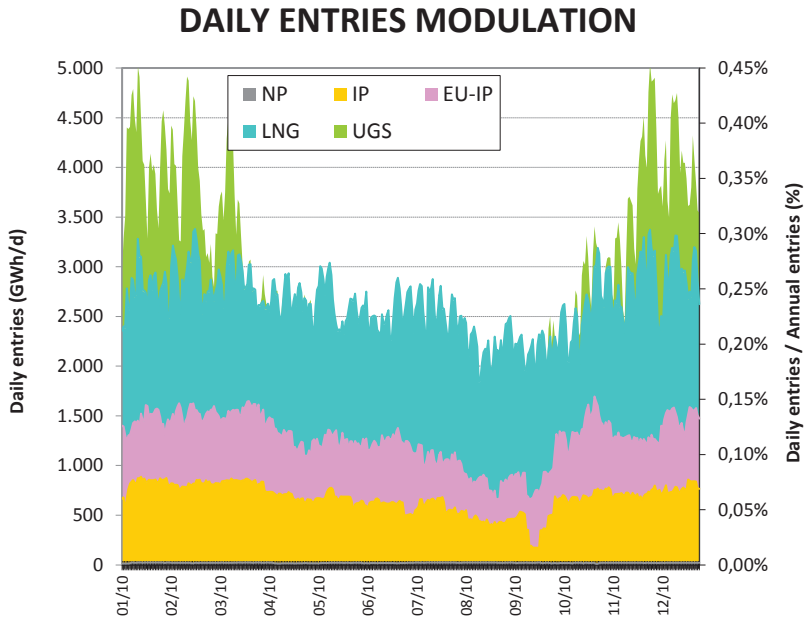


FIGURE 5 - 2 CONTRIBUTION OF EACH ENTRY TO THE SOUTH REGION'S OVER TOTAL ENTRIES

Analysing this graph, we can conclude that:

- The Import Pipelines entries (both IP and EU-IP) are stable throughout the year[5].
- The withdrawal from UGSs is used to cover the modulation of the demand.
- LNG's and withdrawal UGS' contributions to the demand are equivalent.

[5] The decrease at the end of September was due to maintenance work

In **FIGURE 5 -3** we can observe the different kinds of "entry profile" of LNG Terminals and UGS in the South Region during 2010.

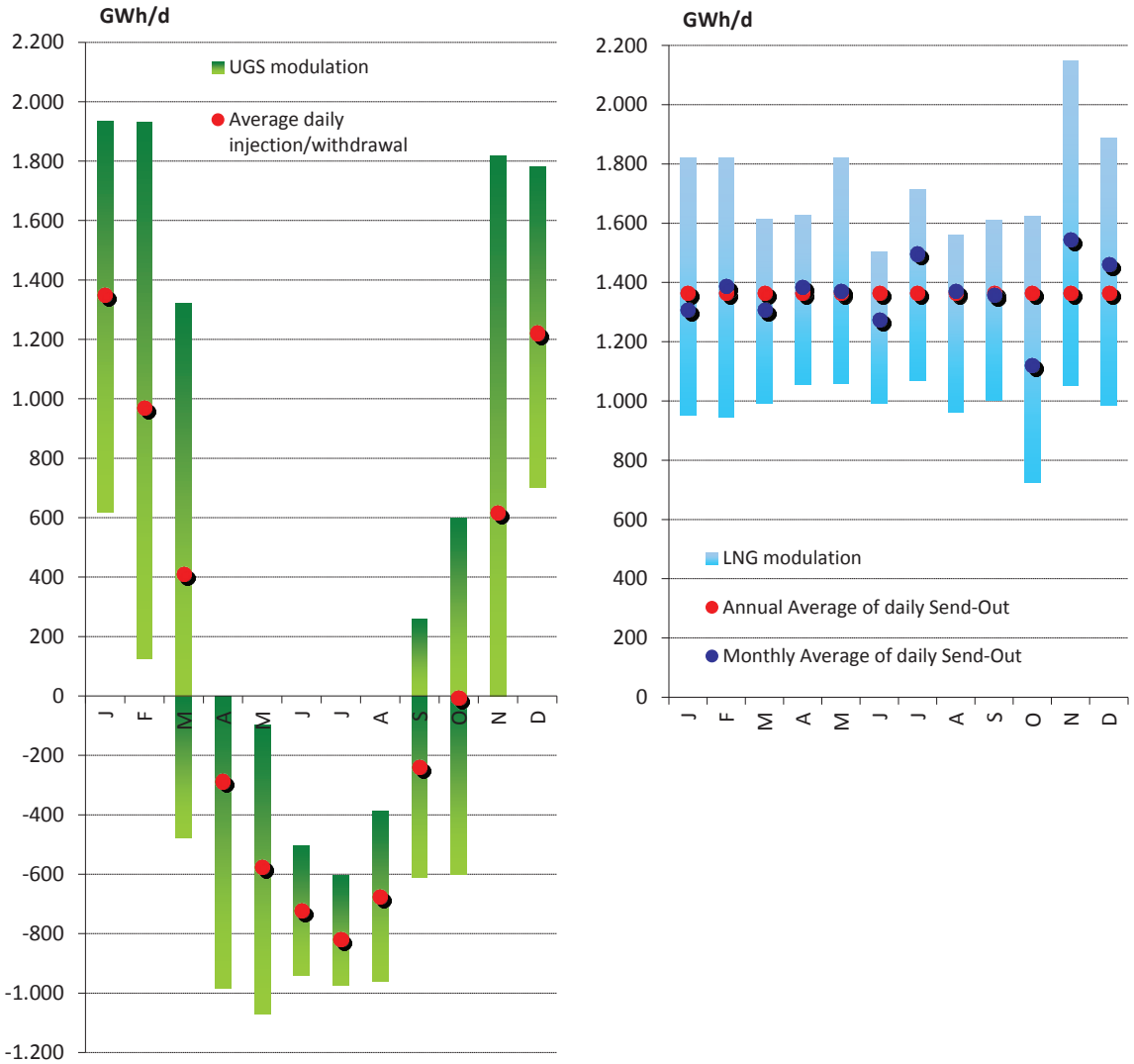


FIGURE 5 - 3 MODULATION OF LNG TERMINALS AND UGS IN THE SOUTH REGION (2010)

Key conclusions on Tools of Flexibility in the South Region

In summary we can conclude that:

- The main **instruments of flexibility from the gas system in the South Region are Underground Storages (UGS) and LNG Terminals**, each with their own specific characteristics, and both complementary to each other in covering the gas demand modulation. Daily and Intra-daily modulation is possible by means of LNG Terminals and UGS.

- It is important to note the role played by **these facilities providing flexibility** in order **to enable the *CCGT intermittent consumption*** due to renewable energies intermittency.

- The three gas systems in the Region show strong complementarities in terms of flexibility tools.

- Increase interconnection capacity will help to better cope with the flexibility needs in the South Region.

6. INTERCONNECTION PROJECTS

© Image courtesy of GRTgaz

6.1 Technical description: FRANCE-SPAIN

The Iberian-French Corridor is part of the North-South Corridor in Western Europe. Its purpose is to better interconnect the Mediterranean area and thus the supplies from Africa and the Northern Corridor with supplies from Norway and Russia.

The full development of the Iberian-French Corridor, creating reversible interconnection capacity between France and Spain, has been divided into two stages: Western Axis and Eastern Axis.

The Western Axis includes three sub-projects:

- **Larrau** and **Biriatou** between TIGF and Spain, and
- **Guyenne** between TIGF and GRTgaz,

and the Eastern Axis is composed by three sub-projects:

- **Le Perthus** sub-project between TIGF and Spain,
- **GRTgaz South-TIGF** sub-project
- **GRTgaz North-GRTgaz South** sub-project.

Except the Le Perthus sub-project, the rest of the sub-projects are not only dedicated to the France-Spain IP. They would also be triggered by capacity developments at Fos (LNG terminals), at Manosque (gas storage), and/or on the North-South link.

The achievement of the Iberian-French corridor is not only conditioned by the development of the infrastructures at the French-Spanish cross border. It also depends on other core system developments that are not exclusively linked to the interconnection project.

The **MAP 6-1** shows the infrastructures linked to the development of the Iberian-French Corridor.

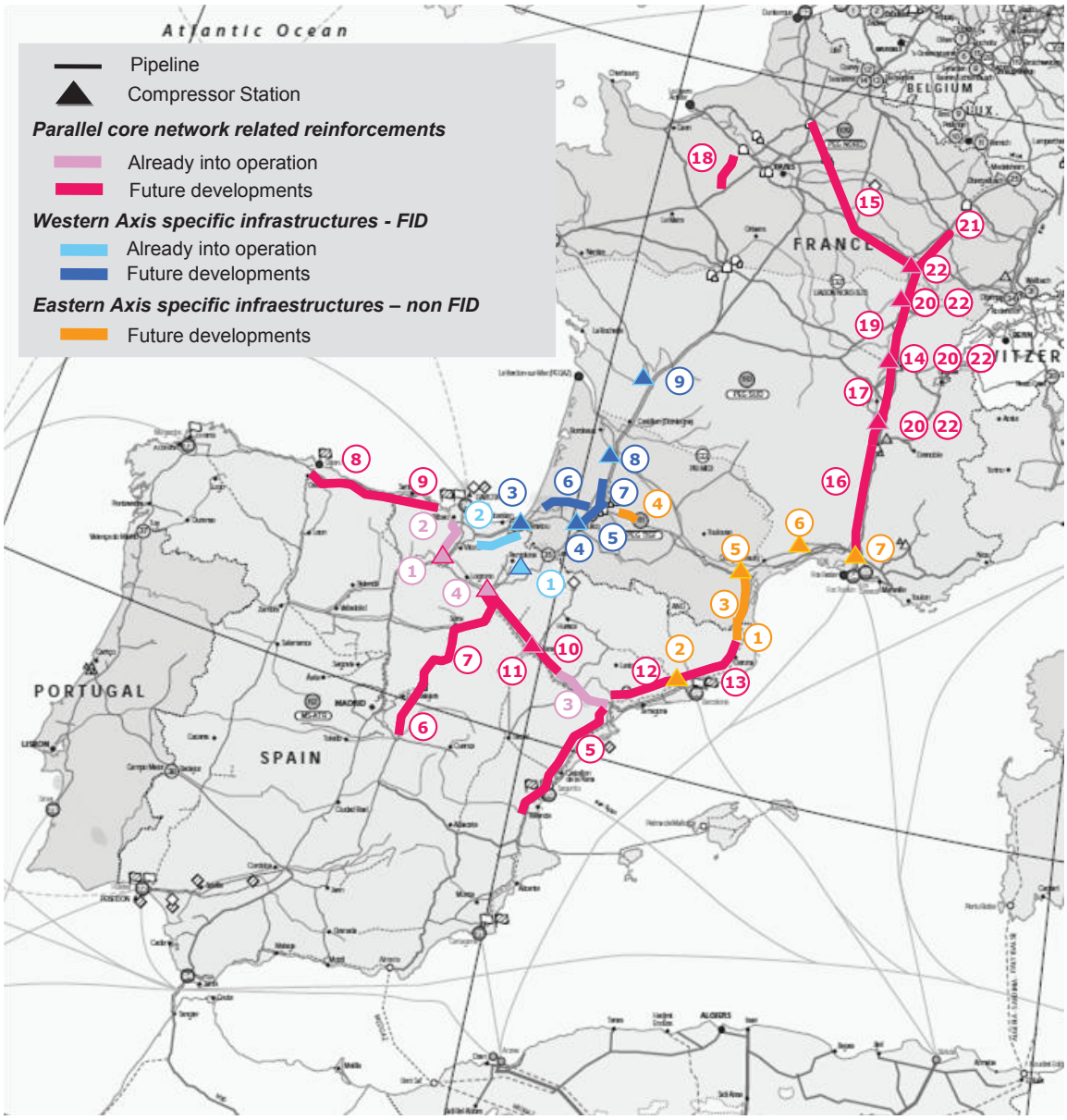


FIGURE 6 - 1 "MAP 6 - 1": THE INFRASTRUCTURES LINKED TO THE DEVELOPMENT OF THE IBERIAN-FRENCH CORRIDOR

The core network developments crucially affecting the interconnection capacity are summarized in **FIGURE 6-2**.

The GRTgaz core network developments linked to the Iberian-French Corridor are triggered by many projects of new capacities on IPs, LNG terminals and storage. The results are detailed in GRTgaz Ten Year Development Plan (published in October 2011)[6] .

Likewise, the Spanish core network infrastructures have additional functionalities providing the integration of the planning entry points into the Gas System[7] .

	Infrastructure	Main characteristics	Project status	Expected date of commisioning
Infrastructures in SPAIN				
1	CS Haro Reinforcement	23 MW (total)	In Operation	3Q/2009
2	Pipeline Lemona-Haro	92 km, 26"	In Operation	3Q/2009
3	Pipeline Tivissa-Casstelnou (loop)	92 km, 26"	In Operation	4Q/2009
4	CS Villar de Arnedo	36 MW	In Operation	1Q/2011
5	Pipeline Tivissa-Paterna (loop)	231 km, 40"	Authorized for starting construction	2Q/2012
6	Pipeline Zarza de Tajo-Yela	106 km, 30"	Pending on environmental assessment	3Q/2012
7	Pipeline Yela-Villar de Arnedo	251 km, 30"	Authorized for starting construction	4Q/2012
8	Pipeline Treto-Llanera	220 km, 26"	Pending on administrative procedures	4Q/2013
9	Pipeline Bilbao-Treto	45 km, 26" / 8 km, 12"	Pending on authorization for starting construction	4Q/2012
10	Pipeline Villar de Arnedo-Castelnou (loop)	200 km, 26"	Pending on adminsitrative procedures	4Q/2014
11	CS Zaragoza Reinforcement	18 MW	Pending on adminsitrative procedures	4Q/2014
12	New pipeline Tivissa-Arbos	115 km, 30"	Pending on adminsitrative procedures	4Q/2014
13	Pipeline Martorell-Figueras	164 km, 36"	Pending on environmental assessment	3Q/2013
Infrastructures in FRANCE				
14	CS Etrez	18 MW	FID	4Q/2013
15	ARC de DIERREY Project Cuvilly-Dierrey-Voisines	310 km, 48"	FID (expected in 2011)	2015
16	ERIDAN Project or Artère du Rhône Pipeline St Martin-St. Avit	220 km, 48"	FID	2016
17	EST LYONNAIS Project St Avit - Etrez	140 km 42"/48" (1)	Non-FID	2017 (1)
18	Pipeline "Artère de Beauce" (end of looping)	63 km, 36"	Non-FID	2017 (1)
19	Etrez - Palleau (partial looping Artère de Bourgogne)	80 km 42"/48" (1)	Non-FID	2018 (1)
20	Upgrades (1) CS Saint Avit, Etrez and Palleau	(1)	Non-FID	2018 (1)
21	Pipeline Morelmaison - Palleau	190 km, 42-48" (1)	Non-FID	2019/2020 (1)
22	Upgrades (1) CS Saint Avit, Etrez, Palleau and Voisines	(1)	Non-FID	2019/2020 (1)

(1) Depending on the level and the planning of the developments identified

FIGURE 6 - 2 LIST OF THE CORE NETWORK DEVELOPMENTS AFFECTING THE INTERCONNECTION CAPACITY

[6] See summary in Annex "1"

[7] See summary in Annex "1"

6.1.1 Western Axis between France and Spain (FID)

The Western Axis includes three sub-projects:

- Larrau – between France and Spain
- Biriatou – between France and Spain
- Guyenne – between TIGF and GRTgaz

The full corridor got the final investment decision after the Open Season processes carried out in July-November 2009 and in May-July 2010.

6.1.1.1 Larrau

The infrastructures of the Larrau Interconnection point were initially designed to allow flows in the France to Spain direction for the capacity associated with a long term supply contract of Norwegian gas. This supply contract started in 1993 and since then no significant new cross-border capacity had been developed between France and Spain until 2009.

According to the Spanish Mandatory Planning 2002-2011, a Compressor Station was built in Navarra (intermediate point at Lacal pipeline) in order to increase the interconnection capacity between France and Spain. This new Compressor Station in Navarra is in operation since 2Q-2009, but due to a lack of parallel developments in the French side, the increase of capacity was limited to flows from France to Spain reaching a total capacity of 100 GWh/d. The reinforcements in the French network increasing the interconnection capacity up to 165 GWh/d in both directions, were decided through the Open Season process carried out in July-November 2009.

The Larrau project (Gas Interconnection Western Axis Larrau Branch), with its specific actions Pipeline Tivissa-Castelnou (loop), Pipeline Tivissa-Paterna (loop), and Pipeline Yela-Villar de Arnedo, was selected for the European Energy Programme for Recovery, and granted with 45 M€.

6.1.1.2 Biriatou

The infrastructures of the Biriatou Interconnection point were initially designed to cover local consumptions in the border area. After the Open Season process carried out in May-July 2010, the necessary reinforcements in the French network enabling the development of interconnection capacity and the reversibility of flows, were decided. This unlocked the authorization of a Compressor Station at the border, which was included in the Spanish Mandatory Planning 2008-2016 conditioned to the development of the infrastructures in the French side of the interconnection[8].

6.1.1.3 Guyenne

The Guyenne sub-project includes the development of the existing interconnection point between GRTGaz South and TIGF at Castillon-la-Bataille. The development of these investments in the French network leads to the creation of real gas corridors between the gas from/to the Iberian Peninsula and the central European markets.

[8] There is an option to increase the capacity of this Interconnection Point up to 120 GWh/day (both senses of flow). This possibility is still under study.

The **FIGURE 6-3** shows the list of specific infrastructures directly linked to the development of the Western Axis.

	Infrastructure	Main characteristics	Project status	Expected date of commisioning	Sub-project
Infrastructures in SPAIN					
1	CS Navarra	37 MW	In Operation	2Q/2009	Larrau
2	Pipeline Vergara-Irún (loop)	90 km, 26"	In Operation	3Q/2010	Biriatou
3	CS Border (Irún)	NA	Pending on Administrative procedures	NA	Biriatou
Infrastructures in FRANCE					
4	Reversibilité LACAL CS Mont adjustments		FID - On schedule	4Q/2012	Larrau
5	Artère du BÉARN Pipeline Lussagnet - Lacq	57 km, 32"	FID - On schedule	4Q/2012	Larrau
6	EUSKADOUR Pipeline Arcangues-Coudures	96 km, 24"	FID - On schedule	4Q/2015	Biriatou
7	GIRLAND canalisation Pipeline Lussagnet - Captieux	60 km, 36"	FID - On schedule	3Q/2013	Guyenne
8	GIRLAND compression CS Sauveterre	8 MW	Non-FID (*)	2015/2016	Guyenne
9	CS Chazelles	26 MW	FID - On schedule	2Q/2013	Guyenne

(*) This additional compression capacity is not required for the provision of the FT service

FIGURE 6 - 3 LIST OF THE INFRASTRUCTURES LINKED WITH THE DEVELOPMENT OF THE WESTERN AXIS

The development of these infrastructures will lead to the interconnection capacities shown in **FIGURE 6-4**.

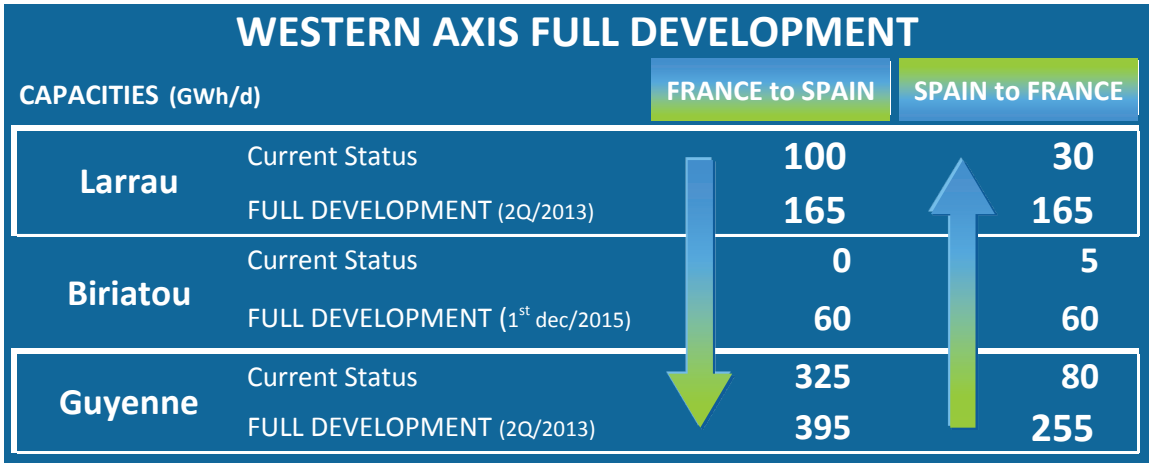


FIGURE 6 - 4 INTERCONNECTION CAPACITIES BETWEEN FRANCE AND SPAIN AFTER THE DEVELOPMENT OF THE WESTERN AXIS

In **FIGURE 6-4** we can observe that the full development of the Western Axis creates a bidirectional gas flow between France and Spain. We highlight that the reversibility of flow in the IPs Larrau and Biriatou achieves 100%.

6.1.2 Eastern Axis between France and Spain: MidCat Project (Non-FID)

The MidCat Project involves the development of a full corridor (Eastern) between Spain and the North of France, by the association of a new interconnection point (Le Perthus sub-project), the GRTgaz South-TIGF subproject and the expansion of the interconnection capacity between GRTgaz North and GRTgaz South (GRTgaz North-GRTgaz South subproject). The MidCat project was offered to the market in the Open Season carried out in May-July 2010, but the capacity products required by the market were not enough to validate the economic tests. Anyway, due to the fact some long term capacity demand was not allocated and the benefits provided in terms of market integration, diversification of sources and routes and security of supply, the project has not been discarded waiting a better investment climate.

The GRTgaz South-TIGF sub-project includes the infrastructures that provide gas flow from France to Spain. It would be developed in phases adjusting the capacity generated to the requirements of the market. Under these considerations, **FIGURE 6-5** shows the list of specific infrastructures directly linked with the intermediate development of the Eastern Axis (Le Perthus and GRTgaz South-TIGF sub-project)[9] .

Infrastructure	Main characteristics	Expected date of commisioning	Sub-project
Infrastructures in **SPAIN**			
1 Pipeline Figueras-French Border	36 km, 36"(1)		Le Perthus
2 CS Martorell	36 MW		Le Perthus
Infrastructures in **FRANCE**			
3 Pipeline Spanish Border-Barbaira	120 km, 32"(1)		Le Perthus
4 Pipeline Lupiac-Barran	28 km, 32"		Le Perthus
5 CS Barbaira	10 MW		Le Perthus
6 CS Montpellier	15/20 MW(2)	2020	GRTgaz South-TIGF subproject
7 CS Saint Martin de Crau	10 MW	2020	GRTgaz South-TIGF subproject

(1) The diameter of the interconnection will be concreted by TSOs' joint studies.
(2) CS design have to be specified by detaliled studies.

FIGURE 6 - 5 LIST OF THE INFRASTRUCTURES DIRECTLY LINKED TO THE DEVELOPMENT OF THE EASTERN AXIS

[9] This report is not focused on the expansion of the GRTgaz North-GRTgaz South link, which solutions are detailed in the GRTgaz Ten Year Development Plan (October 2011

The development of these infrastructures (including the rest in the core of the network) would lead to new capacities in the Eastern Axis (Le Perthus IP) showed in the **Figure 6-6**[10].

However the amount of capacity created was estimated in 2009. These figures need to be updated to take into account different evolutions foreseen in the French market.

FIGURE 6 - 6 EASTERN AXIS DEVELOPMENT

The planned infrastructures related to the development of the Eastern Axis reaches a reversible gas flow between France and Spain.

The new axis capacity will represent around 40% of the total interconnection capacity between France and Spain.

The Iberian-French Corridor creates a new route of gas flow. The creation of new interconnection capacity in both flow directions will bring the Spanish and French gas markets closer, making possible the development of large scale energy trade between countries. The availability of capacity in the cross borders in both directions of flow increases the competitiveness and liquidity of the gas markets providing equal opportunities for shippers in both markets and offering a high level of competition and cross-border gas trading, and contributing to the reduction of market concentration.

The lack of interconnection capacity has been identified as one of the main obstacles to create a Gas Regional Market in the South Region, especially between Spain and France. The existence of sufficient accessible interconnection capacity between countries is a prerequisite for a liquid market emergence. For this purpose it is necessary, both, to enhance investments in new interconnection capacity and to optimize the use of the existing interconnection facilities.

The development of Interconnection capacity in the Spain to France direction, increases the security and diversification of the supply level not only of the South Region, but also of the European gas market. This is due to the creation of a real transmission corridor enabling gas flows from the Iberian Peninsula to the North of France by network effect, connecting the central European markets with the Iberian LNG terminals and Algerian sources of supply.

[10] These figures correspond to the Intermediate development case of the 2010 Information Memorandum.

6.2 Technical description: PORTUGAL-SPAIN

The Gas Iberian Market (MIBGAS) development is one of the main priorities of the Spanish and Portuguese Governments in energy terms, and, in consequence, REN and ENAGAS have been entrusted with investment and reinforcement of their interconnections and storages.

Currently, there are two operative Interconnection Points between Portugal and Spain: Tuy/Valença do Minho and Badajoz/Campo Maior. The increasing interest that the market is showing on the Spain-Portugal transit is provoking that the interconnection capacity in the Spain to Portugal direction is close to saturation, especially at the Badajoz location.

6.2.1 Badajoz/Campo Maior

Maghreb-Europe pipeline delivers gas in Spain, in a terminal located in Zahara de los Atunes, Cádiz, which became operative in November 1996. The Al Andalus pipeline, followed by the Extremadura pipeline, transports a significant part of Spain and Portugal's natural gas supplies. The first interconnection point between the Spanish and Portuguese natural gas transport network, Badajoz/Campo Maior, became operative in 1996.

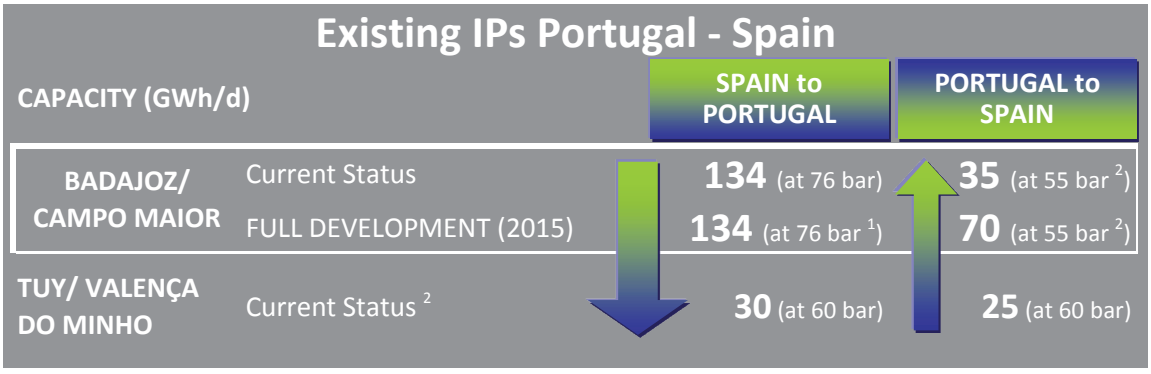
The capacity at this Interconnection Point is 134 GWh/d (at a pressure of 76 bar) from Spain to Portugal and 35 GWh/d –in winter- or 70 GWh/d –in summer- in the opposite direction (Portugal-Spain). Currently this capacity is completely booked and there is no additional capacity available. The reinforcements at the Carregado Compressor Station, will increase the interconnection capacity form Portugal to Spain up to 70 GWh/d in winter and 105 GWh/d in summer.

6.2.2 Tuy/Valença do Minho

The second interconnection point between Spain and Portugal is located in Tuy and it became operative in 1998. It was initially designed to cover local demand at the Spanish border coming from Badajoz/Campo Maior through the Portuguese network.

Currently, and after Mugardos LNG terminal start-up, this interconnection point is operated in both directions.

Current interconnection capacities are shown in **FIGURE 6-7**:



1) When delivery pressure at border is 80 bar, the max physical capacity is 128 GWh/d.
2) Winter capacities

FIGURE 6 - 7 CURRENT INTERCONNECTION CAPACITIES BETWEEN SPAIN AND PORTUGAL

6.2.3 3rd IP Portugal – Spain (Non-FID)

The creation of a new infrastructure interconnection between Spain and Portugal GN is part of the development of the **Iberian Gas Market (MIBGAS)** which, taking into account the important LNG regasification capacity in the Iberian Peninsula in the European and global context, aims to become a relevant market worldwide. In this context, the additional capacity in both directions provided by a new interconnection is an opportunity to promote energy exchange between the gas system in Portugal and Spain, contributing to a transparent and non-discriminatory market access by all stakeholders. As a driving force of these energy exchanges, a potential growth in the natural gas demand in both countries should be considered, as well as strong infrastructure developments to perform in both gas systems, and the planned developments for the generation of electricity in Portugal and Spain (with high component groups of combined cycle natural gas).

MAP 6-8 shows the infrastructures linked to the development of the 3rd IP Portugal-Spain:

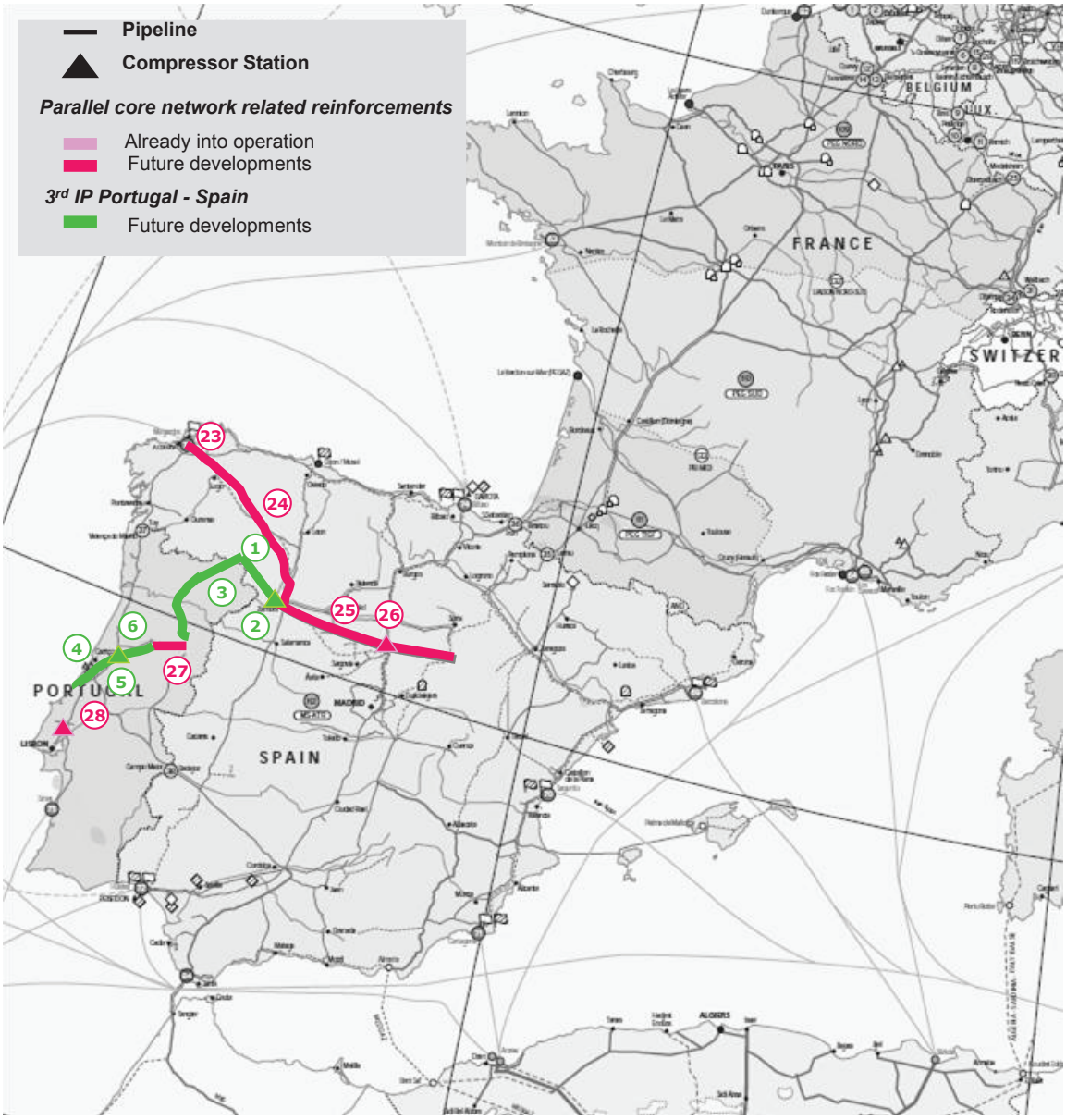


FIGURE 6 - 8 "MAP 6-8": THE INFRASTRUCTURES LINKED TO THE DEVELOPMENT OF THE 3RD IP PORTUGAL – SPAIN

There are some core network developments in both systems that are not exclusively linked to the interconnection points[11] but crucially affect the interconnection capacity offered. These core network developments are summarized in **TABLE 6-9**.

Infrastructure	Main characteristics	Project status
Infrastructures in SPAIN		
23 Guitiriz-Lugo	30 km, 30"	Pending environmental permiting
24 Lugo-Zamora	290 km, 30"	Non-FID
25 Zamora-La Barbolla-Adradas	270 km, 32"	Non-FID
26 CS La Barbolla	20 MW	Non-FID
Infrastructures in PORTUGAL		
27 Pipeline Mangualde - Celorico	48 km, 28"	FID
28 CS Carregado	14 MW	FID

FIGURE 6 - 9 "TABLE 6-9": THE CORE NETWORK DEVELOPMENT AFFECTING INTERCONNECTION CAPACITY

FIGURE 6-10 shows the list of specific infrastructures directly linked to the development of the 3rd IP Portugal-Spain.

Infrastructure	Main characteristics
Infrastructures in SPAIN	
1 Zamora- Portuguese Border	85 km, 28"
2 CS Zamora	34 MW
Infrastructures in PORTUGAL	
3 Pipeline Spanish Border-Celorico	158 km, 28"
4 Pipeline Carriço-Cantanhede	60 km, 28"
5 CS Cantanhede	10/12 MW
6 Loop Cantanhede-Mangualde	67 km, 28"

FIGURE 6 - 10 LIST OF THE INFRASTRUCTURES LINKED TO THE DEVELOPMENT OF THE 3RD IP PORTUGAL-SPAIN

The project consists of a new pipeline of approximately 370 km length, around 285 km in Portugal and 85 km in Spain, with a 28 " diameter and compression reinforcement in both countries.

[11] See summary in Annex "1"

The development of these infrastructures will lead to the following physical capacities:

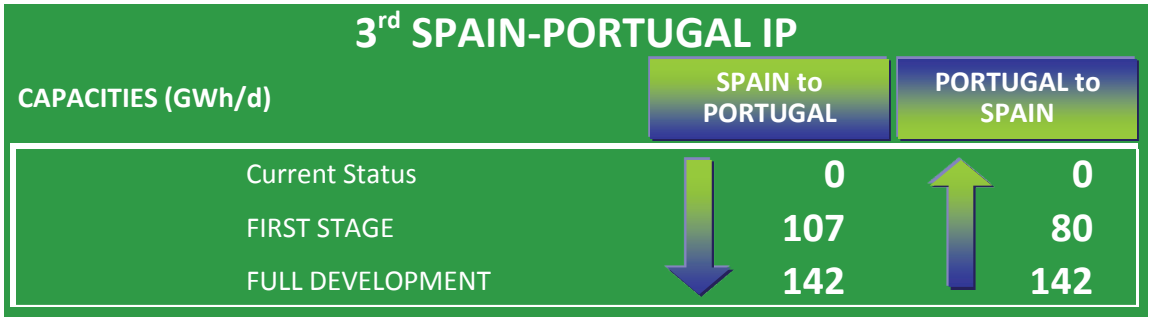


FIGURE 6 - 11 INTERCONNECTION CAPACITIES BETWEEN PORTUGAL AND SPAIN AFTER THE DEVELOPMENT OF THE 3RD IP

In **FIGURE 6-11** we can observe that the full development of the 3rd IP Portugal-Spain creates a bidirectional gas flow between both countries. We highlight that the reversibility of flow in the IP achieves 100%.

The 3rd Interconnection between Spain and Portugal, is an important tool towards the Iberian single market (MIBGAS) development, and will connect both gas systems between Celorico da Beira and Braganza (Portugal) and Zamora (Spain).

This development will also facilitate the energy exchange between both Systems, as well as the integration of the LNG plants of the Iberian Peninsula in the European market.

Among the benefits that the 3rd Interconnection between Portugal and Spain could provide,

- European systems integration and, therefore, an internal gas market development, fulfilling the objectives of the European Union policies and guidelines
- Diversify, not only the routes, but also the sources in the Iberian Peninsula and in Europe
- Reinforce the security of supply in any system, increasing the solidarity between countries in all of Europe
- Integrate the underground storages from Portugal and Spain
- Foster the integration of the new combined cycle power plants in both Systems, supporting the development of the Iberian electricity market (MIBEL) and the development of renewable energies, mostly, wind generation, which is increasing notably in the Iberian peninsula and which needs the back up from the combined cycle power plants.

6.3 Cross border projects contributing to create the European internal market

Investment in gas infrastructures is a key issue in the construction of the European Internal Gas Market where Transmission System Operators have a vital role to play. Developing the energy infrastructure will not only enable the EU to deliver a properly functioning internal energy market, it will also enhance the security of supply and enable the integration of renewable energy sources. The Member States and European institutions strongly reiterated the importance of developing new infrastructures as a means of enhancing Europe's supply security and achieving an integrated gas market in Europe.

To create the European internal gas market essentially means linking the gas sources or facilities in one country (or region) to another country (or region) through interconnection projects. The effects of this are twofold:

- Firstly, consumers have access to a larger number of suppliers, and the suppliers have a wider choice of supply sources. This increases competition to the benefit of the end consumer.
- Secondly, in the event of disruptions to the international supply chains, a greater number of alternative solutions are available to the affected suppliers. As a result, the supply security for consumers in highly interconnected areas is greatly improved.

The transmission process is inherently highly capital-intensive and requires long-term planning. While the financial crisis and volatile fuel prices may cast temporary doubt on development initiatives, the energy context demonstrates the long-term need for new gas transmission infrastructures in Europe.

To conclude on the development challenges for the transmission system, we should remind ourselves of the overall economic impact of making investments in this domain. For many stakeholders, the benefits gained in terms of supply security and increased competition on the wholesale markets, greatly outweigh the moderate addition of the cost of transmission to the final price of natural gas, representing an average of 7%-10% of the price of the gas delivered to the customers.

TSOs in the South Region want to use this Ten-Year Gas Regional Investment Plan to give a clear picture of the different infrastructure projects so far identified, focussing on the interconnection projects, showing the capacity created by development on them.

South Region Transmission System is currently interconnected:

- In the North of France with Belgium and Germany and in the East with Swiss transmission systems;
- on the North-West coast with Norway's GASSCO system;
- on the South Spanish coast with Algerian pipelines GME and Medgaz;
- around the Iberian Peninsula coast with Barcelona, Sagunto, Cartagena, Huelva, Sines, Reganosa and Bilbao LNG Terminals and on the French coast with the Fos and Montoir LNG terminals;
- with underground storage facilities spread across all countries;

The indigenous production in the South Region is already negligible. Currently, only France has a minimum production that will disappear at the end of 2013.

The following maps show the evolution of the current entry-exit capacity in the South Region developing the FID projects until 2020.

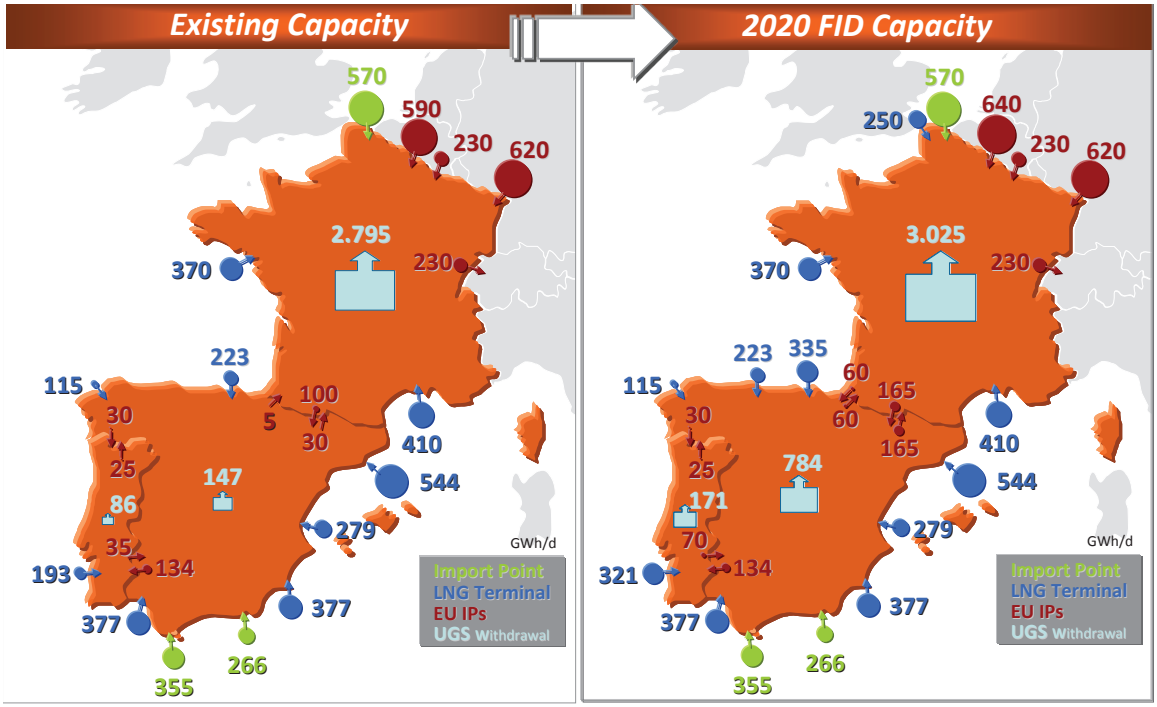


FIGURE 6 - 12 THE EVOLUTION OF ENTRY-EXIT CAPACITY IN THE SOUTH REGION AFTER THE DEVELOPMENT OF THE FID PROJECTS

Highlighted is the increase of the interconnection capacity at the Spanish-French border, by developing the Western Axis which was decided as a result of the Open Season processes during 2009-2010.

While the development of the Larrau, Biriatou and Guyenne projects (Western Axis) will break the current total isolation of the Iberian Peninsula, this opening will be limited by the current capacity between the two balancing zones GRTgaz North and South (currently 230 GWh/d in both directions) and the current capacity between France and the rest of Europe (no reverse flow with Germany and Belgium and an exit at Oltingue without available capacity)[12] .

It is also important to note that there are other FID projects in the Region:

- in Portugal, the extension of the Portuguese LNG Terminal and UGS developments;
- in Spain, extension of the existing LNG Terminals, a new LNG terminal and UGS developments;
- in France, the extension of Taisnières H IP, a new LNG terminal in the North of France, and UGS developments.

[12] Currently, gas odorization is under study by GRTgaz in order to allow gas export from France to northern Europe.

Interconnection between PORTUGAL and SPAIN

The Portugal gas history began in 1996 receiving gas flow through the GME that carries gas from Algeria to the Iberian Peninsula. The Portuguese network was connected to the Spanish network at 2 locations: Badajoz/Campo Maior IP and Tuy/Valença do Minho IP. The evolution of the Portuguese gas demand has been covered by developing internal facilities, LNG Terminal and UGS in Portugal.

While TSOs in both countries have cooperated in the operation of the network, the interconnection capacity between both countries has not been increased since 1996.

In recent years, following the EU´s energy policy, the cooperation has become closer in order to create the Iberian Gas Market, MIBGAS. MIBGAS aims to achieve a single market by developing cross border infrastructures to enhancing transmission fluidity between both Member States.

The 3rd IP Portugal-Spain will contribute to reaching this objective, as well as the creation of the MIBGAS, allowing the usage and optimization of all facilities located in the Iberian Peninsula, and showing a very important value integrating both markets.

Interconnection between SPAIN and FRANCE

The decided interconnection capacity in the Spanish-French border limits free gas flows in the Region, preventing the use of the FID import facilities to its best. The 2020 entry-exit balance for the peak day yields a surplus of developed entry capacity that could not be optimised due to infrastructures capacity bottlenecks at the cross borders. The following chart **(CHART 6-13)** shows the results obtained.

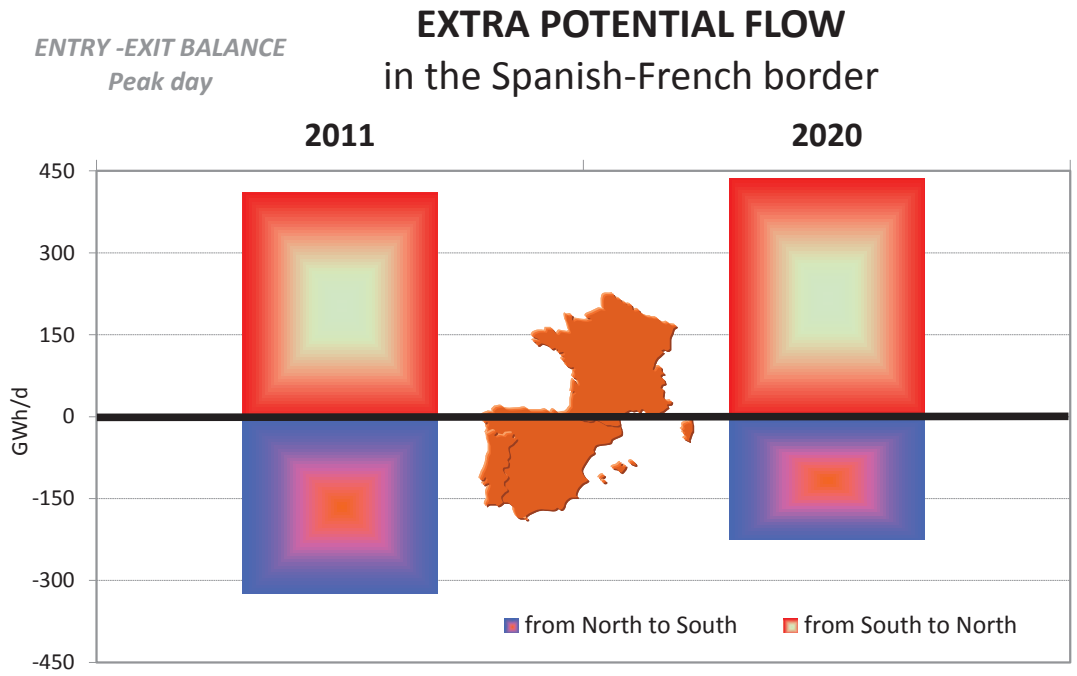


FIGURE 6 - 13 "CHART 6-13": EXTRA POTENTIAL FLOW IN THE SPANISH – FRENCH BORDER

CHART 6-14 shows how the development of the Eastern Axis will contribute to removing these bottlenecks. The design of the MidCat projects, developing Le Perthus IP and the link GRTgaz North-South, would allow the utilization of the import facilities in both directions.

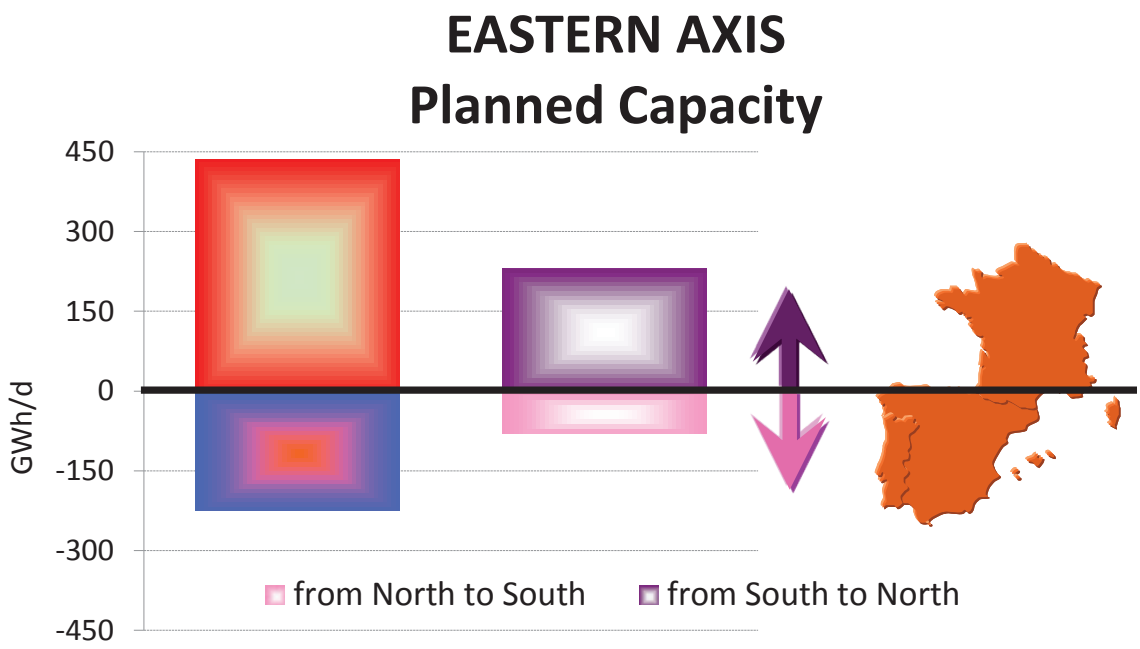


FIGURE 6 - 14 THE DEVELOPMENT OF PLANNED CAPACITY AT THE EASTERN AXIS REMOVING THE EXTRA POTENTIAL FLOW IN THE SPANISH – FRENCH BORDER

The **FIGURE 6-15** shows the entry-exit capacity at the cross border from the South Region developing the non-FID interconnection projects MidCat and the 3rd IP Portugal-Spain.

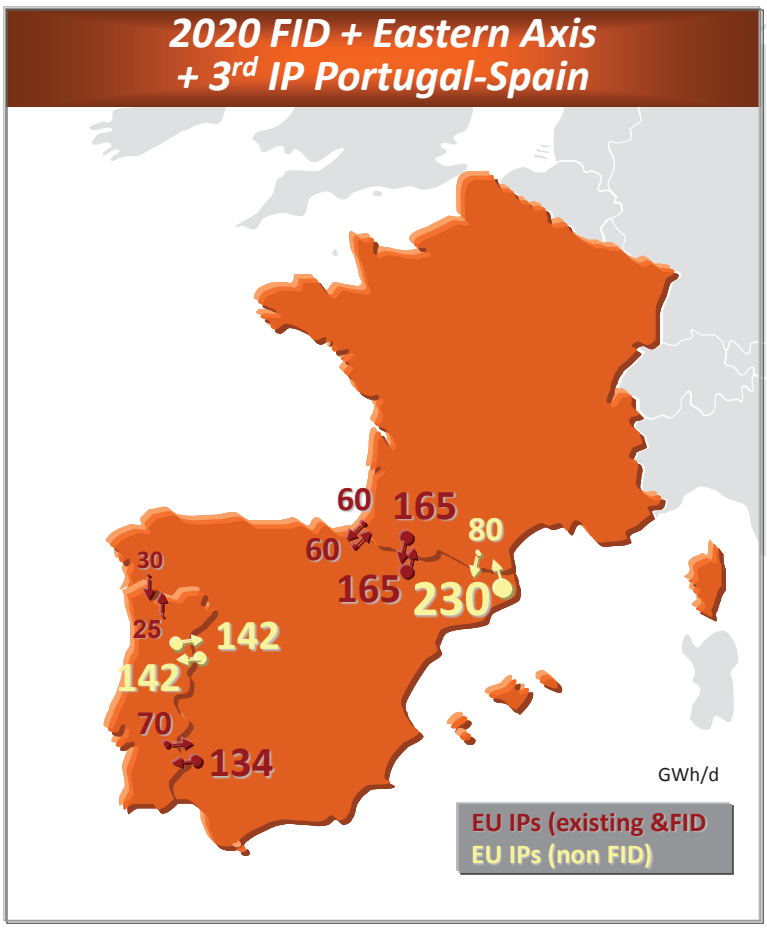


FIGURE 6 - 15 INTERCONNECTION PROJECTS IN THE SOUTH REGION (EASTERN AXIS AND THE 3RD IP PORTUGAL SPAIN)

Following, we describe the contribution of the 3rd IP between Portugal and Spain and the development of the Iberian-French Corridor to create the European internal market under diverse aspects:

a) 3rd IP Portugal-Spain creating the Iberian Gas Market: integrating the European gas System.

The 3rd IP Portugal-Spain will facilitate the energy exchange between Portuguese-Spanish gas systems, as well as the integration of the LNG plants on the Iberian Peninsula in the European market, providing European System integration through the creation of the MIBGAS (Iberian Gas Market).

b) Iberian-French Corridor covering gas Demand: creating the European internal Market

CHART 6-16 shows the evolution of the interconnection capacity between France and Spain considering the current FID projects Larrau and Biriatou and the non-FID project MidCat.

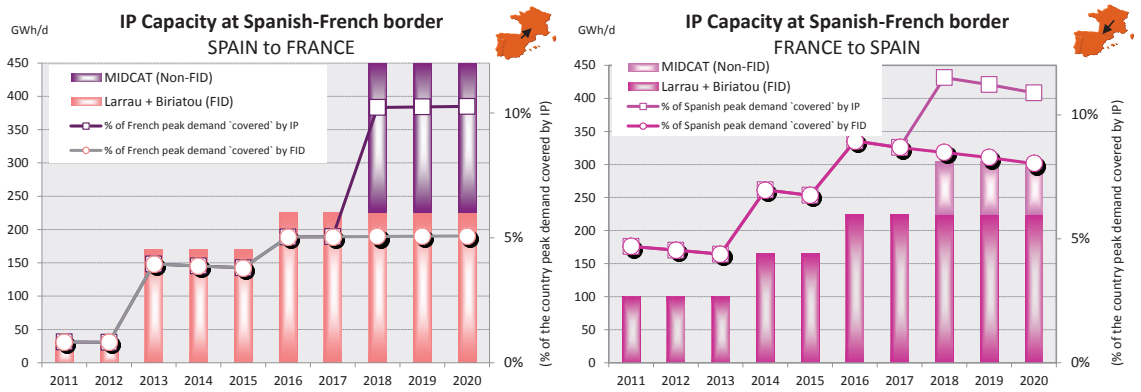


FIGURE 6 - 16 "CHART 6-16": THE EVOLUTION OF THE INTERCONNECTION CAPACITY AT THE FRENCH-SPANISH CROSS BORDER

The increase in the level of interconnection as a consequence of developing the Iberian-French Corridor is remarkable:

- **Covering an important share of the peak demand**, the Iberian-French Corridor will increase the level of security in both country's Gas Systems:
  - → FROM THE FRENCH SIDE, the share of peak demand that could be covered by the FID projects Larrau and Biriatou evolves from the current 1% to 5%, while it would increase to 10% after development of the Eastern Axis.
  - → FROM THE SPANISH SIDE, the share of peak demand that could be covered by the FID projects Larrau and Biriatou evolves from the current 5% to 8%, while it would increase to 11% after developing the Eastern Axis.
- **Contributing to the integration of the markets**: **CHART 6-17** shows the increase of daily average gas demand that potentially could be covered by interconnection capacity depending on the development of infrastructures.

  This evolution reflects how the development of the Iberian-French Corridor contributes to the creation of the European market. Highlighted is the creation of a reversible gas flow from South to North.

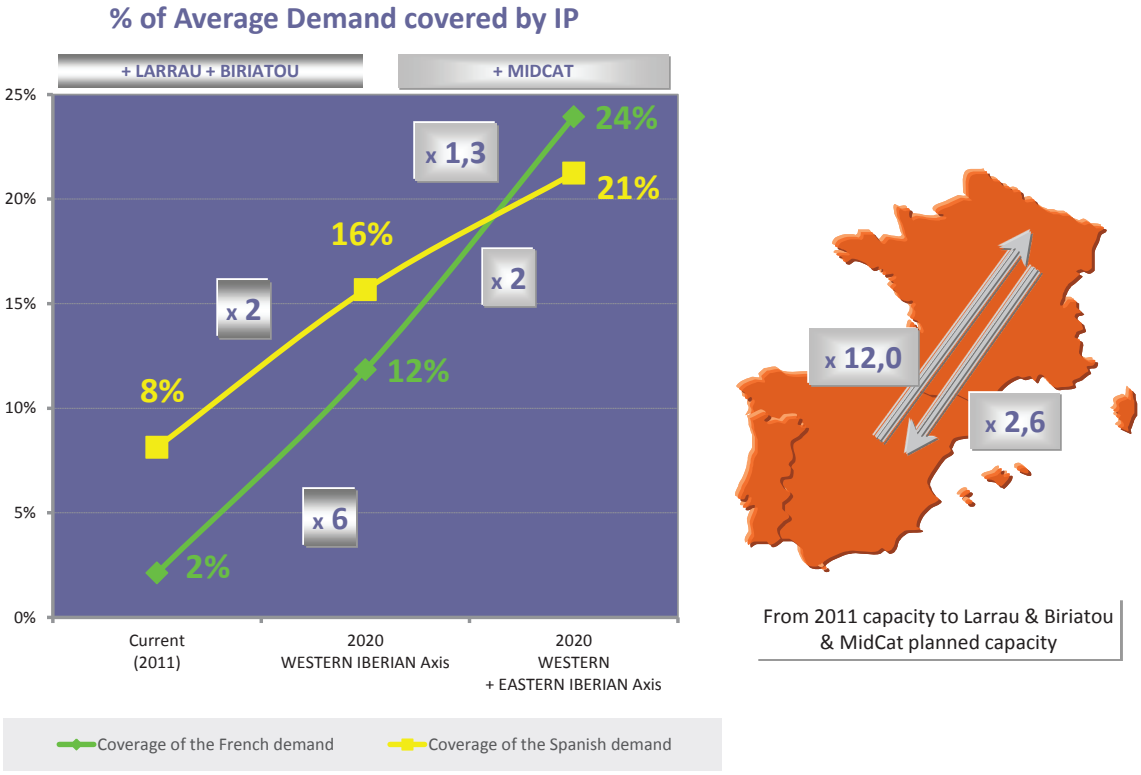


FIGURE 6 - 17 "CHART 6-17": EVOLUTION OF THE DAILY AVERAGE GAS DEMAND THAT POTENTIALLY COULD BE COVERED BY INTERCONNECTION CAPACITY, DEPENDING ON THE DEVELOPMENT OF THE DIFFERENT INFRASTRUCTURES

c) 3rd IP Portugal-Spain and Iberian-French Corridor providing flexibility: Renewable Energy Integration

Gas demand will become more volatile as a consequence of low carbon policies. The interactions between the electricity market and the gas market will become increasingly more important, with wind generation affecting not only the electricity system but also the gas system. Increased volatility of demand requires more day-to-day and within-day flexibility of supplies, and seasonal swings. This flexibility may be mainly supplied:

- from cross-border interconnections,
- by UGS facilities, and,
- from LNG Terminals.

Because gas cannot be stored at the point of consumption and because gas production and transport by import pipelines tends to be operated at a constant maximum rate due to their high cost structure, the demand fluctuations have to be met by facilities with storage capacity: LNG Terminals and UGS.

As we have shown in the chapter describing the current gas market in the South Region, the main instruments of flexibility from the gas system in the Region are Underground Storages (UGS) and LNG Terminals, being complementary to each other in covering the gas demand modulation. Daily and Intra-daily modulation is possible by means of LNG Terminals and UGS.

The ability of the interconnections to provide network flexibility enabling the integration of renewable energies and rhythmic gas demand fluctuations is a consequence of the profile of production from the facilities in the involved Gas Systems France-Portugal-Spain:

→ **The flow of gas through these interconnections will be mainly linked with LNG facilities and UGS as tools that provide flexibility.**

The development of the 3rd IP Portugal-Spain and the Iberian-French Corridor contributing to remove capacity bottlenecks at the cross-borders, increases free gas flows between countries and allows the increase in short-term deliverability from LNG Terminals and UGS.

The flexible modulation provided by the UGS and LNG Terminals located in the South Region contributes to maintaining a flat line pack in the network compensating the oscillations, increasing drop consumption of the CCGTs, caused by the intermittency of the renewable energy sources. As a consequence, the creation of the Iberian-French Corridor and the 3rd IP Portugal-Spain has a very important role supporting the integration of renewable energies in Europe.

d) 3rd IP Portugal-Spain and the Iberian-French Corridor spreading diversification of Sources into the Union

The Regulation on the Security of Supply stresses that the diversification of gas routes and sources is a key essential component to ensure the security of supply for Member States.

Supply diversification has improved over the past decade in the Region due to the development of new gas sources and the construction of several LNG Terminals and new entries by pipelines. The Iberian Eastern Axis and the 3rd IP Portugal-Spain, better linking the countries in the South Region, will contribute to increased security of Supply into the Region, and additionally, it would provide other European Member States the potential access to a high level of a number of different sources of gas.

The South Region, currently receiving gas from 14 different countries, would spread this level of diversification improving the security of supply in the Union[13] .

e) 3rd IP Portugal-Spain and the Iberian-French Corridor providing diversification of Routes of Gas

A "Route of gas" is a way by which the flow of gas enters into the transmission system, i.e., each individual entry point connected with the network: domestic gas reserves, import pipelines, LNG Terminals, cross-border interconnection points and underground storages during the winter period.

The level of diversification of routes for an area would be determine as function of the number of entry points interconnected with the transmission system of the area and their respective capacities. Notice that under this definition, the level of diversification of routes for an area varies between winter and summer due to the double role played by UGS, being entry points in winter and exit points in summer.

As highlighted in the previous chapters, the domestic gas reserves in the South Region are negligible, where the majority of natural gas that enters the transmission system is imported from external countries. Going deeper into this external dependence level of the South Region, the gas stored in the UGS available for withdrawal during the winter has come to the Region during the summer through LNG Terminals or entry pipelines.

Mutatis mutandis to the Herfindahl Index (HHI or simply H), commonly used to measure levels of concentration/diversification, we measure the level of routes diversification as the sum of the square of the entry capacity share in the total entry capacities. We call "DR Index" this level of routes of gas diversification.

[13] Currently, gas odorization is under study by GRTgaz in order to allow gas export from France to northern Europe.

In order to provide an indication of the level of diversification of routes simultaneously considering the high level of external dependency in the South Region, we calculates the "DR index" without considering the withdrawal capacity or the production from domestic gas reserves[14] .

There are many "Routes of gas" to bring gas to the South Region through pipelines, import pipelines and/or cross border interconnection, and by LNG Terminals.

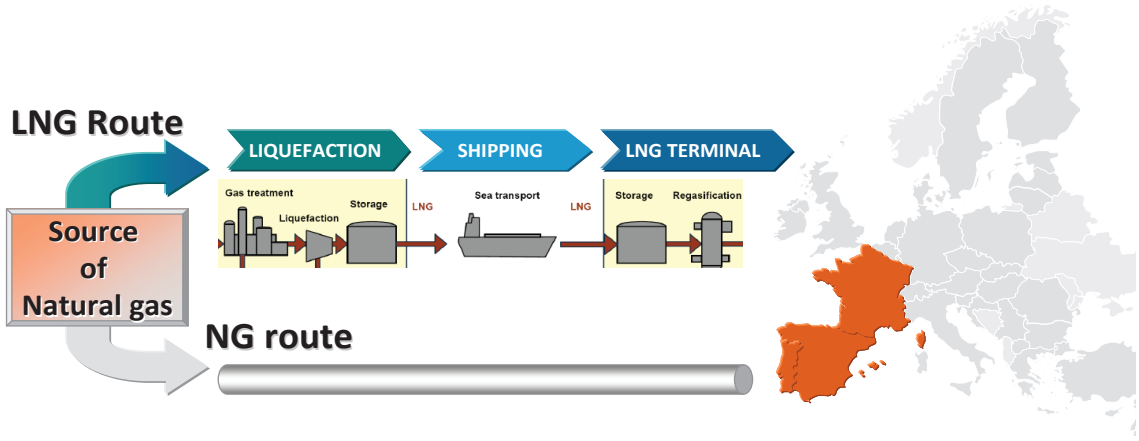


FIGURE 6 - 18 THE" ROUTES OF GAS" THAT BRING GAS TO THE SOUTH REGION

The "DR Index" would provide an indication of the reliability of the gas system under a failure of one or more entry points.

Considering the previous definition for the "DR Index", we determine the level of diversification of routes into an area as shown in the next table:

DR Index	Diversification of Routes
DR<0,01	HIGHLY diversified
0,01<DR<0,15	DIVERSIFIED
0,15<DR<0,25	MODERATELY diversified
DR> 0,25	UNDIVERSIFIED

FIGURE 6 - 19 RANGE OF "DR INDEX" AND DIVERSIFICATION LEVEL

[14] To stress that this value for the "DR Index" means the annual value and represents the most pessimistic level of diversification of gas routes.

The **FIGURE 6 - 20** shows the good level of diversification of Routes of gas achieved in the South Region. Highlighted is the level of diversification achieved in Portugal creating the MIBGAS. The creation of new cross-border interconnections, developing Eastern Axis and the 3rd IP Portugal-Spain, improves the Regional Cooperation reducing the risks associated to technical failures of the entry points or even in a lack of supply from external countries. The development of these new cross-border interconnection capacities makes the South Region gas system more reliable and flexible.

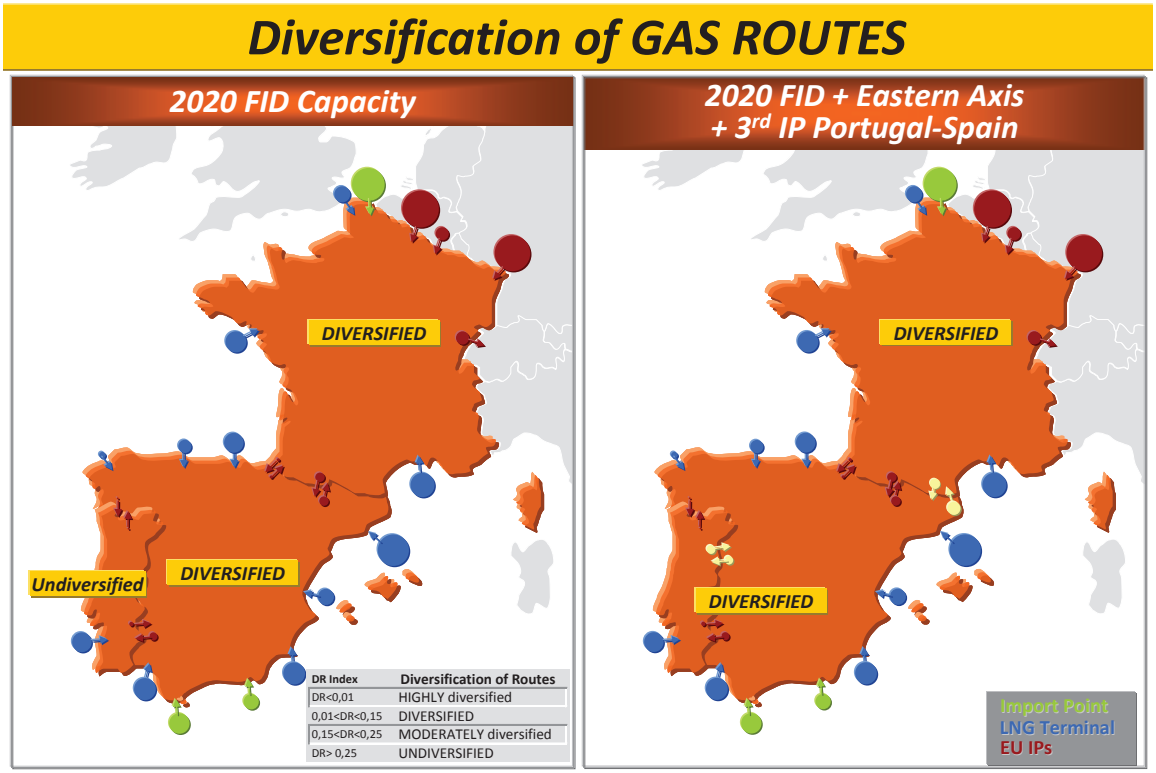


FIGURE 6 - 20 THE EVOLUTION OF THE LEVEL OF DIVERSIFICATION OF GAS ROUTES PROVIDED BY THE DEVELOPMENT OF THE EASTERN AXIS + THE 3RD IP PORTUGAL – SPAIN

7. SECURITY OF SUPPLY

© Image courtesy of GRTgaz

7.1 Resilience of the network

The ENTSOG Ten Year Network Development Plan (TYNDP) assessed the resilience of the network under a set of disruption scenarios.

The GRIP South Region includes a resilience network assessment considering the special features for the Region and under specific risk scenarios as the following:

1. LNG disruption,
2. North Africa disruption,
3. Algerian disruption (NG & LNG)

This part of the study has been carried out in collaboration with the expert team on this task in ENTSOG, using a similar methodology that was used in the elaboration of the TYNDP and the modelling tool developed by ENTSOG.

In addition, considering the main role played by LNG in the South Region, for elaborating these specific disruption scenarios the methodology, the rules and main results obtained in the GLE study "LNG Disruption" [15] have been taken for granted.

The scenarios for these disruptions have been determined with 30 day durations, which would occur in winter, under 1 in 20 weather conditions.

Each of the resilience network assessment has been done for the year 2020 considering different statuses of infrastructure development in the South Region:

i) Existing infrastructures plus those for which Final Investment Decision (FID) has been taken

ii) The same infrastructures as above plus 3rd IP Portugal-Spain and plus Eastern Axis (currently non FID projects)

iii) The same infrastructures as above plus the rest of the non-FID projects in the South Region

[15] GLE study on "LNG Disruption" was adopted by the Gas Coordination Group in November 2010.

1. LNG disruption

The GLE study, elaborated in order to determine the consequences of a "LNG Disruption" for the European Gas market, was focussed on identifying the risks in each part of the LNG process and its dimensions, targeting on its consequences in the availability of supplies; and it evaluating the Impact in the EU Gas Market.

The GLE study analysed the "LNG Chain" and it was concluded that if the disruption occurs in the Midstream, the initial consequences associated are delays in delivery. The solution to mitigate these consequences is to increase LNG storage. The consequence associated with the Downstream is a lack of gas, which could be mitigated by rerouting LNG ships. If the failure occurs in the Upstream, the initial consequence is a lack of LNG that would be the greatest problem for the gas market.

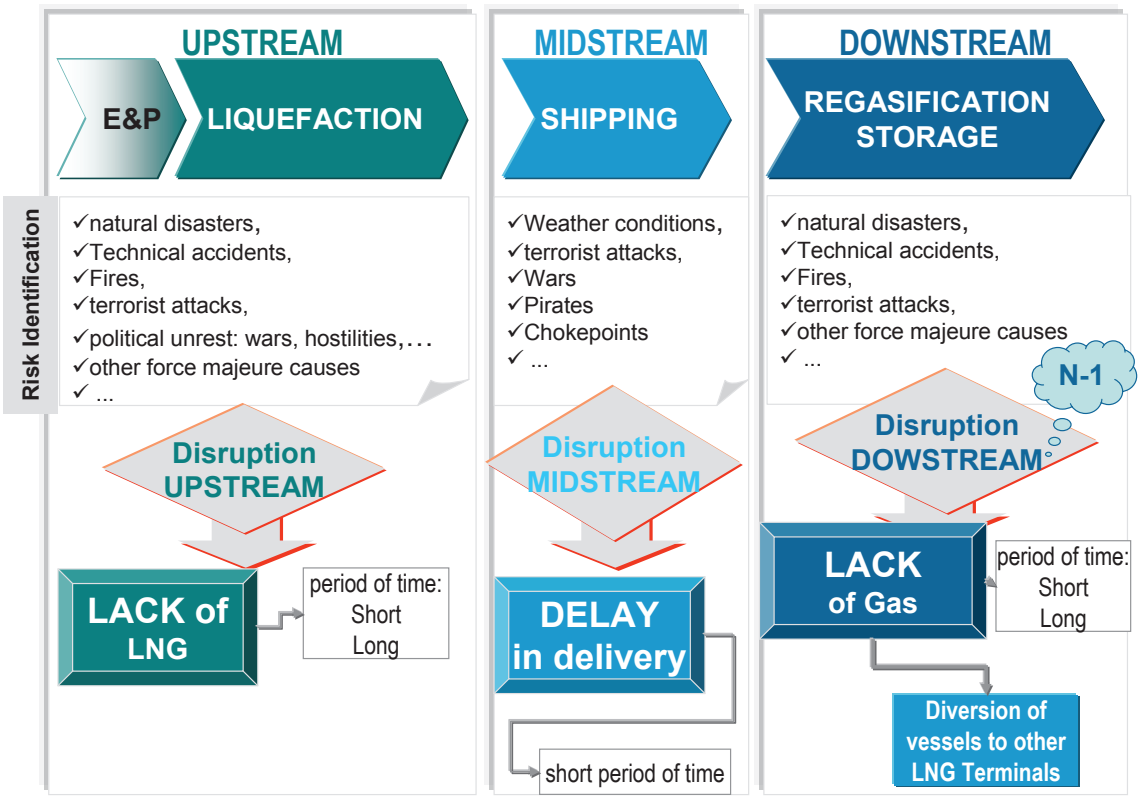


FIGURE 7 - 1 TYPES OF DISRUPTIONS AND THEIR CONSEQUENCES

In order to identify the consequences of a lack of LNG in the gas market, the GLE study analyzed the role played by LNG in each European country. Previous to doing a network simulation in case of disruption, the GLE study identified the role of LNG under normal operating conditions: the Send-Out from each Terminal on a winter day, 1 in 20 climatic conditions, the filling level of the LNG tanks,... That is called "Reference case".

In **FIGURE 7 - 2** we can observe the results obtained. The percentage of the daily Send-Out over the total entries shows very different values depending on the country: the maximum daily Send-Out percentage corresponds to Spain and Portugal, which reaches more than 50% of the total entries to the gas system, and the minimum corresponds to Italy and Greece. For France and Belgium, the values are around 15%, and more than 25% for UK.

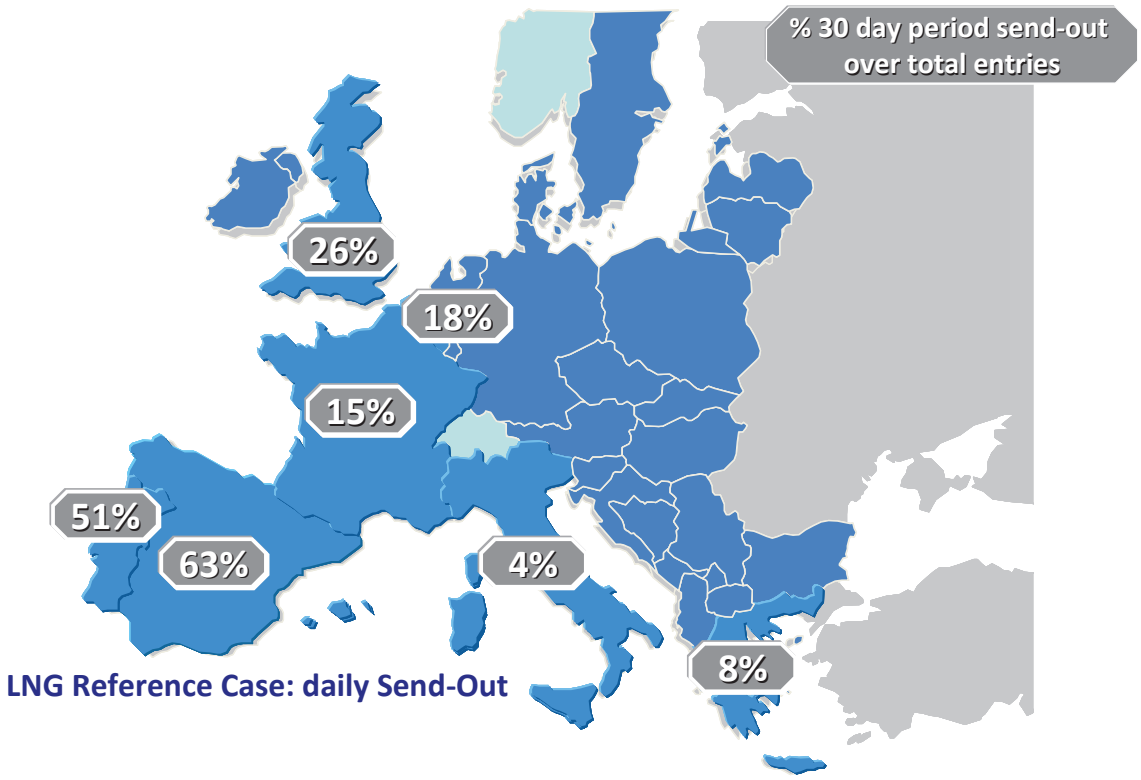


FIGURE 7 - 2 REFERENCE CASE IN THE GLE STUDY

As a result of the LNG balance in normal conditions of operation, the GLE study obtained the Send-Out required for the 30 day period and, using the historical quota per exporting country, the study estimated the amount of LNG by country of source, during a 30 day period.

The following chart **(FIGURE 7 – 3)** shows the main results[16] . We can observe that the worst cases for the South Region are "No LNG from Nigeria" and "No LNG from Algeria". Additionally, a lack of LNG from Qatar would impact the Spanish and French market.

Reference Case

LNG BALANCE

	BELGIUM	FRANCE	GREECE	ITALY	PORTUGAL	SPAIN	UK
Over Total Entries							
%Ships downloads	**18%**	**16%**	**8%**	**4%**	**54%**	**63%**	**26%**
· from **ALGERIA**		**7%**	**8%**	**1%**		**12%**	**2%**
· from **NIGERIA**	**1%**	**4%**			**50%**	**18%**	**1%**
· from **QATAR**	**17%**	**3%**		**3%**	**2%**	**13%**	**19%**
· from OTHERS	1%	2%	0%	1%	2%	21%	4%

Estimation of Origin of the LNG Ships based on annual data for the last years.
The information amounts to 33 days

FIGURE 7 - 3 SOURCES OF LNG CARGOES IN EUROPE

In the definition of the LNG Balance, LNG storage capacity plays a very important role. LNG storage capacity provides some leeway that allows us to vary the inventory and consequently reflects the tanks' ability to limit the impact of a disruption.

[16] These amounts are calculated based on the historical data from recent years and due to the globalised LNG market, would suffer variations for the future.

Lack of LNG from Nigeria

Focussing on the lack of LNG from Nigeria, the country most affected by this disruption would be Portugal, because the majority of the LNG that it is receiving is from this country.

The GLE study analysed in detail by country, taking into account its special characteristics. Based on the results obtained, ENTSOG has done a network simulation using these parameters as input data.

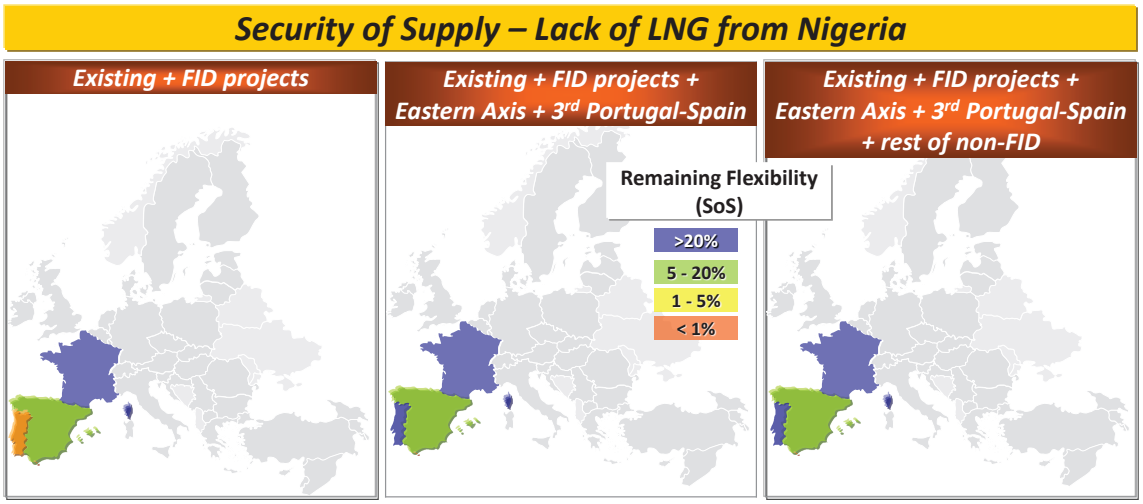


FIGURE 7 - 4 RESULTS OF ENTSOG'S SIMULATION IN THE CASE OF LACK OF GAS FROM NIGERIA

In **FIGURE 7 - 4** we can see the role played by the 3rd IP Portugal-Spain mitigating the risk of the Portuguese gas system under a lack of LNG from Nigeria. The existing cross-border interconnection between Portugal and Spain would be congested leading to a lack of remaining flexibility[17] in Portugal. Although developing the 3rd IP Portugal-Spain, creating the Iberian Gas Market, the consequences of this disruption are solved. Despite this disruption is referring to a lack of supply, it is important to note that the remaining flexibility in the Spanish gas System is increased by developing the rest of non-FID projects.

[17] See definition in page 50 of ENTSOG's TYNDP 2011-2020

Lack of LNG from Algeria

Focussing on the lack of LNG from Algeria, only France and Spain would be affected by this supply crisis.

Assuming the maximum stake that can be obtained from the use of the tanks' inventory in line with the rules defined, the new daily Send-Out was obtained. Using the GLE methodology, we obtain that the reduction in the daily winter Send-Out in the case of Spain, would be compensated by LNG stored in tanks. In the case of France, the LNG Send-Out would be limited to around 8% of the total entries[18] .

The main conclusion obtained from the ENTSOG network simulation is that the transmission system in the Region offers a reasonable level of flexibility and the risk associated with this LNG disruption would be mitigated without affecting the gas market.

Lack of LNG from Qatar

Although the lack of LNG from Qatar was identified as the worst case for Europe, focussing on the South Region, only Spain is receiving LNG from Qatar and France began to be imported a small quantity last year.

Assuming the maximum stake that can be obtained from the use of the tanks inventory in line with the rules defined, it was concluded that the lack of LNG from Qatar would be compensated in Spain and France by LNG stored in tanks. So, it is concluded that it wouldn't reduce the Send-Out from the LNG Terminals, and as a consequence, it wouldn't impact the gas market in the South Region.

2. North Africa disruption

This scenario takes into account a total disruption of the natural gas from Algeria through the Gasoduc-Maghreb-Europe (GME) and Medgaz pipelines to the Iberian Peninsula.

This disruption implies a lack of supply. Considering the LNG Terminals capacity available in the Iberian Peninsula, the first step will be to increase the Send-Out from its Terminals. This solution, that implies replacing the maximum possible amount of supply from Algeria by pipeline by spot LNG cargoes, puts the measures to solve a Supply crisis in the hands of the market, in the hand of the shippers.

As we are envisioning a strategic perspective this kind of solution to solve the crisis should also be complemented by an infrastructure perspective. The resilience of the gas network without these entry points should also detect possible bottlenecks, preventing the free gas flow in the Region due to a lack of interconnection capacity.

While, in order to develop alternative and complementary measures to solve a supply crisis, this analysis assesses the infrastructure's role contributing to the security of supply.

Considering the rules defined by GLE study, the increase in Send-Out from LNG Terminals by handling the LNG stored in tanks is the following:

- **Portuguese LNG Terminal** would increase the Send-Out by 45% over the Reference case,
- **French LNG Terminals** would increase the Send-Out by 8% over the Reference case,
- **Spanish LNG Terminals** would increase the Send-Out by 30% over the Reference Case.

Stressed is the tanks' ability to limit the impact of this disruption: LNG stored in tanks provides some leeway allowing us to increase the LNG Terminals Send-Out and replacing gas from pipeline for gas from LNG origin. Considering these new levels of Send-Out from the LNG Terminals, the results obtained by ENTSOG network simulation highlights that the risk associated with this disruption would be mitigated without any impact on the gas system.

[18] In a Business as usual scenario, LNG Terminal Send-Out represents around 15% of the total entries.

3. Algerian disruption (NG & LNG)

This scenario considers a simultaneous lack of LNG from Algeria and gas from Algeria through the Gasoduc-Maghreb-Europe (GME) and Medgaz pipelines.

Based on the historical data, only France and Spain are receiving LNG from Algeria. Due to the globalization of the LNG market this hypothesis could change in the future, but it is not considered in this analysis.

Considering the assumptions made in the GLE study and the results obtained from it, in the case of this disruption the Send-Out from the French LNG Terminals would drop to 8% of the total entries[19] . Initially, the Send-Out from Spanish LNG Terminals would not be reduced by handling the LNG stored in tanks.

Under the current scenario, the Algerian disruption implies a lack of supply through the GME and Medgaz pipelines. Note that this scenario corresponds to the highest "security of supply" risk for Spain.

The estimation of increase in Send-Out from the Portuguese LNG Terminal by handling the LNG stored in the tanks would be increased by around 45% over the Reference case.

FIGURE 7 - 5 stresses the role played by the Eastern Axis in order to mitigate the risk associated with this disruption in Spain. The Western Axis would be congested leading to a lack of flexibility in the Spanish and Portuguese gas systems. Developing the Eastern Axis, the transmission system in the Region would offer a reasonable level of flexibility and the risk associated with the Algerian gas disruption would be mitigated without affecting the gas market.

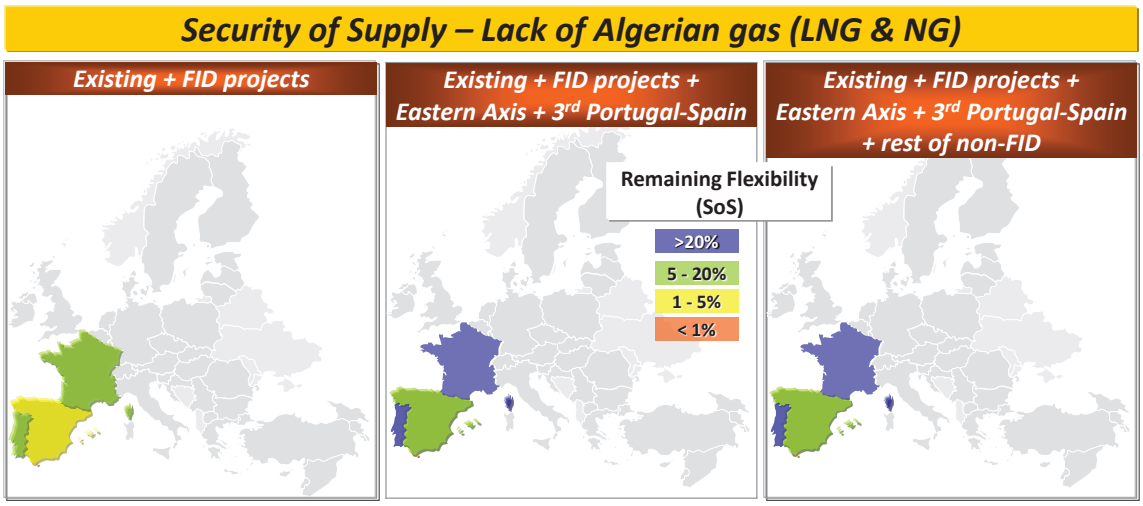


FIGURE 7 - 5 RESULTS OF ENTSOG'S SIMULATION IN THE CASE OF A LACK OF GAS FROM ALGERIA (NG&LNG)

Note that the previous results of the simulation are obtained developing the Eastern Axis at the intermediate stage[20] . However, if under a real Algerian disruption (NG & LNG) this commercial firm capacity was not enough, specific rules of operation of the regional gas system under a Security of Supply risk, would be applied, allowing the maximization of the gas flow to the Iberian Peninsula if needed.

[19] In a Business as usual scenario, LNG Terminal Send-Out represents around 15% of the total entries.

[20] Capacity figures correspond to the Intermediate development case of the 2010 Information Memorandum

Key conclusions on disruption scenarios

- LNG disruption from Algeria and Qatar, and North Africa (via pipelines) disruptions should not limit the ability of the South Region to cover their overall demand.

- Whereas the lacks of LNG from Nigeria and the Algerian disruption (LNG and pipelines) show congestion of the current and FID cross-border projects leading to a lack of remaining flexibility in the Spanish and Portuguese gas systems.

- Developing the full Iberian-French Corridor and the 3rd IP Portugal-Spain could enable facing these disruptions and meeting the whole demand under these extreme situations. Highlighted is the Regional Cooperation in both cases to solve a "security of supply" risk.

8. MARKET INTEGRATION

© Image courtesy of GRTgaz

One of the most important messages transmitted by the Commission stresses that adequate, integrated and reliable energy networks are a crucial prerequisite not only for EU policy goals, but also for the EU's economic strategy.

A well-meshed network, enabling the access to different supply sources, facilitating the establishment of diversified suppliers' portfolios, improving its robustness and making it more flexible is the challenge for the next year period.

The integration of the European networks, increasing interconnection capacity and reducing market concentration, is the way to create the internal energy market which has to be completed by 2014.

The European gas sources will change in the coming years. Even though the indigenous production will continue to play an important role, the European gas market will become more dependent on natural gas imports.

The ENTSOG TYNDP 2011-2020 stressed that the contribution of the indigenous production to cover gas demand will drop from the current 37% to around 22% in 2020. The consequence of the decline of the indigenous production could be understood under different perspectives:

1. From the point of supply, this fact indicates our major external dependence and the requirement of new supply strategies.

2. And, from the point of the infrastructures required, means that new bottlenecks and lack of capacity will appear due to the fact that natural gas will flow a greater distance through the transmission system.

Both of these aspects will be the main investments drivers for the following decades.

FIGURE 8 – 1[21] shows that for the next 10 year period the imports of natural gas in Europe should increase by at least 75 bcm, representing +25% over the current imports, due to the decline of indigenous production. In 2020, the European dependence on gas imports will be around 70%.

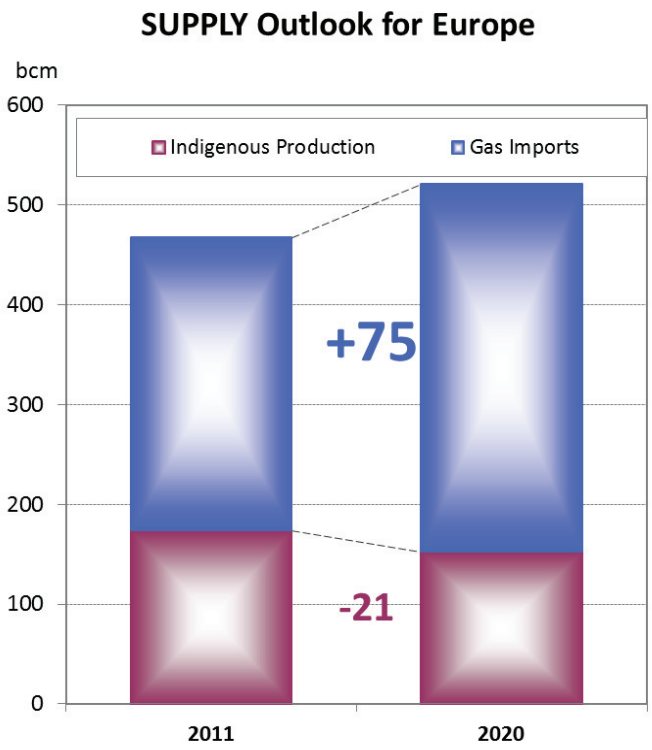


FIGURE 8 - 1 SUPPLY OUTLOOK FOR EUROPE

While there are numerous alternatives and complementary scenarios of supply to cover the gas demand in Europe, in this report we investigate the benefits obtained by the European gas market developing the complete Iberian-French Corridor, and specifically the Eastern Axis, contributing to the development of the core of the European gas network from LNG sources and North Africa.

Focussing on this objective we analyse the contribution of the Eastern Axis to the European market integration under the following scenarios:

1. **To facilitate the usage of the developed and planned LNG Terminals**
2. **To Interconnect the Mediterranean area and the Northern supply Corridor**

[21] Source of data: ENTSOG'S TYNDP 2011-2020

1. To facilitate the usage of the developed and planned LNG Terminals

In **FIGURE 8 – 2**[22] we can see the potential LNG supply to Europe included in the ENTSOG TYNDP 2011-2020. We can observe that, from the point of the supply, this source has a big potential to increase.

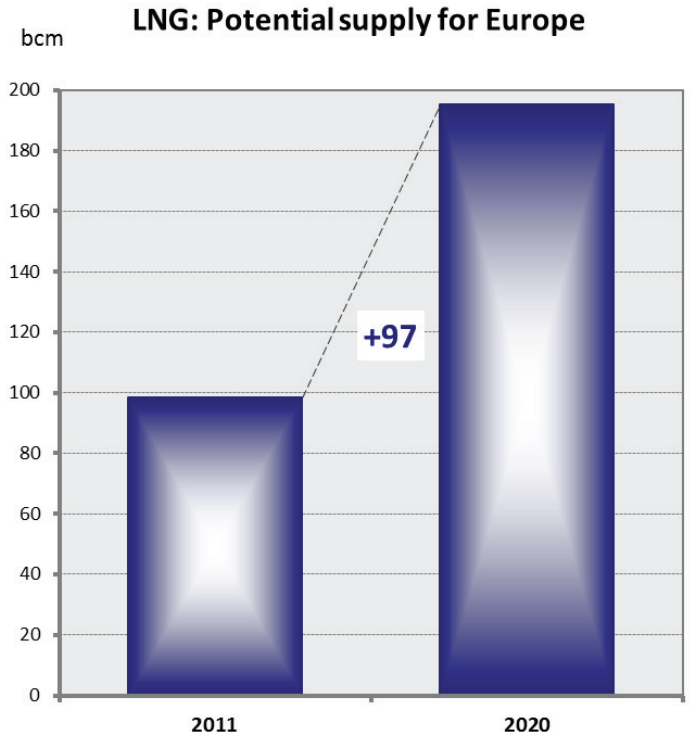


FIGURE 8 - 2 LNG'S POTENTIAL SUPPLY FOR EUROPE

Considering that the South Region has a well developed LNG market, with around 50% of the expected LNG Terminals FID in Europe located on it, and close to 40% on the Iberian Peninsula, a great part of this potential supply will come to the South Region.

However, a main conclusion was obtained in the ENTSOG TYNDP 2011-2020 showing the limitation identified for the LNG Terminals located in the Iberian Peninsula due to the lack of capacity to France: "**Capacity limitation to supply predominance on Average daily demand**. When modelling the Average Daily Demand for the European gas network and applying only the technical capacity limit to each supply source, there are only few internal EU bottlenecks that hamper an even spread of gas coming from a predominant supply. The only limitation was found for LNG which is a counter-flow to the two main historical supply sources (Norway and Russia). Such ***limitation was identified for the Iberian Peninsula*** and Greece. In all cases this was ***due to the lack of capacity to France*** and Bulgaria respectively. ***In 2020 taking into account non-FID LNG terminal projects, even if the capacity congestion between Spain and France will have been relieved, the lack of eastward export capacity from France will hamper LNG maximization in Iberian Peninsula and France and its spread further into the European gas network.***"[23]

Likewise, the "Energy Infrastructure Priorities 2020 and beyond" stresses that there are still infrastructure bottlenecks in the internal market which prevent free gas flow in this Region, such as for example the low interconnection level with the Iberian Peninsula, preventing the use of the well-developed Iberian gas import infrastructure to its best. Although progress of the Spain-France axis has been achieved in recent years, the Western Axis (FID projects) is still inadequate to reach a complete integration of the developed and planned import facilities in the Iberian Peninsula.

[22] Source of data: ENTSOG'S TYNDP 2011-2020

[23] ENTSOG TYNDP 2011-2020 pg 67

One objective of the GRIP South Region is to analyse this limitation.

In order to better identify this limitation, using the ENTSOG modelling tool, ENTSOG has done network simulations for the year 2020 considering several status of infrastructure developments in the South Region:

i) Existing infrastructures plus those for which Final Investment Decision (FID) has been taken

ii) The same infrastructures as above plus 3rd IP Portugal-Spain and plus Eastern Axis (currently non-FID projects)

iii) The same infrastructures as above plus the rest of the non-FID projects in the South Region

As explained in the ENTSOG TYNDP 2011-2020, simulations are carried out under the Average Daily Demand conditions without the deployment of storage.

For the market integration analysis, each import source is individually increased up to a 95% import route capacity, and in the case of LNG up to 80% of the Terminal Send-Out. The respective other import sources are reduced in the same proportion (to their supply share). Dominant source is then spread homogeneously considering neither any potential contractual swaps nor flow pattern aiming at one particular region[24] .

Note that market integration modelling aims at assess how far gas coming from each supply source can flow into the European gas network. So, the objective is to detect ***how the gas from one specific source spreads through the network*** and the simulations do not try to represent business as usual flow patterns.

FIGURE 8 - 3 shows the main results obtained from the network simulations.

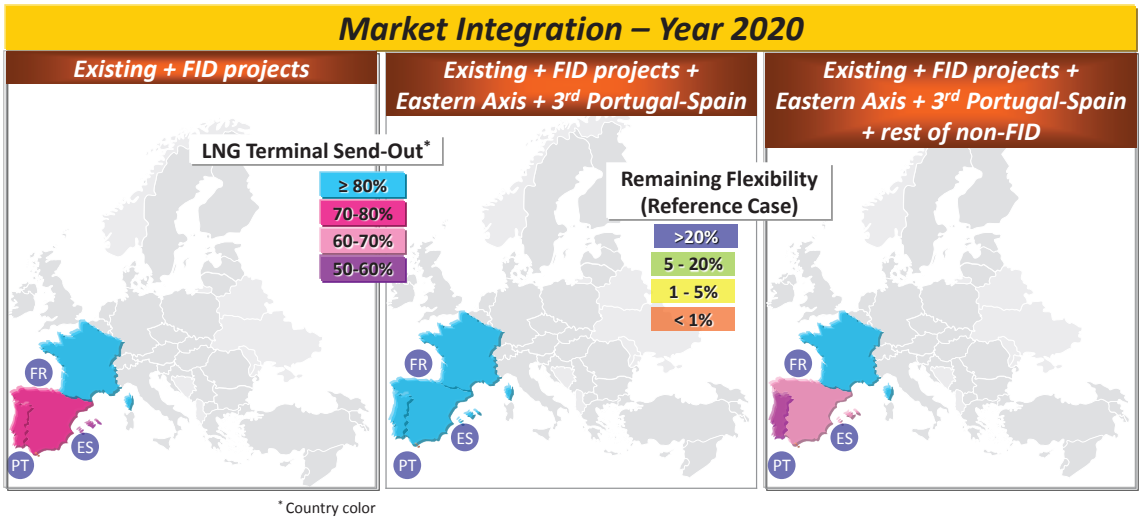


FIGURE 8 - 3 RESULTS OF THE NETWORK SIMULATIONS

[24] Refer to ENTSOG TYNDP 2011-2020 pg 46

Highlighted is the role played by the 3rd IP Portugal-Spain and the Eastern Axis allowing the achievement of the market integration goal for the Iberian LNG Terminals. Developing these new cross-border interconnections, the Iberian existing and FID LNG Terminals for 2020 would reach the objective of market integration as well as the rest of the LNG Termina ls located in others European countries (France, Belgium, UK, Netherlands and Italy), spreading the gas flow to central Europe. The centre map highlights that the French LNG Terminal's Send-Out level is not reduced under this new status infrastructure development, maintaining the reached goal of the market integration for France (ie LNG send out superior to 80%).

This availability of cross border capacity will increase the competitiveness and liquidity of gas markets providing equal opportunities for shippers, enabling a high level of competition and contributing to the reduction of market concentration in Europe. Removing the cross-border capacity bottleneck (as identified by market integration tests) between France and Spain will bring the European gas markets closer, making the development of large scale energy trade between countries possible.

The network simulation results obtained from the last infrastructure scenario "Existing infrastructures plus FID plus 3rd IP Portugal-Spain and plus Eastern Axis, plus the rest of the non-FID projects in the South Region" indicates that the lack of capacity in the border between Spain and France would continue if all of the non-FID LNG Terminals under study in the Iberian Peninsula were developed. But, on the other hand, under this infrastructure status we can observe that the remaining flexibility on the Iberian Peninsula is more than 40%, showing that some of these non-FID Iberian LNG Terminals could be redundant for the current forecast of the peak demand.

Then, we can conclude that only some of these Iberian non-FID projects will be carried out if the market evolution shows positive signals and its developments should not have additional congestions in the cross border. In any case, for futures developments of the GRIP, TSOs in the South Region will monitor this aspect.

2. To Interconnect the Mediterranean area and the Northern supply corridor

The strategic concept for the North-South Corridor in Western Europe defined in the "*Energy Infrastructure Priorities 2020 and beyond*" is to better interconnect the Mediterranean area and thus supplies from Africa and the Northern supply Corridor, with supplies from Norway and Russia.

Taking it into account, the GRIP South Region report wants to highlight the outcomes obtained by ENTSOG TYNDP 2011-2020.

In the following maps we can observe the effect of the Iberian-French Corridor development: gas from Algeria will flow to central Europe through France[25] . Creating a new route from South to North, the European diversification of supply will increase, reducing the dependence on the incumbent gas source jointly with the risks linked to security of supply, and through a better interconnected area in developing the internal European gas market.

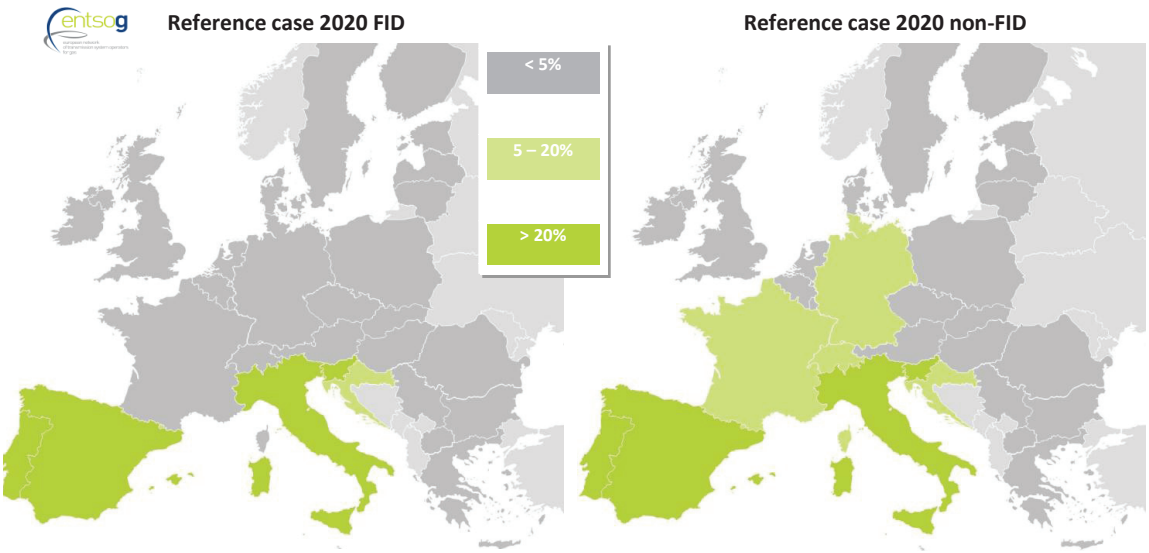


FIGURE 8 - 4 EVOLUTION OF ALGERIAN PIPELINE GAS INFLUENCE IN THE EUROPEAN NETWORK

The development of the Iberian-French Corridor also opens a path to transport gas from new extended capacity in the existing import pipelines from Algeria.

The ENTSOG TYNDP 2011-2020 shows the potential supply to Europe through the Algerian pipelines. It will increase +24 bcm, reaching more than 60 bcm.

[25] This result doesn't take into account the study launched by GRTgaz to harmonise gas odorization in order to allow gas export from France to northern Europe. Such a reverse flow could largely improve this result.

Regarding the existing pipelines from Algeria to Iberian Peninsula, both pipelines can be extended:

- Gazoduc-Maghreb-Europe (GME) from the current 12 bcm to 18 bcm, i.e.,+ 6 bcm
- Medgaz from the current 8 bcm to 20 bcm, i.e., + 12 bcm

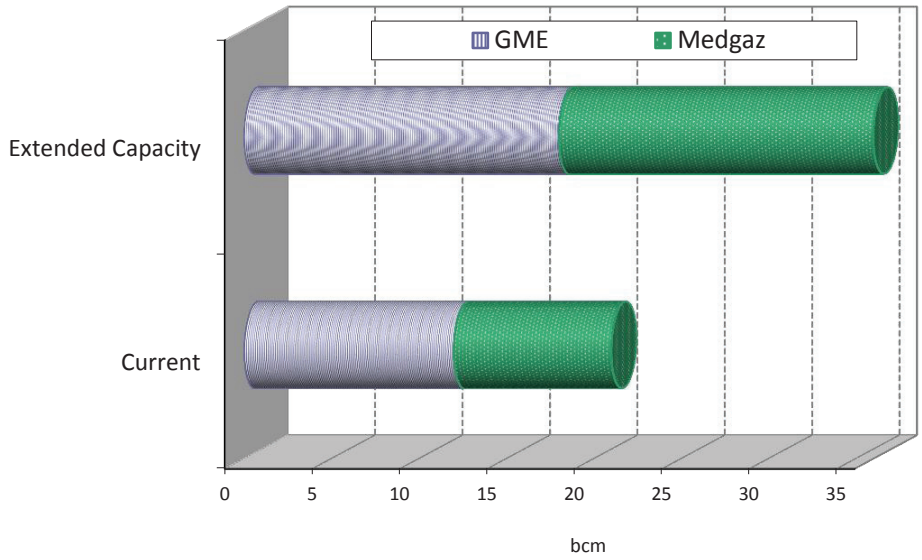


FIGURE 8 - 5 POSSIBLE EXTENSION OF PIPELINES FROM ALGERIA TO THE IBERIAN PENINSULA

These extensions of capacity could carry 38 bcm to Europe. It is important to note that reaching this supply level, Europe's dependence on Algerian gas would represent around 16%, far from the dependence on Russian gas.

As the Iberian-French Corridor will be reversible, this characteristic allows that the gas flow from Russia would reach the Iberian Peninsula, if needed, non-FID projects within Europe are also developed.

Creating a new route from North to South, opening the access to gas from Russia to the customers and shippers operating in the South of Europe, contributes to the increase of the liquidity in the market. It also opens possibilities of arbitrage between the different European gas sources, making the transmission system a powerful contributor to the security of supply and to the achievement of the single market. The development of the Iberian-French Corridor should contribute to the development of liquidity of hubs in the South Region.

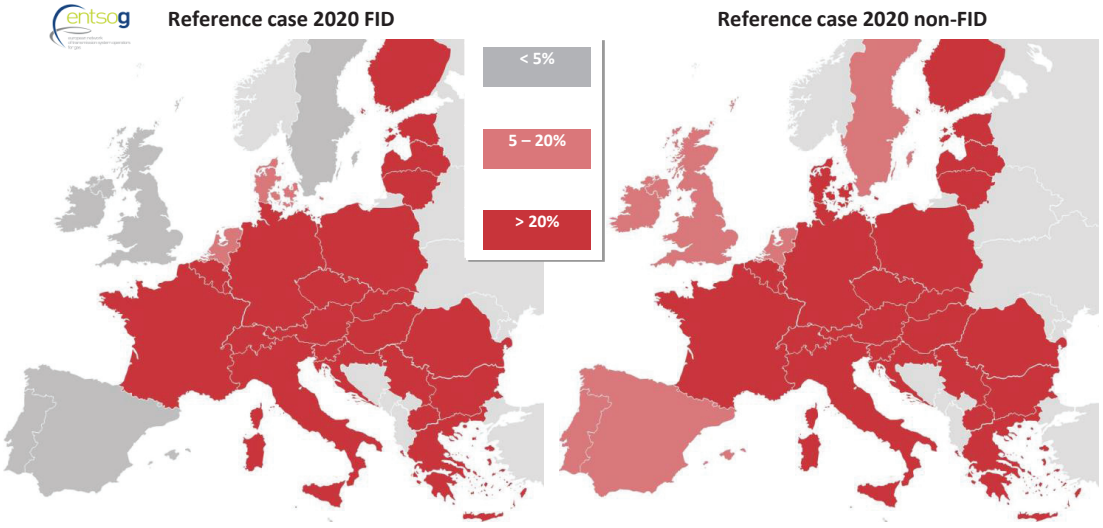


FIGURE 8 - 6 EVOLUTION OF RUSSIAN GAS INFLUENCE IN THE EUROPEAN NETWORK

9. CONCLUSIONS AND THE WAY FORWARD

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The South Region GRIP report seeks convergence and coherency with ENTSOG – TYNDP 2011-2020 and with the "Energy Infrastructures Priority for 2020 and beyond" regulation.

The report **highlights the value** of the cross border projects **IBERIAN-FRENCH CORRIDOR** and **3RD IP PORTUGAL-SPAIN**, both part of the **North-South Corridor in Western Europe, to achieve the European Energy objectives for 2020 and beyond**.

From the point of **DEMAND**, the South Region achieves more than 20% of the total gas demand of Europe stressing the development of the regional gas market. Focusing on the South Region, the French gas market represents close to 55% of the total gas market, followed by Spain reaching 40%.

Natural gas in the South Region is used mainly for residential and commercial heating, industrial processes and electricity generation. The CCGTs consumption is identified as the main driver for increasing the level of gas consumption for the next 10 year period.

As a consequence, gas demand will become more volatile due to the interactions between the electricity market and the gas market, with wind generation affecting not only the electricity system but also the gas system.

Increased volatility of gas demand requires more day-to-day and within-day flexibility of deliveries, and seasonal swings. It is stressed that the main **INSTRUMENTS OF FLEXIBILITY** in the gas system in the South Region are **UNDERGROUND STORAGES** (UGS) and **LNG TERMINALS**. These facilities, providing flexibility, **enable the CCGT *intermittent consumption*** due to the renewable energies intermittency.

From the point of **SUPPLY**, around 55% of the natural gas imports in the South Region are delivered as liquefied natural gas (LNG).

The main changes experienced in the LNG market in recent years are the following:

- the globalization which allows finding alternatives sources and cargoes,
- the increase of the short-term and spot market making possible the access to multiple sources of supply,

This high share of LNG supply provides the gas market in the South Region with a high level of diversification of sources, reducing the level of risk in case of lack of supply.

Creating the European internal gas market, increasing cross-border interconnection into the Region but also with the rest of the European countries, **the South Region will contribute to providing diversification of Supply sources into the Union improving the internal security in facing a lack of supply crisis**.

SOUTH REGION GRIP report, focused on analysing cross-border interconnections, highlights the role played by the development of the **Iberian-French Corridor** and the **3rd IP Portugal-Spain contributing to achieve the European Energy objectives for 2020 and beyond** creating the European gas market.

The **KEY CONCLUSIONS** obtained are the following:

- **INTERCONNECTION LEVEL: IBERIAN-FRENCH CORRIDOR covering gas Demand creating the European internal Market**

  The increase in the level of interconnection as a consequence of developing the Iberian-French Corridor is remarkable in order to increase the level of security in both country's Gas Systems:

  → The share of *peak demand* that could be covered developing the Iberian-French Corridor would be increased by more than 10%.

- **SUSTAINABILITY: 3RD IP PORTUGAL-SPAIN and IBERIAN-FRENCH CORRIDOR providing flexibility facilitating Renewable Energy Integration in Europe**

  The three Gas systems involved show significant complementarities both in terms of flexibility sources (mainly UGS in France, mainly LNG terminals in Spain and Portugal) and flexibility needs. These synergies advocate for increased interconnection capacities, to provide network flexibility enabling the integration of renewable energies and rhythmic gas demand:

  → The flow of gas through these interconnections could be mainly linked to LNG facilities and UGS as tools that provide flexibility.

  The development of the 3rd IP Portugal-Spain and the Iberian-French Corridor contributing to remove capacity bottlenecks (as identified by market integration and security of supply tests) at the cross-borders, increases free gas flows between countries and allows to increase short-term deliverability from LNG Terminals and UGS.

- **DIVERSIFICATION OF GAS SOURCES: 3RD IP PORTUGAL-SPAIN and the IBERIAN-FRENCH CORRIDOR spreading diversification of Sources into the Union**

  The Iberian Eastern Axis and the 3rd IP Portugal-Spain, better linking the countries in the South Region, will contribute to increase security of Supply into the Region, and additionally, it would provide other European Member States the potential access to a high level of a number of different sources of gas.

  The South Region, currently characterized by a highly diversified supply portfolio with imports from over 14 different origins, will spread this level of diversification improving the security of supply in the Union.

- **DIVERSIFICATION OF GAS ROUTES: 3RD IP PORTUGAL-SPAIN and the IBERIAN-FRENCH CORRIDOR providing diversification of Routes of Gas**

  The South Region has a good level of diversification of Routes of gas. The creation of new cross-border interconnections, developing the Eastern Axis and the 3rd IP Portugal-Spain, improves the Regional Cooperation reducing the risks associated to technical failures of the entry points or to a lack of supply from external countries. The development of these new cross-border interconnection capacities makes the South Region gas system more reliable and flexible.

  The report highlights the level of diversification achieved in Portugal creating the Gas Iberian Market (MIBGAS). The 3rd IP Portugal-Spain will facilitate the energy exchange between Portuguese-Spanish gas systems, as well as the integration of the LNG plants of the Iberian Peninsula in the European market, providing European System integration through the creation of the MIBGAS (Iberian Gas Market).

- **RESILIENCE ASSESSMENT: Regional Cooperation to face "DISRUPTIONS": The role of the 3RD IP PORTUGAL-SPAIN and the IBERIAN-FRENCH CORRIDOR interconnections**

  LNG disruption from Algeria and Qatar, and North Africa (via pipelines) disruptions should not limit the ability of South Region to cover their overall demand whereas a lack of LNG from Nigeria and

the Algerian disruption (LNG and pipelines) show the congestion of the current and FID cross-border projects leading to a lack of remaining flexibility in the Spanish and Portuguese gas systems.

Developing the Iberian-French Corridor and the 3rd IP Portugal-Spain could enable to face these disruptions and to meet the whole demand under these extreme situations. Highlighted is the Regional Cooperation in both cases to solve a "security of supply" risk.

- **MARKET INTEGRATION: the 3RD IP PORTUGAL-SPAIN and the IBERIAN-FRENCH CORRIDOR facilitating the usage of the developed and planned LNG Terminals**

The role played by the 3rd IP Portugal-Spain and the Eastern Axis, allowing to achieve the market integration objective for the Iberian LNG Terminals, is also highlighted. Developing these new cross-border interconnections, the Iberian existing and FID LNG Terminals for 2020 would reach the objective of market integration (as defined by ENTSOG in its TYNDP), as well as the rest of the LNG Terminals located in others European countries (France, Belgium, UK, Netherlands and Italy).

This availability will increase the competitiveness and liquidity of gas markets providing equal opportunities for shippers, enabling a high level of competition and contributing to reduce market concentration in Europe. Removing cross-border capacity bottleneck between France and Spain, as identified by market integration tests, will bring the European gas markets closer, making the development of large scale energy trade between countries possible.

- **MARKET INTEGRATION: the 3RD IP PORTUGAL-SPAIN and the IBERIAN-FRENCH CORRIDOR interconnecting the Mediterranean area and the Northern supply Corridor**

The strategic concept for the North-South Corridor in Western Europe defined in the *"Energy Infrastructure Priorities 2020 and beyond"* is to better interconnect the Mediterranean area and thus supplies from Africa and the Northern supply Corridor with supplies from Norway and Russia.

The development of the **IBERIAN-FRENCH CORRIDOR** opens a path to transport gas from new extended capacity of the existing import pipelines from Algeria, Gazoduc-Maghreb-Europe (GME) and Medgaz to central Europe through France.

Creating a new route from South to North, the European diversification of supply will increase, reducing the dependence on the incumbent gas source jointly with the risks linked to security of supply, and through a better interconnect area in developing the internal European gas market.

As the Iberian-French Corridor will be reversible, this characteristic would allow Russian gas to reach the Iberian Peninsula.

Creating a new route from North to South, opening the access to gas from Russia to the customers and shippers operating in the South of Europe, contributes to the increase of the liquidity in the market. It also opens possibilities of arbitrage between the different European gas sources, making the transmission system a powerful contributor to the security of supply and to the achievement of the single market. The development of the Iberian-French Corridor should contribute to the development of liquidity of hubs in the South Region.

Investment in gas infrastructures is a key issue in the construction of the European Internal Gas Market where Transmission System Operators (TSOs) have a vital role to play. The TSOs in the South Region are strongly involved in it.

ANNEX I

1. Developments in Portuguese Natural Gas System infrastructures

The creation of a new Natural Gas interconnection infrastructure between Spain and Portugal is part of the development of the Iberian Gas Market (MIBGAS) which, taking into account the important LNG regasification capacity in the Iberian Peninsula in the European and global context, aims to become a relevant market worldwide.

The projects presented and detailed in the core of this document are those which directly impact and are necessary for the Third Interconnection between Spain and Portugal (3rd IP). Nevertheless, to achieve some of the important objectives of this new interconnection, like the integration of the LNG plants of the Iberian Peninsula, the integration of the underground storages of Portugal and Spain, and to guarantee the possibility of bi-directional flow of the 3rd IP, some additional core network developments in the Portuguese Natural Gas System infrastructures will be crucial. These core network developments are summarized below.

Compressor Station of Carregado

The compressor station of Carregado is crucial to guarantee the south-north flow from the LNG Terminal in Sines. Without this compressor station the flow from south to north would be restricted to a maximum of 257 GWh/d from the regasification of the LNG Terminal. With the compressor station of Carregado the regasification capacity from the LNG Terminal in Sines can rise to a value of 321 GWh/d with a peak hourly value of 386 GWh/h (1.350.000 $m^3(n)/h$). These capacities are crucial to guarantee the bi-directional flow of the 3rd IP between Spain and Portugal in the future years, namely the export capacity from the Portuguese Natural Gas System to the Spanish Gas Network.

Pipeline Mangualde Celorico

The pipeline Mangualde Celorico is already a FID project that was decided in order to increase the security of supply of the Portuguese Network, linking to brunch lines. With this project the core network will be partially meshed and will increase the security of supply of the Portuguese System. The Mangualde Celorico pipeline is also a component of the 3rd IP between Spain and Portugal, justifying the diameter chosen for this pipeline.

Development of the UGS of Carriço Gas Storage Station

The Gas Storage Station capacity expansion of the UGS at Carriço is also another key driver to guarantee the success of the 3rd IP between Spain and Portugal in future years. The integration of underground storages of Portugal and Spain is one of the main objectives of this new Interconnection Pipeline. The expansion of the capacity of the Gas Storage Station, both the injection capacity and the withdraw capacity are fundamental to take full advantage of the 3rd IP potential. The Gas Storage Station expansion will duplicate the capacity and shall follow the increase of the salt caverns capacity as well.

The Gas Infrastructure Development and Investment Plan is a government responsibility after receiving a proposal of the document from the TSO REN. This Plan includes the main infrastructures development and corresponding investments in the network, underground storages and LNG terminals, as well as new in-takes and off-takes of the Portuguese Natural Gas System. The new Plan 2011/2014, with an overview to 2020, is still under public consultation and approval from the competent authority (DGEG from the government). Only after formal approval will the document be biding and the referenced projects can pass to a Non-FID to a FID status.

2. Network developments on the GRTgaz North–South link

As described in the GRTgaz Ten Year Development Plan (published in october 2011), many projects would involve core network developments, including the North-South link.

Access to the South Zone of GRTgaz has already improved since 2009 thanks to two factors:

- First, the Fos Cavaou terminal has been running at 100% capacity since September 2010. This additional volume in the South zone has resulted in a reduction in the rate of use of the North-South link, which dropped from about 90% in 2009 to around 70% in 2010.
- Moreover, the coupling service of the North and South marketplaces (PEGs) is currently being tested since the 1st July 2011, with the support of Powernext. This service helps to maximise the capacity utilization of the North-South link. In the first phase, the capacity made available by GRTgaz is a firm capacity of 10 GWh/day in each direction, North-South and South-North, on a daily basis.

However, many projects in the South GRTgaz Zone and the development of new entry and exit capacities in the South Zone will require reinforcement of the core transmission system in order to maintain or develop the network fluidity. Indeed, congestion emerges, notably between the North and South of this zone as soon as entry and/or exit capacities are developed in the South.

In light of all the development projects identified in the South Zone, the network's core should be strengthened along a south-north axis between Saint Martin the Crau, in the South zone, and the core transmission system of the North zone.

ERIDAN project

Given the large number of potential projects requiring the reinforcement of this axis in the medium term, the importance of this reinforcement for the European and French markets, and the European Commission's support for this investment via a significant subsidy, GRTgaz decided to proceed with strengthening this corridor in its southernmost part. This project, called ERIDAN, consists in looping the Artère du Rhône pipeline by mid-2016. The French regulator, CRE, approved this investment on the 19th of April 2011.

ERIDAN will help develop the fluidity and flexibility of the South Zone and is an essential step in the process of merging zones. It also participate to the North-South corridor in Western Europe.

Development of LNG Terminals

Adaptation of Fos Tonkin LNG terminal

The operator of this terminal launched an Open Season in early 2011 to validate the market's interest in the renovation and/or expansion of its terminal for 2014-2015 to achieve a capacity of 3 to 7 billion m^3/year (bcm/y). In parallel, GRTgaz launched the technical and economic studies necessary to evaluate the impact of this development on the network.

This adaptation should not require any investment in the GRTgaz main network beyond Eridan.

Connecting a new LNG terminal at Fos-sur-Mer

The company Fos Faster LNG Terminal SAS notified GRTgaz of its intention to build a new LNG terminal at Fos-sur-Mer. The commissioning of this new infrastructure with a regasification capacity of 8 to 16 bcm/y is planned for 2017.

The public debate ran from September to December 2010 and the results were released on 17 February 2011. Fos Faster LNG Terminal SAS decided to proceed with project studies and will launch a market consultation from June to October 2011.

Connecting this terminal with a capacity of 8 bcm/y may require the following investments:

- A pipeline between the terminal and Saint Martin de Crau
- The looping of the Est Lyonnais pipeline (in addition to the Eridan project)
- The end of the project looping the Beauce pipeline

Expansion of the Fos Cavaou LNG terminal

The operator of this terminal informed GRTgaz of its plan to study the eventual expansion of the Fos Cavaou terminal (commissioning date of 2019). This rise in capacity could require:

- Adaptation of the interconnection at Saint Martin de Crau,
- Reinforcements North of the Etrez station,
  - completion of the Artère de Bourgogne looping and,
  - strengthening of compressions on the Saint-Martin - Voisines axis

Development of storage

GRTgaz, in conjunction with Storengy, will proceed to connect a new storage capacity in the new Hauterives storage site (Drôme) to the transmission network at the Saint Avit station.

In addition, the company Géométhane conveyed to GRTgaz its decision to renovate and increase its storage capacity at Manosque. Géométhane plans to increase the injection capacity at the Manosque site by approximately 125% starting in 2016 then to bolster the withdrawal capacity of the same site by around 80% in 2018.

The 2018 boost of withdrawal capacity could require the following transmission developements, in addition to the core network developments identified for the other projects:

- Partial looping of the Artère de Bourgogne pipeline
- Compression reinforcement at Saint Avit, Etrez and Palleau

Development of interconnection capacity with adjacent networks

Capacity development with the TIGF network and Spain

The Spanish market's demand to strengthen the interconnection with France in both directions was identified in 2005. This topic has been at the heart of discussions within the South Gas Regional Initiative led by Spanish, French and Portuguese regulators and with the active involvement of shippers and transporters, including ENAGAS, GRTgaz, Naturgas Energia Transporte and TIGF.

Following the open seasons held in 2009 and 2010, it was decided to increase the capacity of the Spain – France interconnection on the West axes, but capacity requests were not sufficient to decide the creation of a new interconnection at the East of the Pyrenees (Midcat project).

If Midcat project is decided (in addition to the projects described in the preceding paragraphs), the following structures in the GRTgaz network could require changes to deliver the gas to the core of the network:

- Reinforcement of compression station at Saint Martin de Crau
- Creation of a compressor station in Montpellier
- Core network reinforcements (in addition to the reinforcements described in the preceding paragraphs):
  - completion of the looping of the network north of the Palleau station
  - expansion of the compressor stations located between Saint-Martin de Crau and Voisines.

Development of the line between GRTgaz's North and South zones

Since its inception GRTgaz has been committed to simplifying its offer by reducing the number of entry-exit zones. The number of zones has been lowered from four areas in 2005 to two as of 1st January 2009. The continuation of this simplification approach, if confirmed by the market, would result in the merger of the North and South Zones.

To merge the two GRTgaz zones using only network-strengthening solutions, a GRTgaz study conducted in 2009 showed that it was necessary to loop the Lille-Marseille line at an estimated cost of € 2.5 billion (see GRTgaz Ten Years Development Plan).

Today, with the completion of two major core network projects (Eridan in the South Zone and Arc de Dierrey in the North Zone) it is advisable to again study the opportunity of defining a single zone for the GRTgaz network. At the request of CRE, GRTgaz entrusted the preparation of the study to an independent firm. This study, overseen jointly by the Ministry, the Energy Regulation Commission (CRE) and GRTgaz, will be finalised by the end of 2011.

It will then be necessary to evaluate the solutions which can alleviate bottlenecks in terms of feasibility, cost and impact on stakeholders. Three types of combinable solutions are being considered at this stage:

- Investments
- Restrictions on network terms of use
- Contractualisation of flow commitments in the more or less long term

3. Network Developments in Spanish Natural Gas System infrastructures

This paper has outlined some infrastructures linked to interconnection points, but is part of the "core network". These facilities are covered by national planning both for supporting interconnections and for additional functionalities linked to the criteria that determine the gas network design, such as:

- ✓ Covering peak demand (conventional and gas power generation)
- ✓ Covering winter/peak demand in case of disruption of one of the entry points
- ✓ Covering peak demand in case of unpredictable additional demand increases
- ✓ Sufficient system meshing
- ✓ Etc…

These additional functionalities are summarized below:

- Loop Tivissa-Paterna: Significant increase in the *Levant* axis capacity up to 240 GWh/d under normal conditions, allowing free flows among the LNG terminals located there, in order to face a potential Barcelona terminal failure by covering demand in the Catalonian area. Barcelona is the biggest facility in the Spanish gas system, and its failure should be analysed in order to meet the requirements set out in SOS regulation. Gas needed to cover demand in case of its failure might come both from Levant axis and from *Valle del Ebro* area.

- Zarza de Tajo-Yela: It is an essential infrastructure to allow the Yela UGS integration in the network, by transporting the correct flows of injection and withdrawal.

- Yela-Villar de Arnedo: This pipeline is required to integrate Yela UGS in the *Valle del Ebro* axis. It also increases the transmission network meshing and increases the interconnection capacity between the north and south of Spain.

- Treto-Llanera: The main functionality of this infrastructure is linked to Musel's new LNG terminal. This pipeline enables the whole evacuation of Musel's production and increases the network meshing in the North axis, allowing the correct integration of the *Cantabrian* LNG Terminals in the network, in order to cover the demand in the event of disruption of one of the LNG terminals located in this area.

- Bilbao-Treto: This infrastructure increases the network meshing and links the *Cantabrian* and *Basque Country* areas, providing therefore, flexibility to the system and support to the Treto-Llanera pipeline, in the event of a possible disruption at any entry point in this area.

- Loop Villar de Arnedo-Castelnou: As mentioned before, a disruption in Barcelona would be a critical situation for the Spanish gas network, impacting the historic national criteria (infrastructure disruption on a winter day) and the SoS regulation related to the infrastructure standard incoming gas flow is needed, from Levant and *Valle del Ebro axis*. The Villar de Arnedo-Castelonu loop increases the *Valle del Ebro* capacity, required to transport gas from *Cantabrian* and centre areas to Catalonia's area, with the scope of covering the demand in case of a Barcelona disruption.

- New Tivissa-Arbos pipeline: It is an indispensable infrastructure to cover the demand in the area of Catalonia in the event of a Barcelona disruption, taking into account the requirements established in the SoS Regulation.

- Pipeline Martorell-Figueras: This infrastructure allows Figueras gasification and increases gas supply to Gerona's network, solving the existing bottle-neck of Montmeló-Gerona pipeline.

- Guitiriz-Lugo: This pipeline is required to solve the existing congestion in the Lugo distribution network. Lugo is an important city in Galicia, that currently is not able to promote new industrial growth due to gas supply limitations, therefore, Guitiriz-Lugo is considered an urgent infrastructure in the national planning. Also, this pipeline, along with Lugo-Zamora is needed to cover the winter gas demand, domestic, industrial and power generation of Galicia in case of failure of the Mugardos LNG terminal.

- Lugo-Zamora: This axis is mainly composed of three pipelines: Lugo - Villafranca del Bierzo, Villafranca del Bierzo - Castropodame and Castropodame – Zamora. As mentioned above, these pipelines, along with Guitiriz-Lugo are needed to cover the winter gas demand in the Galicia area in the event of disruption in the Mugardos LNG terminal. These infrastructures

also contribute to the interconnection of the North-West area with the consumption markets located in the centre of the Iberian network, looking for more flexibility and meshing in the network.

- Zamora-La Barbolla-Adradas and CS Barbolla: This connection is envisioned as a new axis crossing the West area, providing more flexibility and meshing to the network and providing communication with the entry points in the area.

National planning regarding electricity and gas networks is a government responsibility, but is developed on the proposal of the Technical System Manager, a department of Enagas. Planning is binding in terms of transmission infrastructure, storage and entry points (both LNG terminals and Import pipelines).

Currently, the Spanish gas system is ruled by the current planning, PO 2008-2016 after being actualised by the Annual Review 2009. New planning 2012-2020 is being developed and, once approved, should replace the previous one. The draft of the new planning is currently under public consultancy, and can be checked on the following link: http://www.mityc.es/energia/es-ES/Novedades/Documents/PlanificacionElectricidadGas_2012_2020.pdf

In the draft there are multiple actions planned, such as new terminals and reinforcement of the existing ones, storage development and transmission needed to meet the criteria agreed between the TSO and the Ministry.

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european network
of transmission system operators
for gas

ENTSOG • Avenue de Cortenbergh 100 • 1000 Brussels • T +32 2 209 05 00 • info@entsog.eu • www.entsog.eu