entsog

european network
of transmission system operators
for gas

Ten-Year Network Development Plan

2011 - 2020

17 February 2011

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Foreword

It is my pleasure to present to you the second European Ten Year Network Development Plan 2011-2020 of the European Network for Transmission System Operators for Gas (ENTSOG). This second edition takes one step further what was started one year ago in the inaugural Plan, by developing and emphasising the pan-European perspective and analysis. To achieve this, ENTSOG has endeavoured to take on board many of the comments, recommendations and input that you have put forward, which we very much appreciate.

I would like to see the European Ten Year Network Development Plan growing into an important means of communication on infrastructure evolution, because we all know: Europe is rapidly changing the way in which it sources, transports and uses its primary energy. ENTSOG is convinced that natural gas and tailored infrastructure will play an increasingly important role to reach the energy policy goals to which the EU is committed. As a clean fuel, transported in powerful, efficient and flexible systems, natural gas will be a vital resource to achieve Europe's aim of keeping energy competitive, sustainable and secure.

With declining indigenous production and requirements for more flexibility and supply security, the transmission network must be able to accept and transport new and evermore diverse sources of gas from its delivery point to where it is needed. The necessary investments to achieve all this will only come on-stream in a stable environment with a sound investment climate. This is a major challenge considering the uncertainties about the further development of the energy market. ENTSOG believes that this Plan, by promoting communication between stakeholders and transmission system operators, may contribute to develop a clearer picture of the evolving European gas market. Therefore, the significant dialogue with you should be continued and all views on this Plan are most welcome.

Finally, I sincerely hope that you will find the plan an interesting and informative read and I encourage you to take part in its evolution, as your input will enable ENTSOG to better cater for the needs of all of us in future editions.

Stephan Kamphues
ENTSOG President

Executive Summary

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This report produced by the European Network of Transmission System Operators for Gas (ENTSOG) is the second, of what will be a bi-annual Ten Year Network Development Plan (TYNDP). The principle aim of the TYNDP is to provide, from the perspective of the European Transmission System Operators, a pan-European view of potential gas transmission infrastructure developments during the period 2011 to 2020.

The European 3rd Energy Package sets out a requirement for ENTSOG to publish a Ten-Year Network Development Plan. Whilst this does not come into force until March 3rd 2011, ENTSOG has worked proactively with other industry stakeholders to produce this second TYNDP report, in just twelve months since the original report was published. ENTSOG has sought stakeholder feedback on the first TYNDP report, and incorporated key priorities identified into this second TYNDP report.

The European gas market is in a period of transition, declining indigenous production, coupled with increasing levels of demand, has lead to even higher levels of gas being imported. The changing European gas environment requires the European Transmission System to deliver gas from ever more diverse sources, and has seen traditional infrastructure approaches become less optimal in favour of a market led approach. Greater flexibility across the whole of the European Transmission System is necessity, and diversification of supply imperative.

In this changing environment ENTSOG has approached the TYNDP, with the aim of:

- highlighting future development projects
- showing potential supply and demand scenarios
- modelling future European network resilience to identify potential investment gaps

Infrastructure Projects:
In this report, ENTSOG provides an outlook on the development of the European gas system during the period. It has sought to include information from all existing operators and all potential infrastructure developers whilst remaining mindful of the developments in the EU gas market dynamics. Projects have been separated by infrastructure type (Transmission/Storage/LNG) along with whether the project has yet got a final investment decision.

Supply and Demand:
ENTSOG has created two demand scenarios based on 'top down' European gas demand forecasts. These are: an Average Daily Demand (1 in 2 conditions), and a High Daily Demand (1 in 20 conditions). Clearly, infrastructure needs to be designed to meet peak demands and should allow sufficient flexibility for the market to operate efficiently. ENTSOG used public information to forecast potential European supply scenarios for each supply source entering the European gas market in the period 2011-2020.

Network Modelling:

The primary aim of ENTSOG's modelling has been to assess the resilience of the European gas network through scenario development and subsequent modelling of the integrated network based on those scenarios. The network modelling completed in this TYNDP focussed on three main areas; reference case scenarios, security of supply scenarios and market integration scenarios.

- Reference case scenarios are defined by the climatic conditions and infrastructure parameters. There is no change in storage deliverability, supply disruption or supply source mix.

- Security of Supply scenarios are defined by the climatic conditions, infrastructure, supply disruption and storage deliverability parameters. There is no change in supply source mix. Comparison with the reference case gives an overview of how a certain unavailability of supply affects the gas flow distribution.

- Market Integration scenarios are defined by the climatic conditions, infrastructure and supply source mix. There is no change in supply source availability. Comparison with the reference case gives an overview of how a different supply mix affects the gas flow distribution.

This report is not intended to provide any priority list of projects to be implemented. Instead, ENTSOG aims to provide market participants and other stakeholders with signals that can be further investigated in their decision-making processes for market-triggered investment or for central funding. The TYNDP is meant to be used in conjunction with regional [1] and national plans so that a wider appreciation of potential network needs is transparent.

The key conclusions reached through the network modelling analysis are that although the overall situation improves over the 10-year range owing to the FID projects being implemented in the near future, there are still three regions that will not have enough capacity to achieve full supply demand balance under High Daily Demand conditions. Such regions are:

- Denmark-Sweden under the Reference Case
- the Balkans under the Ukraine disruption
- Poland-Lithuania under the Belarus disruption

Finally, ENTSOG modelled the European network covering a wide range of scenarios which combine different values of specific parameters (available infrastructures, climatic conditions, supply disruption, storage deliverability and supply source mix). The results show that the European gas network is evolving from a very deterministic design based on main historical imports underlined by big trunk pipelines to a more integrated grid design. Three main investment drivers may be identified as follows:

- new import routes introducing the ability to send gas directly to the centre of the European gas network
- a better integration of historic transit countries receiving gas from mainly one single source until now
- an adaptation of the core of European gas network to enable these new trends

ENTSOG actively encourages all input and feedback from stakeholders regarding the TYNDP; only through further dialogue can future editions of the TYNDP develop to continue to meet the evolving market expectations.

[1] TSOs, operating through ENTSOG, aim to produce the first regional plans around the end of 2011 or early in 2012.

Introduction

© Image courtesy of BEB

This European Ten Year Network Development Plan provides a pan European view of supply, demand and capacity development from the perspective of Europe's gas transmission network operators.

In the third EU Energy Package legislation, it becomes a legal requirement for ENTSOG to publish a "community wide ten year network development plan, including a European supply adequacy outlook, every two years" (Art. 8(3)(b), REG-715). The third EU Energy package does not become applicable until 3 March 2011 however, in the spirit of the legislation, ENTSOG has been acting as if the REG-715 was already in force. This led to the production of the first TYNDP report in December 2009 and, now, ENTSOG is presenting its second edition, the TYNDP 2011-2020 report.

The aim of this Plan is to show a consistent European gas infrastructure outlook signalling potential future investment gaps. It also endeavours to capture the wider gas market dynamics by looking at aspects such as supply potential, market integration, and Security of Supply.

ENTSOG built upon the inaugural TYNDP report incorporating market recommendations to enhance the output of the second TYNDP report to meet high stakeholders' expectations. In the limited amount of time, we did our best to strike the right balance between the market expectations and the interests of all stakeholders. The following areas were identified as key priorities and formed the main focus:

- Development of a top-down approach to demand and supply scenarios
- Enhancement of the network modelling tool
- Improvement of graphical representation of modelling results
- Transparency on modelling assumptions
- Closer involvement with project sponsors

For system planning, TSOs need information on the gas market evolution, including demand and supply. Having been 'unbundled' from certain information sources, TSOs have to develop their own expertise regarding relevant aspects of the gas chain, the accuracy of which depends also on the interaction with other stakeholders who make their own market projections.

This TYNDP is published amid the context of a world which is changing the way in which it sources, transports and uses its primary energy. Natural gas plays an important role in the energy mix of the EU and a number of priorities must be dealt with in the coming years.

Declining indigenous production and increasing demand means the transmission network must be able to accept and transport new and ever more diverse sources of gas from its delivery point to where it is needed regardless the national boundaries.

Therefore a sound investment climate is required. Investment parameters should be set in such a way that TSOs are able to build the required infrastructure for any project the market asks for and wants to commit to, under economically viable conditions.

As Europe pushes hard to embrace cleaner forms of energy, natural gas can certainly be key to Europe replacing older, carbon intensive forms of electricity generation. Gas power stations are well positioned to fill much of this generation deficit directly and relatively quickly, and they will also provide the necessary backup for the periods when renewables such as wind turbines are not able to generate.

The recent economic downturn has had some effect on the annual gas demand (yearly volumes). However, infrastructure is designed according to the peak capacity demand driven by trading flexibility requirements, severe winter conditions and supply disruptions. The 1-in-20 minimum standard in the new security of supply regulation may thus impose even stricter design conditions on TSOs than before.

The above illustrates the uncertainties linked to any future outlooks. The uncertainty increases further with the projected timeframe. In order to address this level of uncertainty, ENTSOG undertook 'sensitivity studies' (Resilience scenarios) around a reference case to give a picture of some characteristic scenarios.

This can be seen in the graphical representation below:

In this TYNDP, firstly potential Infrastructure (I), Supply (S) and Demand (D) scenarios are defined. Secondly, these scenarios are combined in Infrastructure-Supply-Demand (ISD) scenarios in order to capture the various developments. Thirdly, the scenarios are modelled to assess the resilience of the overall European gas network.

The key ERGEG recommendation from the first TYNDP report was to combine the existing 'bottom up' methodology, using the TSO national data regarding supply and demand, and incorporate a more 'top down' European approach. The 'top down' approach requires a broader European perspective of the TYNDP, instead of national methods. The focus for the TYNDP 2011-2020 was consistency of approach across a number of areas such as: demand data, new infrastructure projects and the provision of information by each country. The 'top down' approach also focused on transparency, ensuring a clear understanding with regard to network modelling and European supply and disruption scenarios.

Supply will still meet demand but the modelling process is different as the simulation will start with supply-driven flow assumptions rather than with pro-rata supply coverage of the demand like in the first TYNDP report. The 'bottom up' approach remains incorporated into the TYNDP in accordance with the REG-715 to 'build on national investment plans', meaning that the TYNDP 2011-2020 is an amalgamation of both approaches.

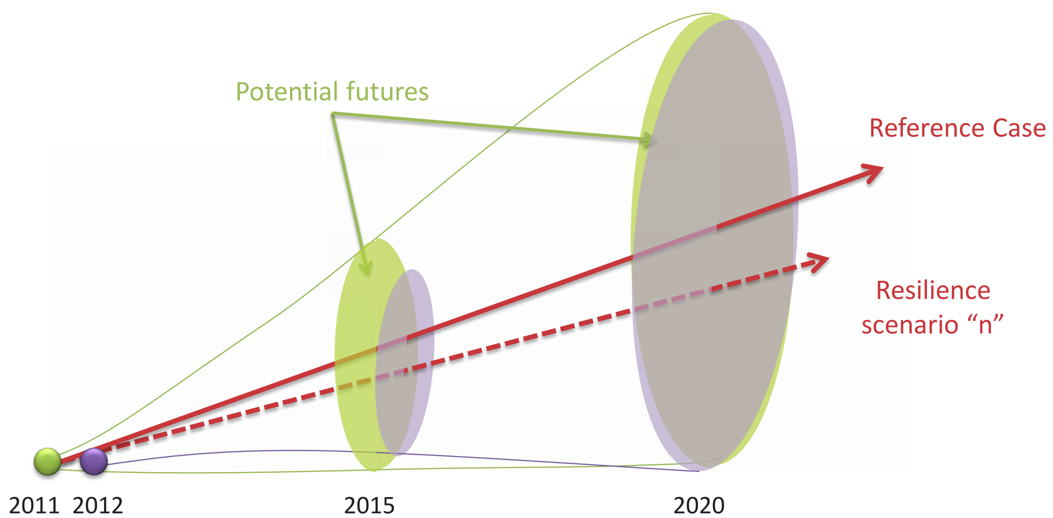

Figure 1: Uncertainties of future outlooks

Each TSO is responsible for 'operating, maintaining and developing under economic conditions secure, reliable and efficient transmission facilities to secure an open market, with due regard to the environment, and to ensure adequate means to meet service obligations[1] and infrastructure capacity data has therefore been directly supplied by each TSO accordingly[2]. The supply data required for the 'top down' modelling approach has not been supplied by TSOs and as such ENTSOG were required to gather supply information from public sources. ENTSOG would like to make it clear that we accept no responsibility for the accuracy of the data which comes from public sources or third parties. The TYNDP report will make clear distinctions between TSO data and public and third party information. Public and third party information has been used on a best endeavours basis and for future editions of the TYNDP further interaction from suppliers would be welcomed.

The TYNDP report is constantly evolving to meet market and stakeholder expectations. We at ENTSOG welcome feedback on this report, and further market participation.

[1] Art. 13(1)(a) DIR-73

[2] Data were supplied by TSOs between September and October 2010 and, therefore, they reflect the situation and knowledge at this period.

Infrastructure Projects

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To provide an outlook on the development of the European gas system in the following ten years while capturing the EU gas market dynamics, ENTSOG has adopted an open approach to future infrastructure. This nevertheless means that ENTSOG needs to collect data from project sponsors that are not directly affected by legal obligations of Regulation (EC) 715/2009 regarding the production of the TYNDP Report.

To collect all necessary data for the TYNDP 2011-2020 from non-ENTSOG members, ENTSOG launched an 'Infrastructure questionnaire' in July 2010 relying on the relevant stakeholders' good will as well as their high expectations from the TYNDP to provide the data. Even though ENTSOG has not received all information from the project sponsors as requested, considering the pilot character of the exercise, ENTSOG has decided to include all projects where sufficient information was provided with regards to the network modelling needs (capacity, interconnection, FID date, date of commissioning [1]). ENTSOG has also recognized that the cost estimates for some projects were marked as confidential. Initially, we considered aggregation of cost estimates per country, which nevertheless, in the last stage of data processing, proved insufficient to protect the confidential information in all cases. This led to the aggregation of cost estimates per infrastructure type broken down per FID and non-FID projects. These may be found at the end of this chapter. As some project sponsors refused to provide the cost (investment) estimate under the application of country aggregation and we have not had time to discuss the last stage compromise with them, such costs are not covered, and projects which are concerned are listed.

Despite the difficulties encountered during the data collection exercise, ENTSOG would like to note that it was very useful to interact with the stakeholders in this way and would like to use an improved method of collecting data based on the original approach for the following edition of TYNDP as well. In addition, it should be noted that ENTSOG members were requested to provide the exact same data as non-ENTSOG members as well as some additional information relevant to their operation of the transmission systems. Due to the enormous amount of data received from TSOs, it was decided to provide a summary of all TSOs' projects per each TSO rather than a separate entry for each project reported.

To capture the uncertainties of the following ten years, ENTSOG was interested in receiving information about projects that are at different stages of development thus covering those 'Under construction' as well as projects in 'Planning/Under consideration'. For this edition of the TYNDP, ENTSOG has considered all projects that have indicated the date of commissioning in 2019 or earlier. As projects that have not yet received a Final Investment Decision are less likely to come on-stream than those past such decision, ENTSOG has divided all future projects

[1] Where this date had not been provided or the date was indicated as 'beyond' a particular year of the covered period, an assumption was taken that the commissioning would be at the beginning of 2020, that is, the last year of this TYNDP. The year 2020 is then marked with a star throughout the TYNDP Report [*].

into two groups: FID Projects and Non-FID Projects [1]. This division was necessary for determining correctly the potential investment gaps within the network modelling simulations [2].

In the following sub-chapters, ENTSOG lists all infrastructure projects where information was provided as part of the infrastructure enquiry [3]. The projects are presented according to the above-mentioned grouping and further divided by the type of infrastructure (transmission, storage and LNG). The lists include only main project specifications while full submissions are available in Annex A: Infrastructure Projects. The capacities listed below include only additional capacity where the project is an expansion of the current facility.

The information reflects situation as at 30 September 2010.

[1] Note that Non-FID Projects cover projects at different stage of development. More detailed Information about the stage reached is available in Annex A.

[2] Details of the network modelling methodology are described in Chapter on Network Modelling & Resilience Assessment.

[3] Some projects have been aggregated for the purpose of these lists to provide a global view of the underlying developments.

• FID projects (TSO and 3rd Party Projects)

Transmission				
Country Code	Name	Capacity [8] (Mcm/d)	Estimated Go-live [9]	Remarks
AT	WAG Expansion 3	()[8]	2013	
BE	Fluxys - Winksele & Berneau CSs	()[8]	2012- 2013	
BG	Bulgartransgaz - System Capacity Enhancements	()[8]	2012-2013	
BG / RO	Bulgartransgaz/Transgaz – RO-BG interconnection	4.1	2012	EEPR project
CZ	N4G - UGS Tvrdonice connection	()[8]	2012	EEPR project
CZ	N4G - CZ-PL interconnection (Project Stork)	2.4	2011	EEPR project
CZ	N4G - CZ-SK interconnection (Reverse Flow)	()[8]	2011	EEPR project
DE	Open Grid Europe - System Capacity Enhancements	()[8]	2011-2013	
DE	NEL	54.8	2012	
DE	OPAL	95.9	2011	
DK	ENDK - DK-DE interconnection (Ellund)	Entry: 16.8 Exit: 4	2013	
ES	Enagás - System Capacity Enhancements	()[8]	2011-2015	
ES	Enagás - ES-FR interconnection (Larrau)	Entry: 5.7 Exit: 14.3	2013	EEPR project
ES	Enagás - ES-FR interconnection (Biriatou)	Entry: 5.2 Exit: 4.8	2012-2015	

(8) Transmission capacity is given only for third-party projects and where projects relate to a single cross-border IP. The capacity represents the figure feeding into the network modelling. Additional capacity information is available in Annex A and Annex C.

(9) See footnote No. 6

Transmission (continued)				
Country Code	Name	Capacity [(8)] (Mcm/d)	Estimated Go-live [(9)]	Remarks
ES	Enagás - UGS connections	()[8]	2011-2020	Marisma UGS Castor UGS Yela UGS Gaviota UGS El Ruedo UGS Las Barredas UGS
FR	GRTgaz - FR-BE interconnection (Taisnières)	Entry: 4.4	2013	EEPR project
FR	GRTgaz - Chazelles CS	()[8]	2013	EEPR project Relates to the development of Larrau IP
FR	TIGF - TSO-TSO interconnection (PIR Midi, Project Artère de Guyenne)	()[8]	2013	EEPR project
FR	TIGF - FR-ES interconnection (Larrau, Project Artère du Béarn)	Entry: 14.3 Exit: 5.7	2012 2013	EEPR project
FR	TIGF – FR-ES interconnection (Biriatou)	Entry: 4.8 Exit: 5.2	2015	FID to be taken in January 2011 Project treated as FID in the modelling as being part of the integrated Open Season at the FR-ES border.
GR	DESFA - N. Messimvria CS	()[8]	2011	Affected countries GR/BG/TK
GR	DESFA - Aliveri pipeline	()[8]	2011	Connection of a gas-fired power plant
GR	DESFA - Megalopoli pipeline	()[8]	2012	Connection of a gas-fired power plant
HR	Plinacro - HR-HU interconnection (Dravaszerdehaly - Donji Miholjac - Slobodnica)	3.3	2011	
HR	Plinacro - System Capacity Enhancements	()[8]	2012	

Transmission (continued)				
Country Code	**Name**	**Capacity [8] (Mcm/d)**	**Estimated Go-live [9]**	**Remarks**
IT	SRG - LNG terminal connection	14	2011	New IP
IT	SRG - Montesano CS , incl. Montalbano-Messina	2.3	2011	Capacity relates to the affected IP of Gela
IT	SRG – System Capacity Enhancements in Po Valley	()[8]	2014	
LT / LV	Lietuvos Dujos / Latvijas Gaze – LT-LV interconnection	()[8]	2013	EEPR project
NL	GTS - System Capacity Enhancements	()[8]	2013	Affected Countries: NL/BE/DE
PL	Gaz-System - PL-CZ interconnection (Cieszyn)	Entry: 2.4	2011	EEPR projects: Cieszyn-Skoczów PL border MS
PL	Gaz-System - PL-DE interconnection (Lasów)	Entry: 2	2011	Phase 1 EEPR projects: Dziwiszów-Taczalin Taczalin-Radakowice Radakowice-Galów
PL	Gaz-System - System Capacity Enhancements	()[8]	2011-2014	
RO	Transgaz - RO-BG interconnection	4.1	2012	EEPR project
SI	Geoplin Plinovodi - SI-AT interconnection (Murfeld/Ceršak)	Entry: 1.4	2011	
SI	Geoplin Plinovodi - SI-IT interconnection (Šempeter-Gorizia)	Exit: 2.4	2014	
SI	Geoplin Plinovodi - System Capacity Enhancements	()[8]	2011-2014	
SK	Eustream - System Capacity Enhancements	()[8]	2010-2016	
SK	Eustream - Storage connection	()[8]	2011	
UK	National Grid - System Capacity Enhancements	()[8]	2011	

Storage					
Country Code	Name	Deliverability (in Mcm/d)	WGV (in Mcm/d)	Estimated Go-live	Remarks
AT	7 Fields	20	1608	2014	Also connected to the German network
CZ	Tvrdonice	1.7	195	2016	EEPR project
CZ	Třanovice	3.9	290	2012	EEPR project
DE	Etzel II	12.7	452	2013	Also connected to the Dutch network Assumed deliverability based on the total of 38.4 Mcm/d given for the whole project
DE	Etzel II	12.7	452	2013	Also connected to the Dutch network Assumed deliverability based on the total of 38.4 Mcm/d given for the whole project
DE	Etzel III	12.8	453	2014	Also connected to the Dutch network Assumed deliverability based on the total of 38.4 Mcm/d given for the whole project
ES	Yela	15.0	1,050	2011	
ES	Castor	25.0	1,300	2012	
ES	Marismas	5.2	622	2012	
ES	Serrablo	7.4	680	2012	Expansion
ES	Gaviota	14.0	1,558	2014	Expansion
ES	El Ruedo	0.5	90	2018	
ES	Las Barreras	0.8	72	2017	
FR	Etrez / Manosque I	10.5	140	2015	Assumed deliverability based on the total of 30 Mcm/d given for the whole project
FR	Hauterives	8	100	2015	
FR	Serene Nord / Gournay	1.8	55	2012	
FR	Trois Fontaines	0.60	30	2012	
IT	Stogit Enhancements and new developments	33	2,700	2013	
IT	Cellino	1.1	118	2010	
IT	Collalto	9	825	2011	
IT	S. Potito e Cotignola	7.2	915	2013	

Storage (continued)					
Country Code	**Name**	**Deliverability (in Mcm/d)**	**WGV (in Mcm/d)**	**Estimated Go-live**	**Remarks**
NL	Bergermeer	57	4,000	2014	GTS' IOS
NL	Zuidwending	20	300	2010	
UK	Holford	16	150	2011	
UK	Hill Top Farm	15.24	102	2012	
UK	Stublach	32.5	400	2018	

LNG terminals					
Country Code	**Name**	**Annual Capacity (bcm/y)**	**Daily Send-out (in Mcm/d)**	**Estimated Go-live**	**Remarks**
ES	Barcelona	-	-	2011	8th LNG Storage Tank
ES	Bilbao	3.5	9.6	2012 2014	Send-out increase 3rd LNG Storage Tank
ES	Sagunto	-	-	2011	4th LNG Storage Tank
ES	Musel	7.0	19.2	2012	
ES	Tenerife	1.3	3.6	2014	
ES	Gran Canaria	1.3	3.6	2015	
GR	Revythoussa	2.1	5.76	2015	Expansion ('2nd upgrade') TEN-E project
NL	Gate LNG I & II	12	39.6	2011	
PL	Świnoujście	5	13.6	2014	EEPR project; TEN-E project
PT	Sines	2.6	10.8	2012	
UK	Grain 3	6.6	21.6	2010	

• Non-FID projects (TSO and 3rd Party Projects)

Transmission				
Country Code	**Name**	**Capacity [8] (Mcm/d)**	**Estimated Go-live [9]**	**Remarks**
AT	Nabucco	84.9	2015	EEPR project; TEN-E project Affected countries: TR/BG/RO/HU/AT
AT	TGL (Tauerngasleitung)	30.9	2017	Affected countries: AT /DE
AT	South Stream	160.8	2015	Affected countries: BG/RS/ HU/SI/AT/ HR/GR
BG	Bulgartransgaz - BG-RS interconnection	4.9	2015	
CZ	N4G - DE-CZ-DE interconnection (Project Gazelle)	86.5	2012	
DE	GUD - System Capacity Enhancements	()[8]	2014-2015	Affected IPs: Ellund Oude Statenzijl
DE	GUD - UGS connections	()[8]	2014	Affected storage facilities: Etzel Jemgum Peckensen
DE	Open Grid Europe - System Capacity Enhancements	()[8]	2014-2020	
DE	Wingas Transport - System Capacity Enhancements	()[8]	N/A	
DE	Thyssengas - Emden-Werne-Eynatten/Bochholz	()[8]	2016	Affected countries: DE/BE
DE/PL	IPG (Interconnector Poland Germany)	8.2	2012	
DK	ENDK - DK-SE interconnection (Dragør)	Exit: 1.2	2013	
EE	Eesti Gaaze - Balticconnector	5.5	N/A	Affected countries EE/FI
ES	Enagás – ES-FR interconnection (Le Perthus)	Entry: 20 Exit: 15.7	2020*	
ES	Enagás – ES-PT interconnection (3rd IP)	Entry: 12.4 Exit: 12.4	2016-2018	

Transmission (continued)				
Country Code	**Name**	**Capacity [8] (Mcm/d)**	**Estimated Go-live [9]**	**Remarks**
FR	GRTgaz - FR-BE interconnection (Taisnieres or new IP)	Exit: 7	2014	January 2014
FR	GRTgaz - Core System Capacity Enhancements	()[8]	2015-2017	Affected IPs: Antifer LNG, Dunkerque LNG, Fos Tonkin LNG, Fos Faster LNG, Fos Cavaou expansion, North-South link
FR	GRTgaz - FR-CH interconnection (Oltingue IP)	Entry: 8,8 Exit: 5	2016	Affects also CH-IT interconnection
FR	GRTgaz - North-South Link	()8	2017	
FR	GRTgaz - Corsica connection to GALSI	()8	2016	
FR	GRTgaz - Fos Faster LNG connection	22 11	2016 2020*	
FR	GRTgaz - Dunkerque LNG connection	31 (45)	2015	If 10 bcm/y If 13 bcm/y
FR	GRTgaz - Antifer LNG connection	27	2016	
FR	GRTgaz - Fos Tonkin LNG connection	21	2016	Re-commissioning, incl. expansion
FR	GRTgaz - Montoir LNG connection	6 12	2014 2017	Expansion
FR	GRTgaz - Fos Cavaou connection	28	2020*	Expansion
FR	TIGF – FR-ES interconnection (Le Perthus)	Entry: 15.7 Exit: 20	2020*	
GR	DESFA - Komotini-Thesprotia	()[8]	2015	TEN-E project On-shore part of IGI Affected countries: GR/TK/IT
HU	FGSZ - HU-AT interconnection (Mosonmagyaróvár)	Entry: 11.5	2016	
HU	FGSZ - HU-SK interconnection	13.7	2014	EEPR project
HU	FGSZ - System Capacity Enhancements	()8	2013 - 2017	Incl. EEPR project enabling system bi-directionality

Transmission (continued)				
Country Code	**Name**	**Capacity (8) (Mcm/d)**	**Estimated Go-live (9)**	**Remarks**
IT	SRG - System Capacity Enhancements in North-East of Italy	()8	2020*	
IT	SRG - 2nd Southern Sealine	()8	2020*	
IT	SRG - Adriatic and Tirrenica pipe	()8	2020*	
IT	Galsi	21.9	2014	EEPR project Affected countries: DZ /IT
IT	ITGI Poseidon	24.6	2016	EEPR project; Affected countries: GR/IT
IT	TAP (Trans Adriatic Pipeline)	27.4	2017	Affected countries: AL/IT
LT	Lietuvos Dujos - LT-PL interconnection	8.2	2020*	
LT	Klaipeda - Jurbarkas	()8	2012	
NL	GTS - System Capacity Enhancements	()8	2013-	TEN-E project: Integrated Open Season Affected countries: NL/BE/DE GTS has not taken FID on Bergermeer
PL	Gaz-System - PL-DE interconnection (Lasów)	Entry: 3	2015	Phase 2 EEPR projects: Jeleniów II CS
PL	Gaz-System - PL-DK interconnection (Baltic Pipe)	8.2	2019	EEPR projects: Świnoujście-Szczecin Goleniów CS
PL	Gaz-System - PL-LT interconnection	8.2	2020*	
PL	Gaz-System - System Capacity Enhancements	()8	2014-2019	
PT	REN Gazodutos - PT-ES interconnection (3rd IP)	Entry: 8.9 Exit: 6.7	2015	EEPR project
RS	Srbijagas - RS-BG interconnection	4.9	2015	
SW	Swedegas – Skanled (revised)	9.6	2014	

Transmission (continued)				
Country Code	**Name**	**Capacity [8] (Mcm/d)**	**Estimated Go-live [9]**	**Remarks**
SI	Geoplin Plinovodi - SI-AT interconnection (Ceršak-Murfeld)	Entry: 4.5 Entry: 7.4	2014 2016	
SI	Geoplin Plinovodi - SI-IT interconnection (Gorizia / Šempeter)	Entry: 3.3 Exit: 3.6	2016	
SI	Geoplin Plinovodi - System Capacity Enhancements	()[8]	2015-2019	
SK	Eustream - SK-HU interconnection	13.7	2014	EEPR project
UK	National Grid - System Capacity Enhancements	()[8]	2014	
UK	Cluden - Brighouse Bay	48.3	2015	

Storage					
Country Code	**Name**	**Deliverability (in Mcm/d)**	**WGV (in Mcm/d)**	**Estimated Go-live**	**Remarks**
BG	Chiren	10	100	2020*	Expansion
CZ	RWE Gas Storage Virtual Storage	2	140	2015	Capacity increase of the storage facilities portfolio
DE	Behringen	14	1,000	2016	
DE	Ohrensen I	12.54	320	2020*	Assumed deliverability based on the total of 22 Mcm/d given for the whole project
DE	Ohrensen II	9.46	240	2020*	Assumed deliverability based on the total of 22 Mcm/d given for the whole project
DE	Peckensen I	4.23	160	2010	Assumed deliverability based on the total of 9 Mcm/d given for the whole project
DE	Peckensen II	4.77	180	2014	Assumed deliverability based on the total of 9 Mcm/d given for the whole project

Storage (continued)					
Country Code	**Name**	**Deliverability (in Mcm/d)**	**WGV (in Mcm/d)**	**Estimated Go-live**	**Remarks**
DK	Stenlille	2.1*	150	2020*	Assumed deliverability based on the current capacity
FR	Alsace Sud	9.60	200	2020*	
FR	Céré-la-Ronde/Soings I	2	60	2015	Assumed deliverability based on the total of 9 Mcm/d given for the whole project
FR	Céré-la-Ronde/Soings II	7	200	2020*	Assumed deliverability based on the total of 9 Mcm/d given for the whole project
FR	Céré-la-Ronde/Soings II	7	200	2020*	Assumed deliverability based on the total of 9 Mcm/d given for the whole project
GR	South Kavala	4	360	2015	
LT	Syderiai	1	0.5	2016	
LV	Incukalns	6	875	2018	Expansion TEN-E project
PT	Carrico	0	250	2011-2015	Expansion
UK	King Street Energy	32	348	2016	
UK	Portland	20	1,000	2019	
UK	Preesall	45	600	2016	
UK	Saltfleetby	8.6	775	2013	
UK	Whitehill	40	420	2017	
UK	Island Magee	22	500	2017	Northern Ireland

LNG terminals					
Country Code	**Name**	**Annual Capacity (bcm/y)**	**Daily Send-out (in Mcm/d)**	**Estimated Go-live**	**Remarks**
EE	Paldiski	2.4	24	2020*	
ES	Huelva	2.6	7.2	2018 2018	Send-out increase 6th LNG Storage Tank
ES	Musel	1.8	4.8	2018	Send-out increase
ES	Reganosa	3.7	10.1	2018	Send-out increase
ES	Sagunto	1.8 1.8	4.8 4.8	2016 2018	Send-out increase
ES	Bilbao	-	-	2020	4th LNG Storage Tank
FI	Fingulf LNG	4.0	12	2016	
FR	Antifer	9	27.6	2015	
FR	Fos Cavaou	8.3	28.2	2020*	Expansion
FR	Fos Faster I	8	22	2016	
FR	Fos Faster II	4	11	2020*	
FR	Fos Tonkin	7	21	2016	Total capacity after re-commissioning
FR	Montoir II	2.5	6	2014	Expansion
FR	Montoir III	4	12	2017	Expansion
GR	DESFA – Crete I	1.1	3.0	2016	TEN-E project
GR	DESFA - Crete II	1.1	2.9	2020*	TEN-E project
IT	Panigaglia	4.4	12.9	2020*	Expansion
IT	Brindisi	8	25	2020*	
LT	Klaipeda	3	4	2014	
NL	GATE LNG III	4	11	2015	Expansion

Aggregates of cost estimates per infrastructure type broken down per FID and non-FID projects.

LNG terminals		
Aggregation	**Aggregate Cost Estimate for Infrastructure Investments (in € 10^6)**	**Remarks**
Transmission projects -- FID	13,711	
Storage projects -- FID	4,260	Some projects missing from the estimate, see below for more detailed information
LNG Projects -- FID	3,570	
Transmission projects -- Non-FID	58,556	
Storage projects -- Non-FID	2,593	Some projects missing from the estimate, see below for more detailed information
LNG projects -- Non-FID	6,614	Some projects missing from the estimate, see below for more detailed information
Subtotal FID projects	21,514	
Subtotal Non-FID projects	67,763	
TOTAL	**89,304**	

- Storage projects not included: Alsace Sud, Behringen, Céré-la-Ronde/Soings I, Céré-la-Ronde/Soings II, Etrez / Manosque , Etzel, Hauterives, Hill Top Farm, Holford, King Street Energy, Ohrensen I, Ohrensen II, Peckensen I, Peckensen II, Preesall, Serene Nord / Gournay, Stublach, Whitehill, Trois Fontaines, 7 Fields

- LNG projects not included: Fos Cavaou, Montoir

Supply & Demand

© Image courtesy of OMV Gas

This chapter provides an outlook for the European gas demand as well as the potential European supply for the period 2011-2020. The resulting supply and demand scenarios are described below and are used in the network modelling covered in the Chapter on Network Modelling and Resilience Assessment.

Where ENTSOG uses data from third parties that do not cover every year of the whole 10-year period, the missing years are always derived through linear extrapolation.

ENTSOG would like to note that TSOs are not specialists in supply data as it exceeds their areas of responsibility within the gas chain. Supply data was therefore collected from public sources and as such ENTSOG cannot be held responsible for the accuracy of this data. Nevertheless, ENTSOG has made an extraordinary effort in gathering the best quality of data for its analysis.

Supply

For the purpose of this TYNDP, ENTSOG has defined a potential supply scenario for each source (indigenous production/import, including LNG) as the amount of gas available from a gas producer for the European market on an annual basis taking into account the available entry capacity.

For the purpose of TYNDP 2011-2020, ENTSOG has identified and collected data on the following supply sources and their potential [1]:

Indigenous production

The supply potential of the indigenous production of the European countries covered by this TYNDP is based on information provided by public institutions and TSOs themselves. The figures have also been consulted with OGP.

The figures confirm the declining character of gas production in Europe. The resulting curve signals the need to increase gas imports to cover the European demand in the future.

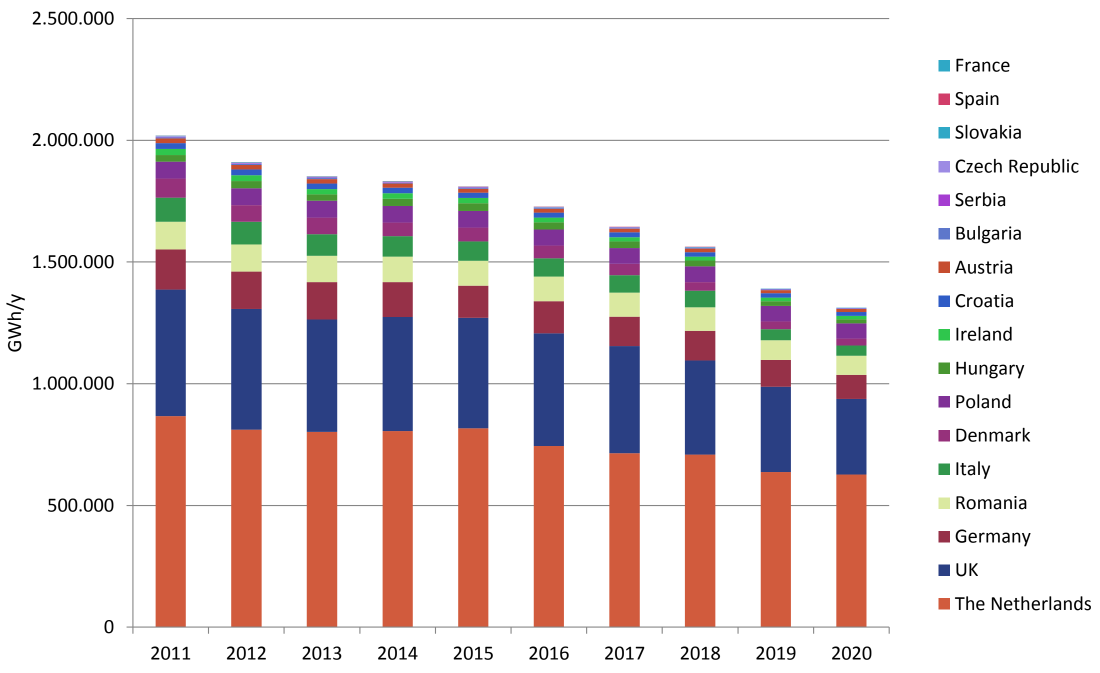


Figure 2: European indigenous production

[1] Note that all data is given in GWh/y unless indicated otherwise. All data is available in tabular form in Annex 3.

Norway

The supply potential of Norwegian gas is based on the average values for the Norwegian Gas Sales as forecasted by the Norwegian Ministry of Energy in 2010 Scenario. The resulting curve shows potential for slight increase in imported gas volumes from Norway.

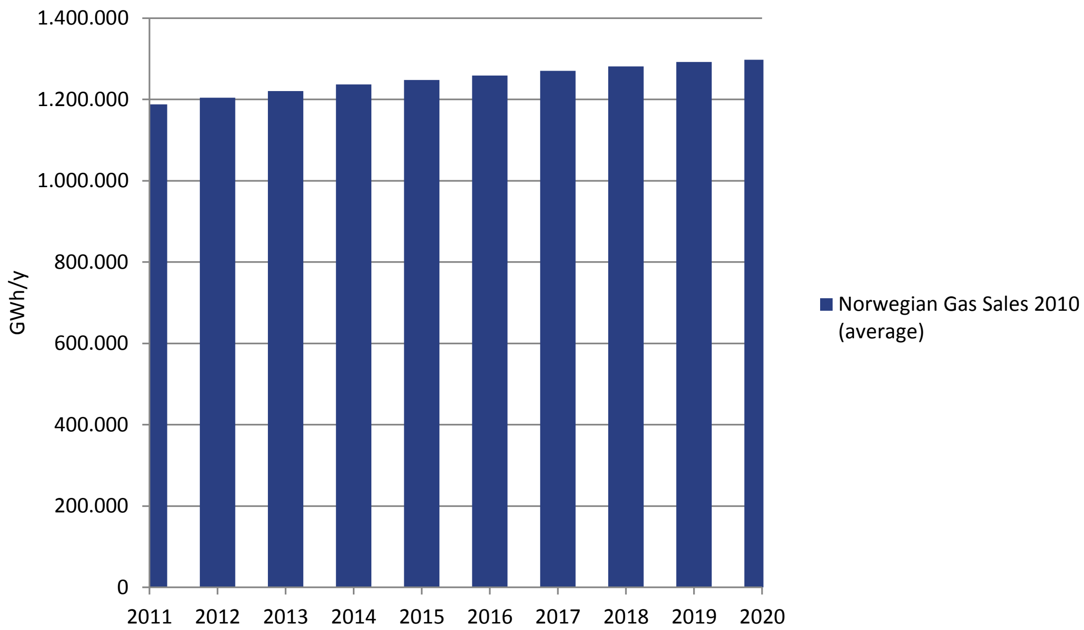


Figure 3: Norwegian gas supply potential for Europe

Russian Federation

The supply potential of Russian gas is based on the average gas exports values given in the Russian Energy Strategy (2009). Total exports through pipelines were defined and a gas balance for these exports calculated for each year of the TYNDP in order to derive the Russian potential gas supply to Europe. The supply to CIS countries was derived based on the assumption of simultaneous economic development as in Russia. Pipeline exports to Asia were not considered. Russian gas exports to Turkey were taken into account based on the supply contracts in place. The potential exports to Europe were determined as the result of the total pipeline exports from Russia given by the Russian Energy Strategy less the derived supplies to Turkey and CIS countries. Potential imports to Russia from the Caspian region were not considered in the balance.Considering the actual volume of Russian gas delivered to Europe in 2009 , the resulting curve shows potential for significant increase in supply of gas from Russia.

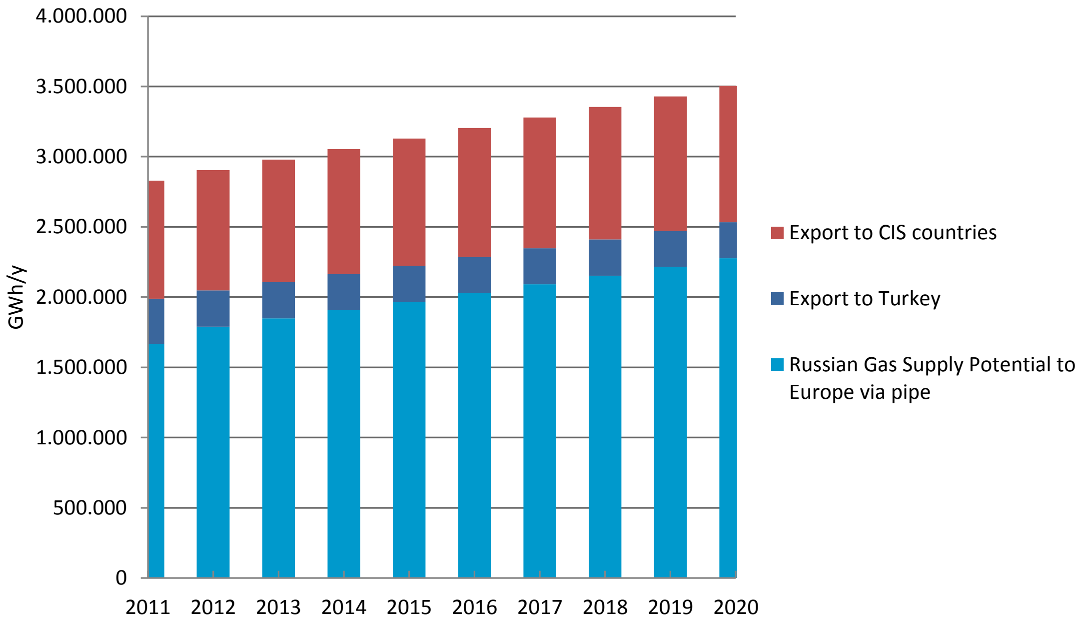


Figure 4: Russian gas supply potential for Europe

Algeria & Lybia

The supply potential of Algerian and Libyan gas is based on the 'Gas Export Availability' data from Mott MacDonald's report: *Supplying the EU Natural Gas Market* (September 2010) which was ordered by the European Commission. To determine the piped gas versus LNG gas volumes ENTSOG applied ratios based on the historical gas exports data of 2008 and 2009.

As far as the Algerian gas potential is concerned, ENTSOG used the High Case scenario data which are reported as *'very similar to the Algerian Government's official forecasts'* [1].

As far as the Libyan gas potential is concerned, ENTSOG used the Base Case scenario. Having considered the actual delivery of piped gas to Italy in 2009, the Base Case 2020 outlook figure constitutes ENTSOG's starting point for 2011 while the growth trend from 2011 to 2020 determined the subsequent extrapolation for the ten years.

The resulting curve shows potential for an increase in imported gas volumes from Algeria and Libya also assuming a possible rising demand in the region.

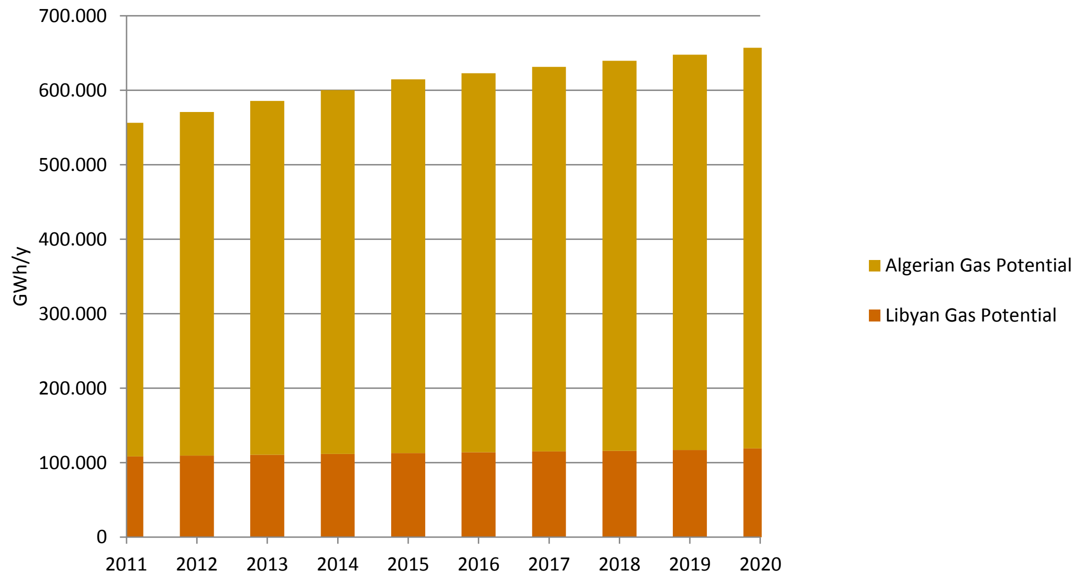


Figure 5: Algerian and Libyan pipe gas supply potential for Europe

[1] ENTSOG used official forecasts by Ministries as basis for the Norwegian and Russian supply potentials and therefore the data used for the Algerian supply potential ensures consistency with the other approaches.

Azerbaijan

Due to uncertainties surrounding other gas sources from the Caspian area, ENTSOG considers only Azeri gas coming from Shah Deniz II development for this edition of TYNDP. The supply potential for Europe is based on the provisions of the Intergovernmental Agreement (IGA) between Turkey and Azerbaijan signed on 7 June 2010 regarding the supply of gas to Turkey as well as transit of Azeri gas through Turkey.

The IGA stipulates [1] that out of the 16 bcm to be made available on annual basis from Shaz Deniz II project as of 2017, 10 bcm would be earmarked for Europe and 6 bcm for Turkey. Even though some of the gas primarily allocated to Turkey may in the end become available for export on to Europe, ENTSOG considers the supply potential of Azeri gas for Europe to stand at 10 bcm/y for the moment.

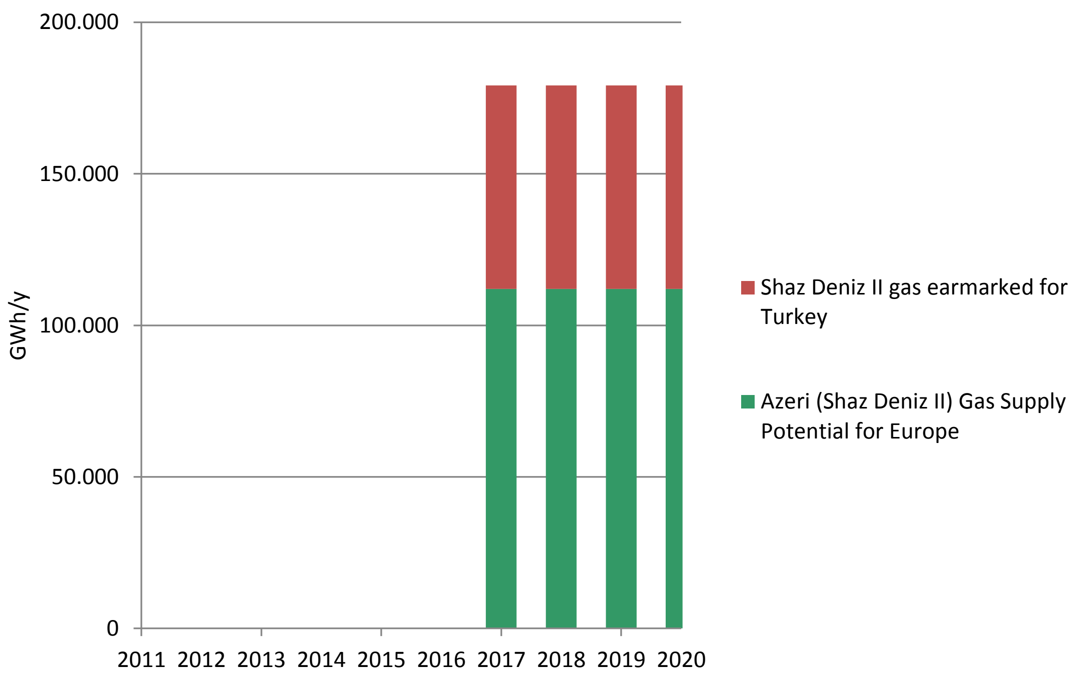


Figure 6: Azeri (Shaz Deniz II) gas supply potential for Europe

[1] For the purpose of this TYNDP the volumes of gas defined in bcm in the IGA were converted into energy in GWh using the GCV of 11.2 kWh/m3.

LNG

Due to the existence of a global LNG market which allows for high flexibility in LNG supplies, it is very difficult to determine the LNG supply potential for Europe.

Based on a thorough analysis of the LNG market, ENTSOG has adopted the following formula and assumptions to calculate such potential:

Total Liquefaction Capacity by Basin x % Liquefaction Capacity Utilization x % LNG coming from each Basin destined for the EU

Applied parameters:

- Total liquefaction Capacity by Basin: as indicated in LNG Journal July/August 2010
- Shares of each Basins' Production: Atlantic basin: 65%; Middle East: 35%; Pacific Basin: 0%
- Liquefaction Capacity Utilization: 85%

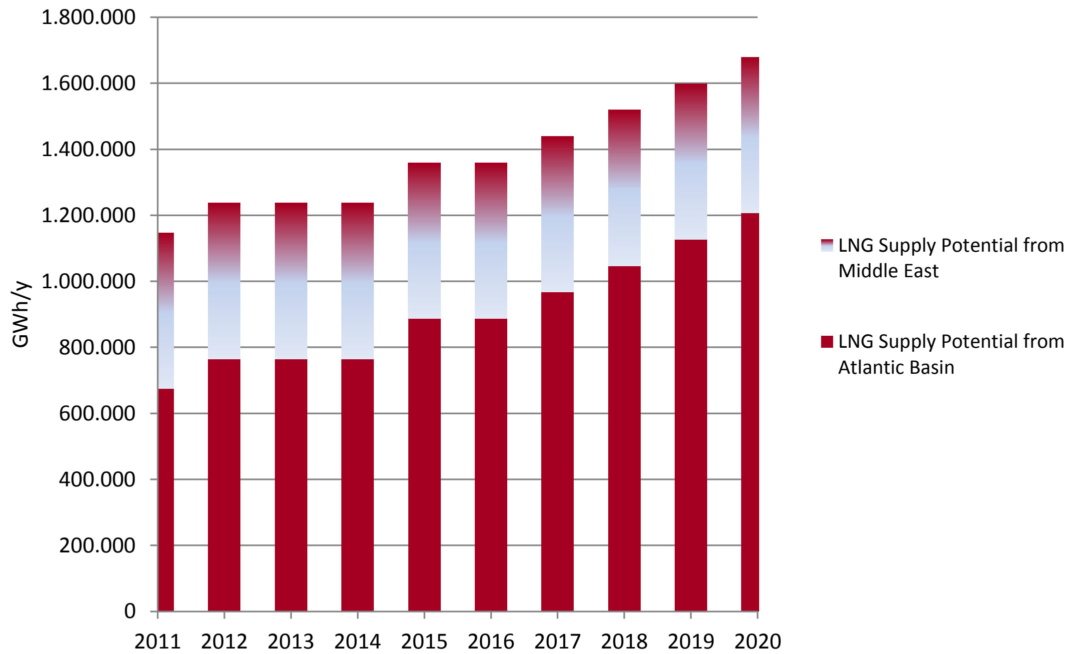


Figure 7: LNG supply potential for Europe

• Aggregate Supply potential for Europe

The following graph represents the aggregate supply potential for Europe based on the assumptions defined above. The indigenous production will continue to play an important role in securing gas for Europe even if the decline in production is clear. Development of all other identified gas sources is required to cover the overall balance and contribute to the security of gas supply.

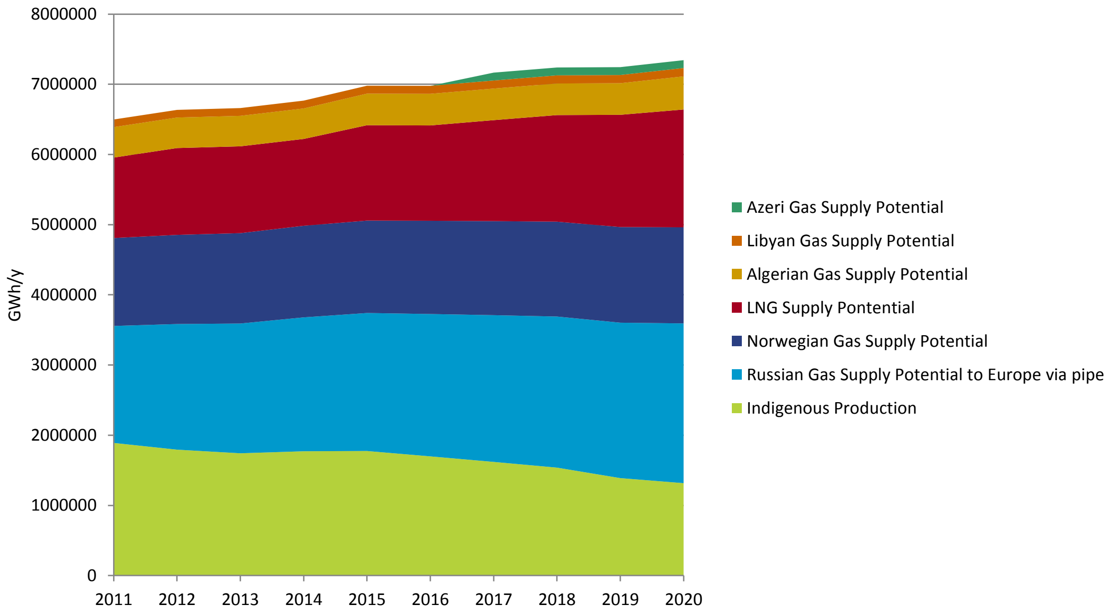


Figure 8: Aggregate gas supply potential for Europe

• Gas Reserves

The following figure gives an overview of the current estimated reserves in those non-EU producing countries that were considered, for the purposes of this TYNDP 2011-2020, more significant in supplying gas to Europe in the considered time horizon. The gas reserve data has been included in the TYNDP 2011-2020 to provide some indications on the potential role of these reserves in the future in covering the EU gas demand based on new supply contracts or the extension of the current ones.

The figure also shows an aggregate for the estimated reserves for countries with LNG supply potential for Europe that are not covered individually. These are: Peru, Trinidad and Tobago, Venezuela, Iran, Oman, Yemen, Egypt, Other Africa.

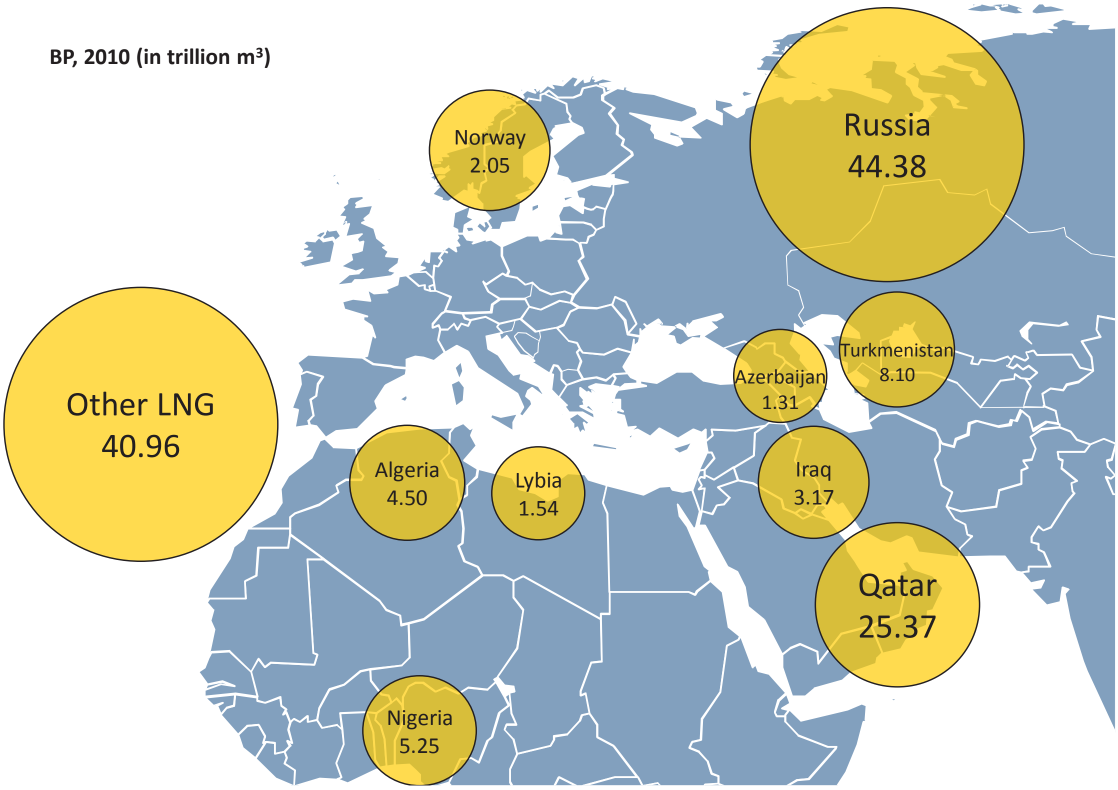


Figure 9: Estimated Gas Reserves (BP, 2010)

• Demand

ENTSOG considers two demand scenarios for the modelling purposes, for which all the data was supplied exclusively by TSOs:

Average Daily Demand

The average daily demand is derived from TSOs' annual demand outlooks for 1-in-2 climatic conditions. The national demand figures were divided by the number of days in the respective year and then used in the defined ISD scenarios according to the methodology described in Chapter on Network Modelling and Resilience Assessment. The Average Daily Demand was chosen as a reference scenario for comparison purposes.

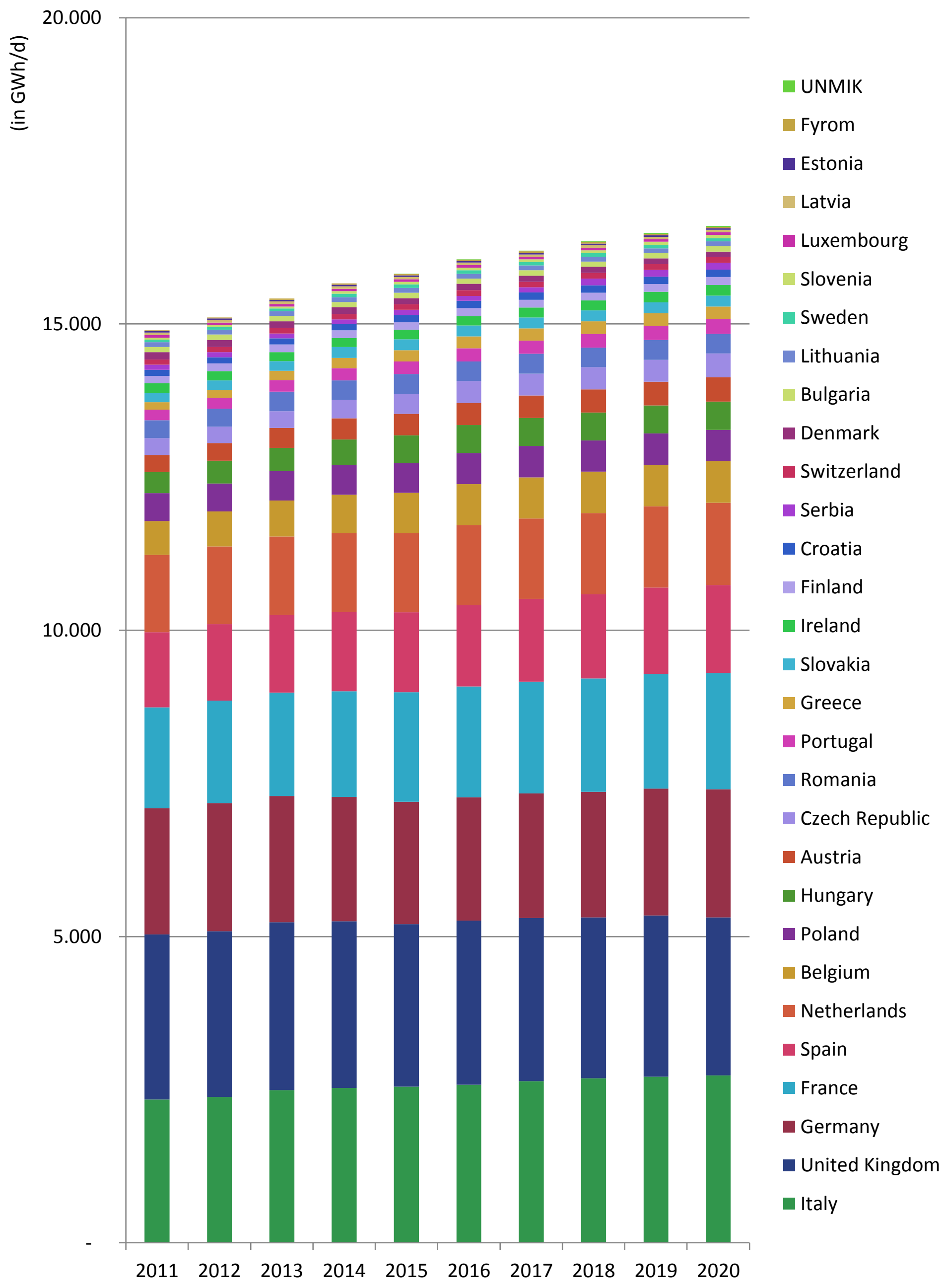


Figure 10: Average Daily Demand in Europe by countries

High Daily Demand in 1-in-20 climatic conditions

The 1-in-20 climatic conditions daily demand was provided by all TSOs based on their knowledge of the national demand, the sensitivity of that demand to climatic changes and the climatic data available to them. ENTSOG adopted the above definition of the high demand in line with the SoS Regulation framework. ENTSOG would like to note that the SoS Regulation still allows TSOs to use stricter climatic conditions when planning and designing their own networks. As such, some countries have submitted demand under such stricter conditions. (See Annex C).

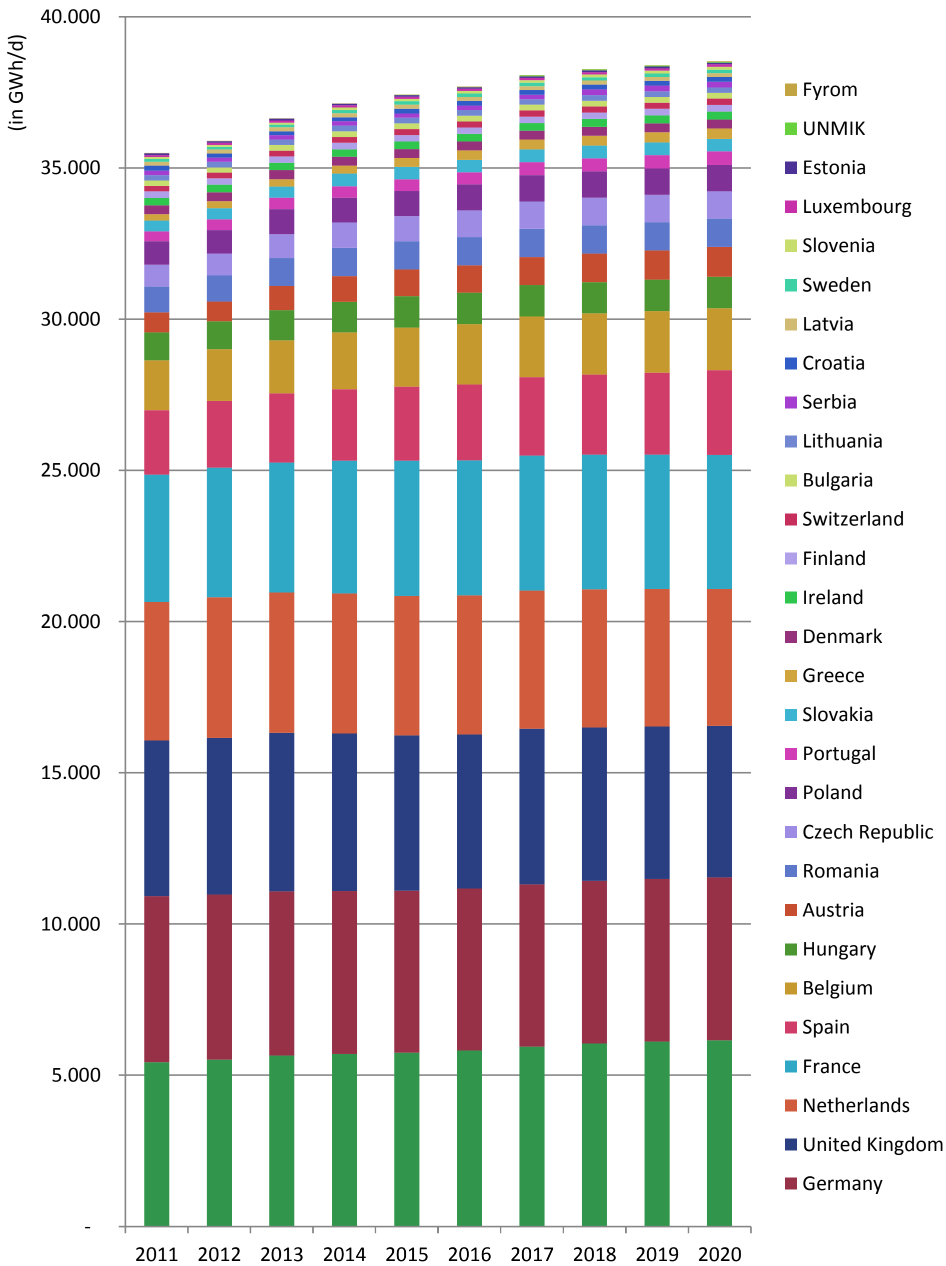


Figure 11: High Daily Demand in Europe by countries

In addition, ENTSOG considers other demand scenarios to assess the supply demand balance on annual basis. Assumptions underlying these scenarios are given below (directly quoting the scenario creators).

Primes Baseline

- *'The [Primes] Baseline scenario determines the development of the EU energy system under current trends and policies; it includes current trends on population and economic development including the recent economic downturn and takes into account the highly volatile energy import price environment of recent years. Economic decisions are driven by market forces and technology progress in the framework of concrete national and EU policies and measures implemented until April 2009. This includes the ETS and several energy efficiency measures but excludes the renew-able energy target and the non-ETS target.' (EU energy trends, p.10)*

Primes Reference

- *'The [Primes] Reference scenario is based on the same macroeconomic, price, technology and policy assumptions as the baseline. In addition to the measures reflected in the baseline, it includes policies adopted between April 2009 and December 2009 and assumes that national targets under the Renewables directive 2009/28/EC and the GHG Effort sharing decision 2009/406/EC are achieved in 2020.' (EU energy trends, p. 10)*

IEA New Policies Scenario (2010)

- *IEA New Policies Scenario is the central scenario and 'takes account of the broad policy commitments and plans that have been announced by countries around the world, including the national pledges to reduce greenhouse-gas emissions and plans to phase out fossil-energy subsidies even where the measures to implement these commitments have yet to be identified or announced. These commitments are assumed to be implemented in a relatively cautious manner, reflecting their non-binding character, and in many cases, the uncertainty shrouding how they are to be out into effect.'(IEA, 2010)*

IEA 450 Climatic Scenario (2010) [1]

- *'IEA 450 Climatic Scenario assumes 'governments [to take] strong action to cut CO2 emissions […] [so that] global energy-related CO2 emissions peak just before 2020 at 30,9 gigatonnes (Gt) and decline thereafter to 26.4 Gt in 2030, which is 34% less than in the IEA Reference Scenario'. CO2 prices in OECD countries are assumed '[to reach] $50 per tonne. […] The 450 Scenario assumes a hybrid policy approach, comprising a plausible combination of cap-and-trade systems, sectoral agreements and national measures, with countries subject to common but differentiated responsibilities'. (IEA, 2010)*

ENTSOG

- *The ENTSOG scenario is a bottom-up approach scenario aggregating TSOs' demand outlooks based predominantly on their knowledge of the national gas market, incl. the planned development of off-take connections. TSOs were requested to submit their outlook considering annual demand under 1-in-2 climatic conditions.*

[1] '450' (450 ppm CO2 equivalent) refers to the level at which the concentration of greenhouse gases should be stabilized to avoid 'the most severe weather and sea-level rise and limit the temperature increase to about 2°C.' (IEA, 2010)

Eurogas Long Term Outlook 2007-2030 Base Case

Eurogas defined the following assumptions for its scenarios:

- *Europe-wide regulatory pressure for intensifying competition (gas and electricity)*
- *Continued development of economically viable gas infrastructure*
- *New gas supplies not prevented from reaching market*
- *In most countries, long-term agreements remain the basis for supplies*
- *Oil prices are the leading indicator in the energy market*
- *Fuels are competing with each other*
- *Upstream gas supply contracts with orientation to oil prices*
- *Continuation of EU CO2 Emissions Trading Scheme with full auctioning beyond 2012*
- *Continuation and further development of energy policies and measures in place*
- *The balance of gas demand and supply is considered with reference to the prices given in the table below expressed in real terms' (Eurogas, p. 3)*

	2009 (1Q)	2015	2030
Oil ($ bbl)	50	60-70	80-100
Coal (€/t)	60	60-70	70-90
CO2 (€/t)	15	20-30	40-50

Figure 12: Oil, coal and CO2 prices (Eurogas, 2010)

Eurogas Long Term Outlook 2007-2030 Environmental

- *'Faster economic recovery and GDP growth*
- *More favourable energy policies towards natural gas*
- *Natural gas prices competitiveness is ensured*
- *CO2 prices at the upper end of the assumed range'(Eurogas, p. 3)*

Annual Demand Scenarios

The graph below shows the different scenarios described above. It accentuates the uncertainty surrounding the demand development in the next ten years and further on. The differences reflect diverging views regarding in particular the achievement of the 20-20-20 targets and the ways of doing it, as well as the outlook for the European economic recovery and the future of energy intensive industries in Europe.

As most of the scenarios cover only EU-27 countries or individual country data are difficult to derive at, the graph below covers only EU-27.

Despite the ENTSOG EU-27 demand outlook (2010) being the highest of all above included annual demand outlooks, the difference between the ENTSOG outlook produced in 2009 and 2010 should be noted. The latest ENTSOG's outlook shows a slowdown in the evolution of annual gas demand as a result of the current economic situation.

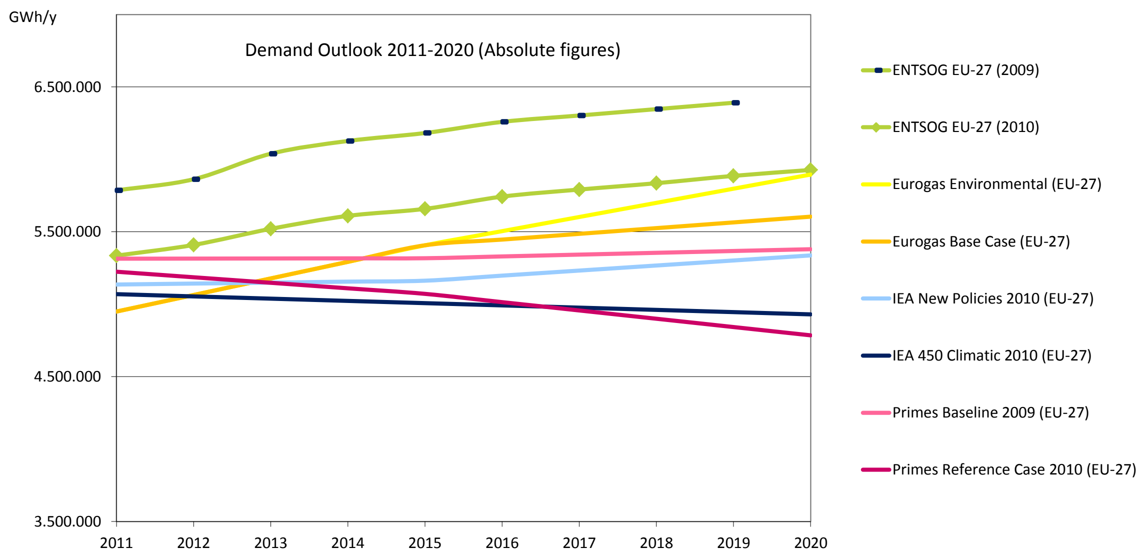


Figure 13: Demand Outlook 2011-2020 (Absolute figures)

In addition, the graph below illustrates the growth trends of the different scenarios presented above. Considering the fact that the outlooks were compiled at different points in time and do not use the same year as basis, as well as that all non-ENTSOG scenarios were produced in mtoe units and required conversion into GWh, it is useful to compare them in a stand-alone way. On the ten-year period, the range runs from an approximate 9% drop in demand in the Primes Reference Case to 19% increase in Eurogas Environmental scenario [1] in comparison with 2011. ENTSOG's outlook anticipates 11% increase in demand on the 2011-2020 period.

The historical perspective of the EU-27 demand (in GWh), based on the TSO data is as follows:

- 2009: 4,978,394
- 2008: 5,325,677
- 2007: 5,218,511

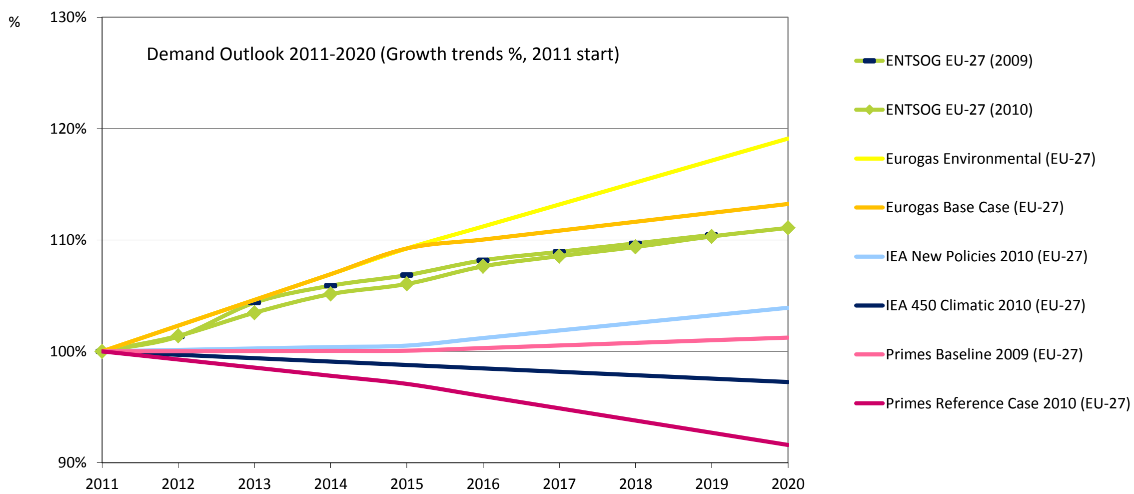


Figure 14: Demand Outlook 2011-2020 (Growth trends in %)

[1] It should be noted that extrapolation techniques and assumptions on the starting point had to be used in some cases to show the curve for the whole ten-year period. Detailed information is provided in the Annex C: Data tables.

• Supply Demand Balance Conclusions

The graph below presents the comparison of the potential supply with the ENTSOG demand outlook for the next 10 years. ENTSOG demand outlook was used as it was identified as the highest demand outlook in absolute terms.

The figures show that there may be significant supply flexibility in meeting the European demand, the level of which will depend on the demand development as well as on the realisation of the supply potential.

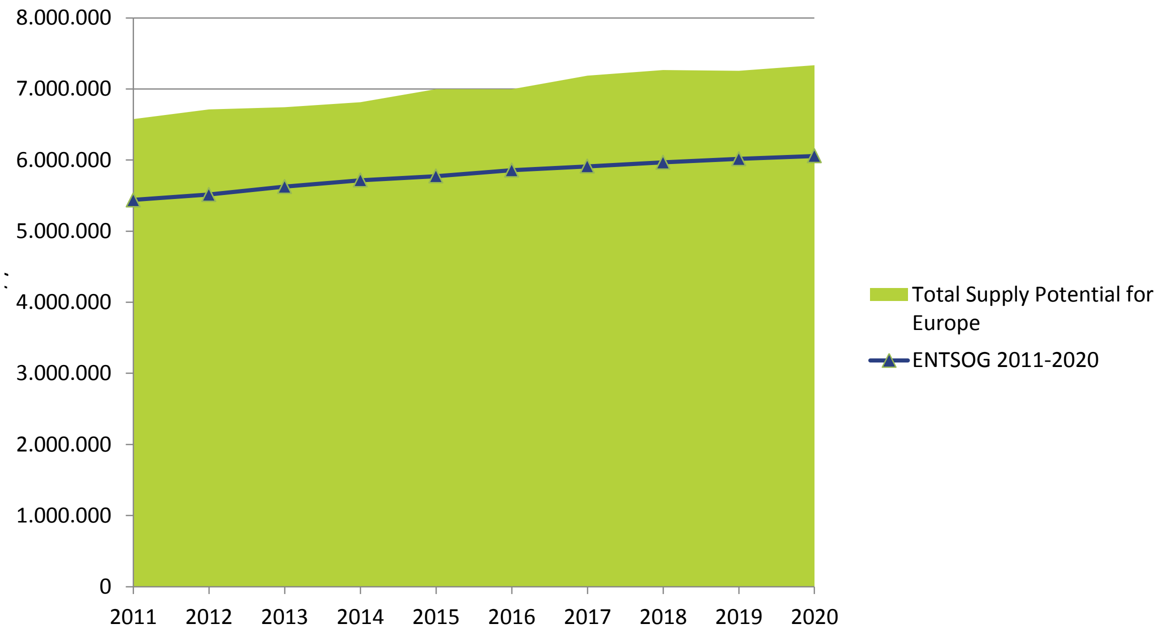


Figure 15: Supply Demand balance 2011-2020

Network Modeling and Resilience Assessment

© Image courtesy of SNAM Rete Gas

The TYNDP aims to assess the resilience of the European gas network through scenario development and subsequent modelling of the integrated network based on those scenarios. Where results of the modelling suggest some investment gaps, possible remedies are identified on the basis of the projects covered by the TYNDP while ensuring non-discriminatory treatment where multiple projects are proposed. Information is also provided on the level of market integration. The sensitivity analysis is ensured through carrying out a wide range of supply scenarios, modelled according to the following infrastructure configurations:

- *existing infrastructures plus those for which final investment decision (FID) has been taken*
- *the same infrastructures as above plus Non-FID projects*

In both options, ENTSOG considered all projects submitted by TSOs and third party sponsors according to the submission process. In order to be sure that new infrastructures are available under High Daily Demand conditions that are assumed to occur in January, all projects were considered eligible for modelling in the year following the start-up date, except for those with a start-up date on 1 January, which are included in the respective year.

ENTSOG defined an initial scenario, the Reference Case, which carries forward the 2008 & 2009 trend of supply shares, in order to ease comparison with other possible scenarios. The Reference Case does not take into account any differential evolution on the supply side and may not be regarded as an ENTSOG forecast.

In order to assess the resilience of the network, ENTSOG has modelled several security of supply scenarios under High Daily Demand conditions, as well as market integration scenarios that maximise the shares of each supply. In the following subchapter, an overview of the scenarios that were modelled as well as definitions of the different demand, supply, disruption, and market integration parameters are given. Thereafter, the modelling process is described and an overview of the results is given.

Parameter and scenario definitions

To assess network resilience, ENTSOG defined a series of scenarios that are a combination of different parameters. Scenarios have been ranked according to three categories being Reference Case, security of supply then market integration. The following table gathers all the modelled scenarios used to assess European gas network resilience. Parameter settings and scenario definitions are given just after the table.

<table>
<tr><th>Parameters</th><th>Scenario#</th><th>Year</th><th>Infrastructure</th><th>Climatic conditions</th><th>Disruption</th><th>UGS deliverability</th><th>Supply source mix</th></tr>
<tr><td rowspan="10">Reference Case scenarios</td><td>1</td><td>2011</td><td rowspan="3">FID</td><td rowspan="5">1 in 20</td><td rowspan="10">None</td><td rowspan="5">Not limited</td><td rowspan="10">No predominance</td></tr>
<tr><td>2</td><td>2015</td></tr>
<tr><td>3</td><td>2020</td></tr>
<tr><td>4</td><td>2015</td><td rowspan="2">Non-FID</td></tr>
<tr><td>5</td><td>2020</td></tr>
<tr><td>6</td><td>2011</td><td rowspan="3">FID</td><td rowspan="5">1 in 2</td><td rowspan="5">Not used</td></tr>
<tr><td>7</td><td>2015</td></tr>
<tr><td>8</td><td>2020</td></tr>
<tr><td>9</td><td>2015</td><td rowspan="2">Non-FID</td></tr>
<tr><td>10</td><td>2020</td></tr>
<tr><td rowspan="31">Security of Supply scenarios</td><td>11</td><td rowspan="7">2011</td><td rowspan="7">FID</td><td rowspan="31">1 in 20</td><td>Norwegian</td><td rowspan="5">Not limited</td><td rowspan="31">Crisis supply</td></tr>
<tr><td>12</td><td>Belarus</td></tr>
<tr><td>13</td><td>Ukraine</td></tr>
<tr><td>14</td><td>Algeria</td></tr>
<tr><td>15</td><td>LNG</td></tr>
<tr><td>16</td><td rowspan="2">None</td><td>80%</td></tr>
<tr><td>17</td><td>70%</td></tr>
<tr><td>18</td><td rowspan="12">2015</td><td rowspan="6">FID</td><td>Norwegian</td><td rowspan="5">Not limited</td></tr>
<tr><td>19</td><td>Belarus</td></tr>
<tr><td>20</td><td>Ukraine</td></tr>
<tr><td>21</td><td>Algeria</td></tr>
<tr><td>22</td><td>LNG</td></tr>
<tr><td>23</td><td>None</td><td>70%</td></tr>
<tr><td>24</td><td rowspan="6">Non-FID</td><td>Norwegian</td><td rowspan="5">Not limited</td></tr>
<tr><td>25</td><td>Belarus</td></tr>
<tr><td>26</td><td>Ukraine</td></tr>
<tr><td>27</td><td>Algeria</td></tr>
<tr><td>28</td><td>LNG</td></tr>
<tr><td>29</td><td>None</td><td>70%</td></tr>
<tr><td>30</td><td rowspan="12">2020</td><td rowspan="6">FID</td><td>Norwegian</td><td rowspan="5">Not limited</td></tr>
<tr><td>31</td><td>Belarus</td></tr>
<tr><td>32</td><td>Ukraine</td></tr>
<tr><td>33</td><td>Algeria</td></tr>
<tr><td>34</td><td>LNG</td></tr>
<tr><td>35</td><td>None</td><td>70%</td></tr>
<tr><td>36</td><td rowspan="6">Non-FID</td><td>Norwegian</td><td rowspan="5">Not limited</td></tr>
<tr><td>37</td><td>Belarus</td></tr>
<tr><td>38</td><td>Ukraine</td></tr>
<tr><td>39</td><td>Algeria</td></tr>
<tr><td>40</td><td>LNG</td></tr>
<tr><td>41</td><td>None</td><td>70%</td></tr>
</table>

Parameters	Scenario#	Year	Infrastructure	Climatic conditions	Disruption	UGS deliverability	Supply source mix
Market integration scenarios	42	2011	FID	1 in 2	None	Not used	Norway
	43						Russia
	44						Algeria
	45						Libya
	46						LNG
	47	2015					Norway
	48						Russia
	49						Algeria
	50						Libya
	51						LNG
	52	2020					Norway
	53						Russia
	54						Algeria
	55						Libya
	56						LNG
	57	2015	Non-FID				Norway
	58						Russia
	59						Algeria
	60						Libya
	61						LNG
	62	2020					Norway
	63						Russia
	64						Algeria
	65						Libya
	66						LNG
	67						Caspian

Figure 16: List of modelled scenarios

Infrastructure

When modelling the European gas network, ENTSOG considered existing infrastructures plus other projects submitted to ENTSOG by TSOs and third party sponsors. Additional projects may exist but have not been considered if not submitted through the public ENTSOG infrastructure questionnaires released in summer 2010.

Two different infrastructure settings have been defined:

- FID (all existing infrastructures plus proposed projects having a FID taken by Q3 2010)
- non-FID (same plus proposed projects without FID taken by Q3 2010)

Each project is activated for the modelling in the first year in which the capacity is fully available on the first of January. (See Infrastructure Projects chapter for a more detailed description of FID and Non-FID projects.)

Climatic conditions

When modelling the European gas network, ENTSOG considered different climatic conditions to define supply and demand (*see also the Supply & Demand chapter*). It is to be noted that ENTSOG made the assumption that the respective conditions occur simultaneously all over Europe.

Two different climatic condition settings were defined:

- *1 in 2*
- *1 in 20; the definition of this climatic condition comes from the REG-SoS, it is to be noted that the same regulation allows Member States to apply more severe condition; in case such figures were submitted, these were used in this TYNDP*

The climatic conditions determine the supply and demand level as described in the following subchapters.

Demand definition

- Average Daily Demand

To model the network under average (1-in-2) climatic conditions, ENTSOG works with the Average Daily Demand. At European aggregated level, such daily consumption approximately corresponds to an October day of a 1-in-2 year.

- High Daily Demand

To capture the influence of severe climatic conditions (1-in-20) on the European demand and subsequently on the flows through the European network, ENTSOG works with the High Daily Demand.

In addition, to determine how much import is needed under the High Daily Demand as well as the Average Daily Demand, for each of the 10 years, ENTSOG defined a Net Daily Demand and Net Annual Demand respectively.

Net Daily Demand means the difference between the High Daily Demand and the daily national production.

Net Annual Demand means the difference between the annual demand and the national production forecasts. Underground storage is considered as not being used.

Supply definition

- Average Daily Supply

Average Daily Supply is defined as the annual supply divided by 365; the Average Daily Supply is used for modelling of the European gas network under the Average Daily Demand conditions.

The annual supply means a mix of supply sources that ensures the supply demand balance on annual basis. The mix defines the share of each supply source (national production, LNG, North Africa, Norway, Russia). For 2011, the share of each supply source, in particular those from outside of the EU (LNG, North Africa, Norway, Russia), is based on the respective supply figures of the 2008 & 2009 BP Energy review. For the following years, each import source increases proportionally to the Net Annual Demand increase. It is assumed that the import shares of LNG, North Africa, Norway and Russia remain constant in relative terms.

To avoid an overestimation of supply sources, however, each source is limited by the lower value between the respective supply potential (cf. Supply & Demand chapter) and the technical capacity of import routes or facilities. When supply from one source can no longer increase according to the above rule, the other import sources cover up the gap according to their share. [1]

- High Daily Supply

To derive the supply flows under the High Daily Demand conditions, the Net Daily Demand is assumed to be covered by imports and underground storage. For 2011, pipeline import shares are based on the average of the highest flows reached during January 2008 and 2009 (TSO data). LNG terminals and underground storage facilities are used as peak shavers and only limited by their maximum deliverability. ENTSOG assumes that during one High Demand day, LNG terminals may function as short term storage. The influence of a potential lower UGS deliverability is analysed under specific security of supply simulations.

For each pipeline gas source, ENTSOG calculated a peak ratio as the ratio between High Daily Supply and Average Daily Supply as previously defined. This ratio is used for the following years to derive the import supply share to cover the High Daily Demand from the Average Daily Supply for a given year. This High Daily Supply is limited by either the Daily Supply Potential or the import route technical capacity respectively.

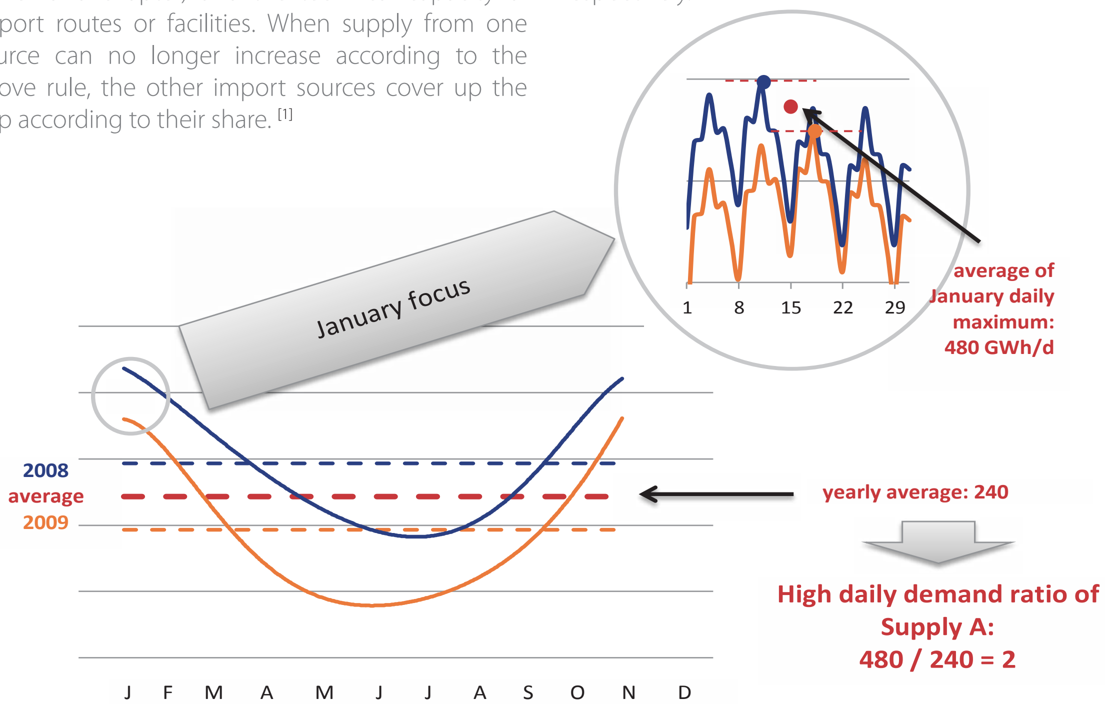


Figure 17: Determination of peak ratio for Supply A

[1] When Caspian supply (pipeline gas entering from Turkey) comes on stream, its share for the first year is derived by using the average load factor of other pipeline gas import sources of the previous year.

• Disruptions

When modelling the European gas network, ENTSOG considered different potential disruptions deriving from the current TSOs' analysis. They may change in future reports taking into account the evolution of the gas market. Four different disruption settings have been defined:

- *Transit disruption of Russian imports*

ENTSOG models two scenarios, a total interruption of flows through Belarus and through Ukraine. ENTSOG assumes a diversion of Russian gas to alternative routes as far as it is possible.

- *Technical disruption of Norwegian imports*

ENTSOG models a total interruption of flows from Norway to the UK. ENTSOG assumes a diversion of Norwegian gas to alternative routes as far as it is possible.

- *Technical disruption of North African imports*

ENTSOG models a 50% interruption of flows from Tunisia to Italy. ENTSOG assumes a diversion of Algerian gas to alternative routes as far as possible. There is no specific case for Libyan supply as this would not lead to new insights on European network resilience.

- *LNG supply disruption*

ENTSOG models a total supply disruption of Qatari gas as being the worst case identified by GLE. Based on the joint study undertaken by GLE and ENTSOG, it is assumed that such disruption lasts 30 days and focuses in particular on the High Daily Demand conditions within such period. Such scenario will only impact countries receiving currently LNG from Qatar, such countries are Belgium, Italy, Spain and UK. LNG terminal storage facilities are used in order to smooth reduction but no spot delivery is taken into account. The resulting send-out levels represent 55% of the send-out defined under the Reference Case for the UK terminals, 11.5% for the Belgian terminal and 53% for the Italian terminals. In the case of Spain, the lack of LNG from Qatar is completely compensated by LNG storage tanks and does not reduce the send-out. Due to the globalised LNG market, the historical data could suffer variations, and consequently the management of the LNG Tanks and % of reduction of send-out could vary.

• Storage deliverability

When modelling the European gas network, ENTSOG considered different levels of storage deliverability depending on the climatic conditions.

Under High Daily Demand/Supply, no limitation to UGS deliverability was considered for the Reference Case. ENTSOG modelled the limitation of storage deliverability to highlight what could be the consequences of low storage deliverability when facing High Daily Demand. Such deliverability reduction may be due to a high withdrawal during the previous period, and to some extent, to technical unavailability. The LNG terminal deliverability stays at 80% keeping the ability to send out gas at a high rate on a single day.

Under Average Daily Demand/Supply, ENTSOG did not consider any withdrawal or injection, as such simulations stand for the simulations of the whole year assuming storage neutrality.

Four different UGS deliverability settings were defined:

- *Not limited*
- *80% in 2011 (as new supply and storage projects decrease the individual storage load factor this case is not relevant for 2015 and 2020)*
- *70% in 2011, 2015 and 2020*
- *Not used*

• Supply source mix

When modelling the European gas network, ENTSOG has considered different supply source shares. Under the Reference Case such shares derive from historical data as defined under Average and High Daily Supply definition above. Then supply source are increased/ decreased depending of the scenario purposes.

Three different supply source mix settings were defined:

- *No predominance: as defined under the Reference Case*
- *Crisis supply: adaptation of the supply source mix under the Reference Case in order to face disruption (increase of LNG and UGS or increase of imports in case of low UGS deliverability)*
- *Supply predominance (Algeria, Caspian, Libya, LNG, Norway, Russia): one of the supply sources is set to the level of technical capacity while the others are decreased accordingly*

• Scenario categories

Reference case scenarios

In order to evaluate the effects of disruptions, unavailability of storage and changes in supply mix (for which there are separate scenarios), ENTSOG defined a series of Reference Case scenarios. These scenarios accommodate different levels of demand (average/high), supply (average/high) and infrastructural capacity (FID / FID + Non-FID). These Reference Case scenarios should be seen as a benchmark for comparison with Security of Supply and Market Integration scenarios.

Security of Supply scenarios

ENTSOG aims at assessing the resilience of the network under a set of disruption scenarios or low storage deliverability. Such simulations were carried out under High Daily Demand condition for a one-day period. The chosen scenarios take into account the history, probability, season, frequency and duration of such occurrence as well as, where appropriate, geopolitical risks. [1] This may lead to some changes of the considered disruption scenarios in the future.

Market integration scenarios

Market integration modelling aims at assessing how far gas coming from each supply source can flow into the European gas network. In addition, this modelling gives an indication of how many sources are available to a certain country.

Market integration scenarios illustrate different possible evolutions of the supply mix impacted by factors such as reserves, their accessibility, the evolution of national demand of exporting countries and the existence of alternative markets to Europe. The market integration scenarios also illustrate the potential for different supply sources as opposed to the supply potential defined under the Supply & Demand chapter.

Simulations are carried out under the Average Daily Demand conditions without the deployment of storage. Each import source (LNG, North Africa, Norway, Russia and Caspian) is individually increased up to 95% import route capacity, and in case of LNG to 80% of LNG terminal send-out (such limits stand for infrastructure availability on a annual basis). This capacity-based modelling does not consider potential supply limitations but is based on the assumption that a supply region can extend its production in the future. The respective other import sources are reduced in the same proportion (to their supply share), local reduction being more important in the region where the predominant source arrives in Europe. Dominant source is then spread homogeneously considering neither any potential contractual swaps nor flow pattern aiming at one particular region.

[1] Art. 9(1)(c), SoS-REG

• Network model definition

To define the network model, ENTSOG applied a top-down approach using countries as basic building blocks interlinked by cross-border capacity. Such capacity is the sum of technical capacity at Interconnection Points between two adjacent countries having applied the lesser-of-rule to the values of the capacity at both sides of the border for each Interconnection Point. National production, LNG terminals and storage facilities enter the model within the respective countries [1] and are considered on aggregate basis per infrastructure type.

In order to be able to run a high number of scenarios, the model assumes that each country is a single decoupled entry/exit zone (not considering interconnection within a country). In addition, ENTSOG assumes that all gas flows can be accommodated for as long as they are consistent with the cross-border technical capacity. Focusing on cross-border issues, the European panoramic approach may not highlight some potential internal bottlenecks, gas quality issues and adaptation of national infrastructure to disruption situations. Such additional investment needs and their impact on cross-border capacity will be dealt with in the regional and national investment plans.

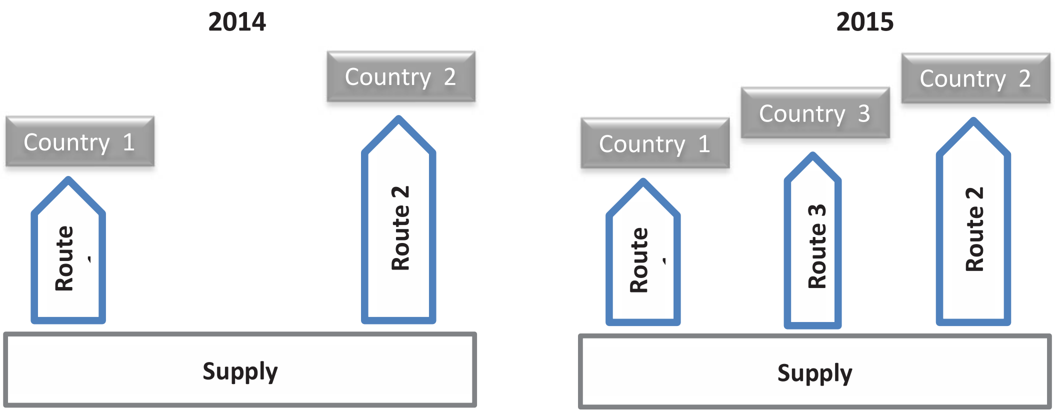
[1] According to their system connection NOT territorial location

Modelling process

Supply initialization

Supply initialization means the process of setting the initial supply and demand values for each modelling exercise. As for the supply, ENTSOG defined the following categories: national production (NP), Russia, Norway, Algeria, Libya, Caspian, LNG, and underground storage (UGS). For each year and within each supply category, the different routes or facilities from the respective category use the same load factor. This initial approach does not consider differences in the use of a given supply source by different Member States as such differential use may not last for the whole 10 years. In case of an increase of the capacity of one supply route, the initialization process induces a relative reduction of the use of existing routes coming from the same supply source (cf. figure below).

This normative approach intends to facilitate the comparison of supply scenarios by applying the load factor reduction within each supply category separately. In addition, to illustrate scenarios with maximum use of each supply category, the high use of routes is modelled within the market integration simulation.



	Capacity	Energy	LF
Supply		100	
Route 1	80	50	63%
Route 2	80	50	63%

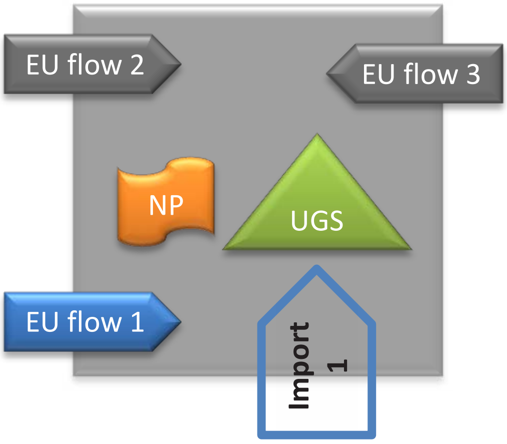
	Capacity	Energy	LF
Supply		105	
Route 1	80	42	52%
Route 2	80	42	52%
Route 3	40	21	52%

The total supply from this source is then shared among three routes decreasing the load factor of existing ones.

Figure 18: Impact of a new import route on load factors

Flow pattern definition

The above described initialization of supply shares predefines a large number of the modelled flows; mainly import flows but also internal EU flows. The remaining flows within the EU which can be freely determined to balance each country's demand with supply are determined country by country using the approximation of an equal load factor for undefined flows entering a country. Such load factors nevertheless differ from country to country.



	Capacity	LF	Energy
NP	100	100%	100
UGS	200	90%	180
Import 1	200	70%	140
EU flow 1	100	50%	50
EU flow 2	30	?	?
EU flow 3	90	?	?
Demand			550

For country A, EU flows 2&3 have to cover 80 energy units but their load factor is still undefined. It is equal to 80/(30+90)=67%. EU flows 2 and 3 thus bring 20 and 60 units respectively.

Figure 19: Example of Load Factor (LF) determination

Modelling fine-tuning

The previous two steps provide general guidelines to define flow directions and levels. Modifications to such flow patterns may be required because of regional balancing issues or within-EU bottlenecks taking into account TSOs experience and assuming a free diversion of each supply along transit routes. Supply category shares nevertheless always stay within a 2% limit from the initialization level for pipe imports (Norway, Russia and North Africa) except under UGS deliverability and market integration scenarios.

When the overall demand of a given area cannot be supplied, flow patterns have been defined in order to spread the lack of supply evenly. Alternative flow patterns could reduce the number of impacted countries by increasing the demand curtailment in others. Such alternative patterns may be considered only after security of supply regulation implementation.

Security of supply modelling

For the modelling of disruptions, ENTSOG considered that market-based mechanisms are used first to cover the demand. Where demand curtailment is necessary, the reduction is equally distributed among the systems (countries) concerned. More targeted demand reductions will be considered once the SoS REG has been implemented and demand-side measures as well as the definition of the protected customers are known.

• Graphical representation

Scenario modelling results are presented through different graphical tools providing information on infrastructure capacity and remaining flexibility under the determined flow pattern. Remaining flexibility is defined as the unused part of the technical capacity under a given scenario and flow pattern. Such flexibility may be used to cope with additional needs or enable shippers to better optimize their supply.

Each infrastructure category is represented with a different symbol, the size of which is linked to its capacity and the colour to the remaining flexibility. Remaining flexibility is also defined at country level.

• Remaining flexibility formulas

For a given infrastructure category (e.g. pipes from country A to country B):

$$1 - \frac{\text{Flows from country A to country B (as defined by the modeling)}}{\text{Firm technical capacity from country A to country B}}$$

Weighted average for country A:

$$1 - \frac{\sum \text{Flow entering Country A from pipes, UGS, NP and LNG (as defined by the modeling)}}{\sum \text{firm technical entry capacity into country A (from pipes, UGS, NP \& LNG)}}$$

In case of disruption scenarios, capacity of entering flows coming from the disrupted area are not considered in order to take into account the disruption impact on flexibility.

As far as remaining flexibility indicators are defined under a given scenario and flow pattern, in particular those referring to individual infrastructure category, they only provide a raw indication on the flexibility level.

Overview of modelling results

The modelling carried out by ENTSOG highlights a number of investment gaps and lists projects that may serve as potential remedies for closing these gaps. As only a single network user or a perfect market enables an optimal use of cross-border capacity, actual investment needs by the market may be higher. The identification of actual investment gaps also need to take into consideration the characteristics of the ENTSOG model which focuses more on cross-border issues and Europe-wide supply demand balance rather than the detailed modelling of each individual system and supply contract considerations.

More specific assessments, such as in regional investment plans and national plans, will enable a deeper analysis of local conditions and each system characteristics and may identify these additional investment needs.

Reference case and Security of Supply

The modelling carried out by ENTSOG in 2010 highlights investment gaps consistent with those identified in the previous TYNDP 2010-2019. The region of Denmark-Sweden still needs better interconnection to the rest of Europe while Hungary, Macedonia and Slovenia do not suffer any demand curtailment under High Daily Demand without disruption anymore owing to the effect of the economic downturn on gas demand.

By analyzing the modelling results, ENTSOG does not intend to provide any priority list of projects to be implemented. ENTSOG aims to provide stakeholders with signals that can be further investigated in their decision-making processes for market-triggered investment or for European funding. Future regional investment plans and national plans will contribute to further analysis of such projects. Identified gaps and their potential remedies may be considered as inputs for those plans.

Modelling of the respective scenarios confirms the predominant role of storage in covering High Daily Demand across Europe and the need for high deliverability when facing such climatic conditions.

Although the overall situation improves over the 10-year range owing to the FID projects to be implemented in the near future, there are still three regions that will not have enough capacity to achieve full supply demand balance under High Daily Demand conditions. Such regions are:

- *Denmark-Sweden under the Reference Case*
- *Central and South-Eastern Europe under the Ukraine disruption*
- *Poland-Lithuania under the Belarus disruption*

In addition some countries suffer from system congestion under Reference Case not impacting neighbouring countries. These are Finland, Greece, Luxembourg and Serbia.

Whereas the proposed non-FID projects could solve the first two regional issues, they are insufficient to close the third one.

The following paragraphs provide an overview of the simulation results and focus on the above identified security of supply issues.

In addition, the remaining flexibility range of each country under each scenario may be found in Annex E.

Identified investment gaps and remedies

The following graphs show the evolution of the remaining flexibility across Europe under the High Daily Demand Reference Case both along the 10-year range and according the two infrastructure scenarios.

In addition, they illustrate the evolution of the above identified congested areas.

The areas lacking flexibility, being group of countries (Region) or individual countries, are defined on the basis of physical congestion at the entries of the area. Physical congestion in these cases is determined for remaining flexibility of less than 5% for Reference Case scenarios and of less than 1% for Security of Supply scenarios.

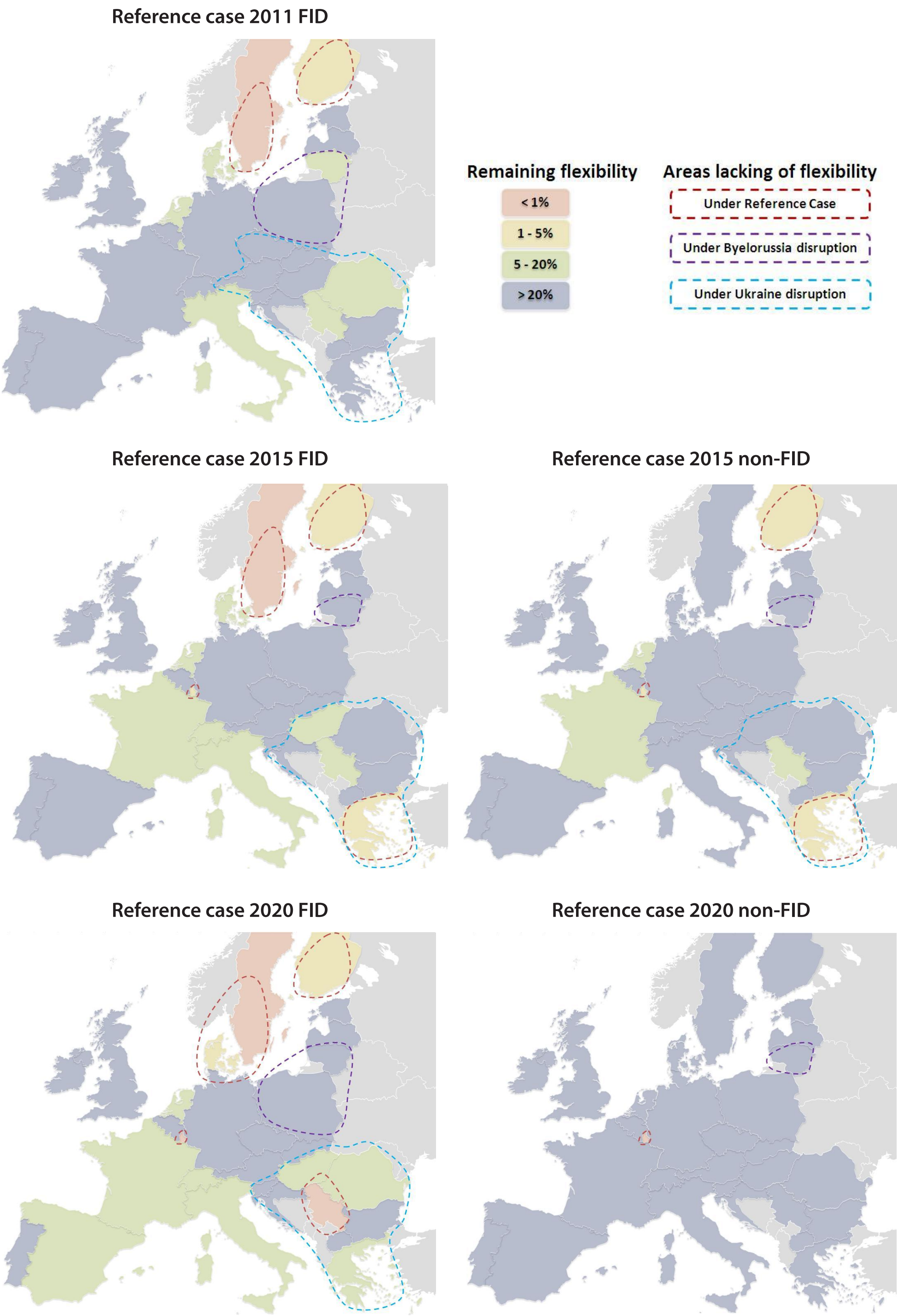


Figure 20: Evolution of remaining flexibility

The following tables list those countries where the supply demand balance indicates additional capacity needs. Identified remedies are part of the proposed FID and non-FID projects with no priority in their use. Additional remedies may exist and remedy efficiency should be further investigated and assessed by stakeholders.

2011

Situation with FID Projects		FID projects closing the gap by 2015	
Country	**Remaining flexibility**	**Congestion**	**Identified remedy**
Reference Case (High Daily demand)			
FI	1-5%	RU > FI	
SE	<1%*	DK > SE	
(*): High Daily Demand covered through the use of DK>SE climatic interruptible capacity			
Belarus disruption (additional investment gaps to the Reference Case)			
LT	<1%	LV > LT	
PL	<1%	DE & CZ > PL	LNG terminal to come on-stream in 2015
Polish and Lithuanian High Daily demand (including transit to Kaliningrad) is covered by 68%			
Ukrainian disruption (additional investment gaps to the Reference Case)			
AT	<1%	DE > AT	IT>AT & DE>AT to come on-stream between 2012 and 2013
BG	<1%	Reg. Cong.	
HR	<1%	Reg. Cong.	
CZ	<1%	DE > CZ	DE>CZ to come on-stream in 2013
FY	<1%	Reg. Cong.	
GR	<1%	TK > GR	
HU	<1%	Reg. Cong.	
RO	<1%	Reg. Cong.	
RS	<1%	Reg. Cong.	
SK	<1%	Reg. Cong.	DE>CZ will enable CZ>SK flow in 2013
SI	<1%	Reg. Cong.	AT>SI to come on-stream in 2012
Total demand for the region defined by all above countries is covered by 81%.Individual country's supply demand balance cannot be assessed in this TYNDP due to the current lack of criteria.			
LNG disruption (additional investment gaps to the Reference Case)			
Remaining flexibility of impacted countries (BE, IT & UK) is higher than 5%			
Norwegian disruption (additional investment gaps to the Reference Case)			
Remaining flexibility of impacted country (UK) is higher than 5%			
North African disruption (additional investment gaps to the Reference Case)			
Remaining flexibility of impacted country (IT) is higher than 5%			
Note: it should be considered that for some countries the analysed disruptions approximate the assessment of N-1 rule envisaged by the REG-SoS			
UGS 80% deliverability (additional investment gaps to the Reference Case)			
No additional disruption (gas quality not considered)			
No additional disruption (gas quality not considered)			
UGS 70% deliverability (additional investment gaps to the Reference Case)			
Global disruption across Europe except for the Baltic (Finland, Estonia, Latvia and Lithuania) and Balkan areas (Croatia, Hungary, Serbia, Romania, Bulgaria, FYROM and Greece), as these regions are poorly connected to the rest of Europe in 2011. Import capacity from Russia and North Africa and Norway was considered at its daily maximum (100% load factor), it is however not possible to supply the required volumes.			

2015

Situation with FID Projects		Situation with non-FID Projects		
Country	**Remaining flexibility**	**Congestion**	**Identified remedy**	**Remaining flexibility**
Reference Case (High Daily demand)				
FI	1-5%	RU > FI	None	1-5%
GR	1-5%	LNG, TK & BG > GR	None	1-5%
LU	1-5%	BE & DE > LU	None	1-5%
SE	<1%*	NO & DK > SE	NO & DK > SE	>25%
(*): High Daily Demand covers through the use of DK>SE climatic interruptible capacity				
Belarus disruption (additional investment gaps to the Reference Case)				
LT	<1%	LV > LT	None	<1%
Lithuanian High Daily demand (including transit to Kaliningrad) is covered by 25% with existing infrastructures plus FID and by 43% with addition of non-FID projects.				
Ukrainian disruption (additional investment gaps to the Reference Case)				
BG	<1%	Reg. Cong.	Global improvement due to AT & SK > HU	<1%
HR	<1%	Reg. Cong.		<1%
FY	<1%	Reg. Cong.		<1%
GR	<1%	BG & TK > GR		<1%
HU	<1%	AT & SK > HU		<1%
RO	<1%	Reg. Cong.		<1%
RS	<1%	Reg. Cong.		<1%
Total High Daily demand for the region defined by all above countries is covered by 70% with existing infrastructure plus FID and by 75% with addition of non-FID projects. Individual country's supply demand balance cannot be assessed in this TYNDP due to the current lack of criteria. *With non-FID projects (AT to HU capacity increase) remaining flexibility for Austria is inferior to one per cent but still enable to cover the whole demand.*				
LNG disruption (additional investment gaps to the Reference Case)				
Remaining flexibility of impacted countries (BE, IT & UK) is higher than 5%				
Norwegian disruption (additional investment gaps to the Reference Case)				
Remaining flexibility of impacted country (UK) is higher than 5%				
North African disruption (additional investment gaps to the Reference Case)				
Remaining flexibility of impacted country (IT) is higher than 5%				
UGS 70% deliverability (additional investment gaps to the Reference Case)				
No additional disruption (gas quality not considered)				
Requires respectively with FID projects (and non-FID projects) Russian imports up to 113% (and 112%) , Algerian imports up to 110% (and 107%) and Norwegian imports up to 115% (and 112% both within Gassco maximum flexibility range) in comparison with the average daily potential supply of each source.				

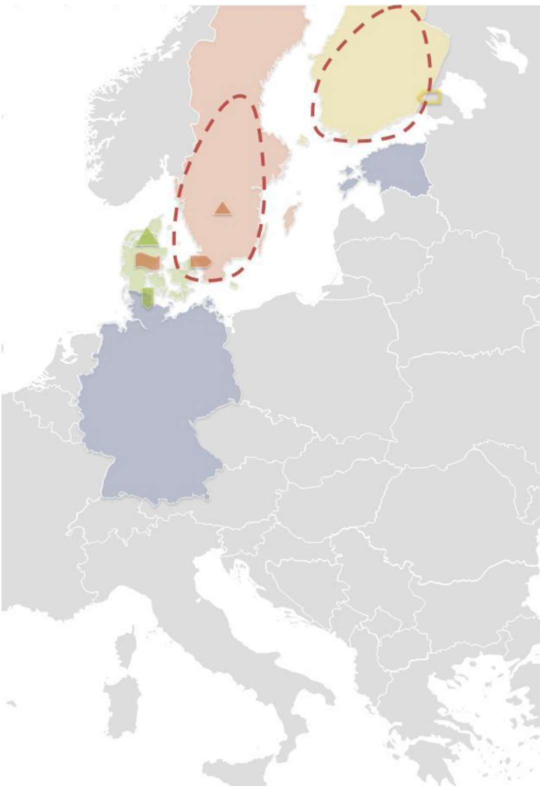
2020

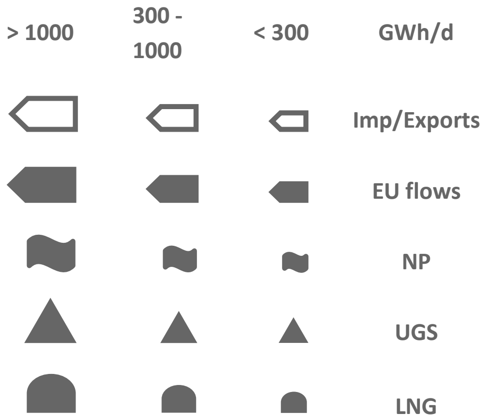
Situation with FID Projects		Situation with non-FID Projects		
Country	**Remaining flexibility**	**Congestion**	**Identified remedy**	**Remaining flexibility**
Reference Case (High Daily demand)				
DK	1-5%	DE > DK	DE > DK	
FI	1-5%	RU > FI	LNG, EE > FI	
LU	<1%	BE & DE > LU	None	
RS	<1%	BG & HU > RS	BG > RS (South Stream & RS-BG Interconnector)	
SE	<1%	DK & NO > SE	NO > SE	
Reference Case (Average Daily demand)				
DK	<1%	DE > DK	DE > DK	
SE	<1%	Regional cong.	DE > DK, NO>SE	
Such congestion results from the annual gas deficit of the Denmark-Sweden region. Such situation implies that Danish system is not able to guarantee full storage injection which may hamper its ability to cover High Daily Demand.				
Belarus disruption (additional investment gaps to the Reference Case)				
LT	<1%	LV > LT	LNG, PL & LV > LT (not sufficient)	
PL	<1%	DE > PL & CZ > PL	DE > PL	
Polish and Lithuanian High Daily Demand (including transit to Kaliningrad) is covered by 80% with existing infrastructures plus FID and by 93% with addition of non-FID projects. With non-FID projects remaining flexibility for Poland is inferior to one per cent but still enable to cover the whole demand. The PL to LT link will move PL under the disrupted area under certain flow pattern, but the project still improved the overall demand cover.				
Ukrainian disruption (additional investment gaps to the Reference Case)				
BG	<1%	Regional cong.	RU>BG (South Stream) & TK > BG (Nabucco)	>25%
HR	<1%	Regional cong.	Fourth Corridor	
FY	<1%	Regional cong.	Fourth Corridor	
HU	<1%	Regional cong.	RO>HU (Nabucco) & RS > HU (South Stream)	>25%
GR	<1%	Regional cong.	TK > GR (ITGI)	
RO	<1%	Regional cong.	BG > RO (Nabucco)	>25%
RS	<1%	Regional cong.	BG > RS (South Stream & RS-BG Interconnector)	
Total High Daily Demand for the region defined by all above countries is covered by 68% with existing infrastructure plus FID. Individual country's supply demand balance cannot be assessed in this TYNDP due to the current lack of criteria. With non-FID projects included there is 100% demand coverage, hence the full High Daily Demand can be met.				
LNG disruption (additional investment gaps to the Reference Case)				
Remaining flexibility of impacted countries (BE, IT & UK) is higher than 5%				
Norwegian disruption (additional investment gaps to the Reference Case)				
Remaining flexibility of impacted country (UK) is higher than 5%				
North African disruption (additional investment gaps to the Reference Case)				
Remaining flexibility of impacted countries (ES & IT) is higher than 5%				
UGS & LNG terminal 70% deliverability (additional investment gaps to the Reference Case)				
Global disruption across Europe except Baltic area (Finland, Estonia, Latvia and Lithuania), Romania, Bulgaria, FYROM, as these countries are not well connected to the rest of Europe in 2020 with only FID projects. Import capacity from Russia and North Africa and Norway was considered at its daily maximum (100% load factor), it is however not possible to supply the required volumes. Such congestion disappears with the non-FID projects.				
With non-FID projects in addition, European balance does not need additional import in comparison with the Reference case where UGS use of storage is below 60% of the maximum deliverability.				

Focus on identified congested areas under Reference Case and disruption scenarios

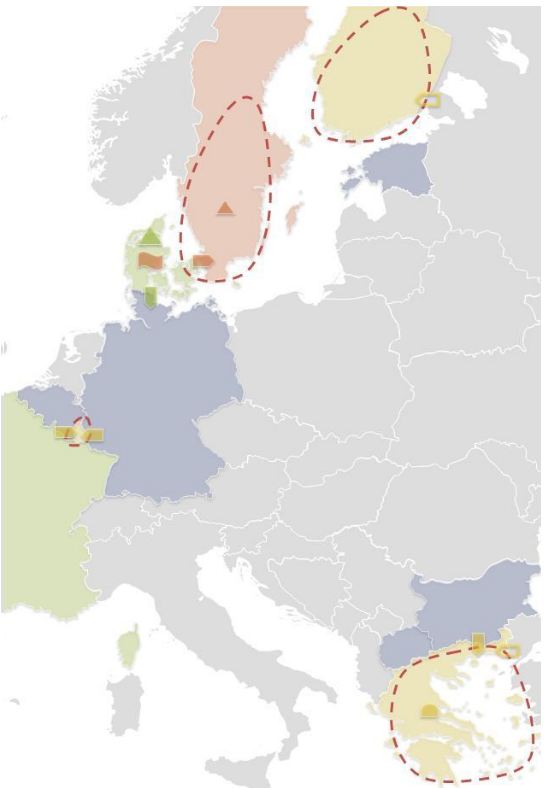
Following maps provide possible flow pattern and supply configuration within and around congested areas.

Reference case 2011 FID





Reference case 2015 FID



Reference case 2015 non-FID

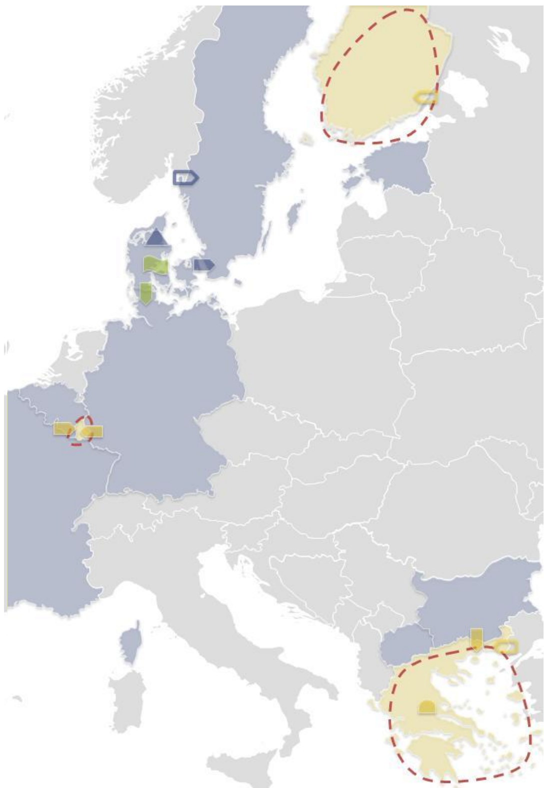
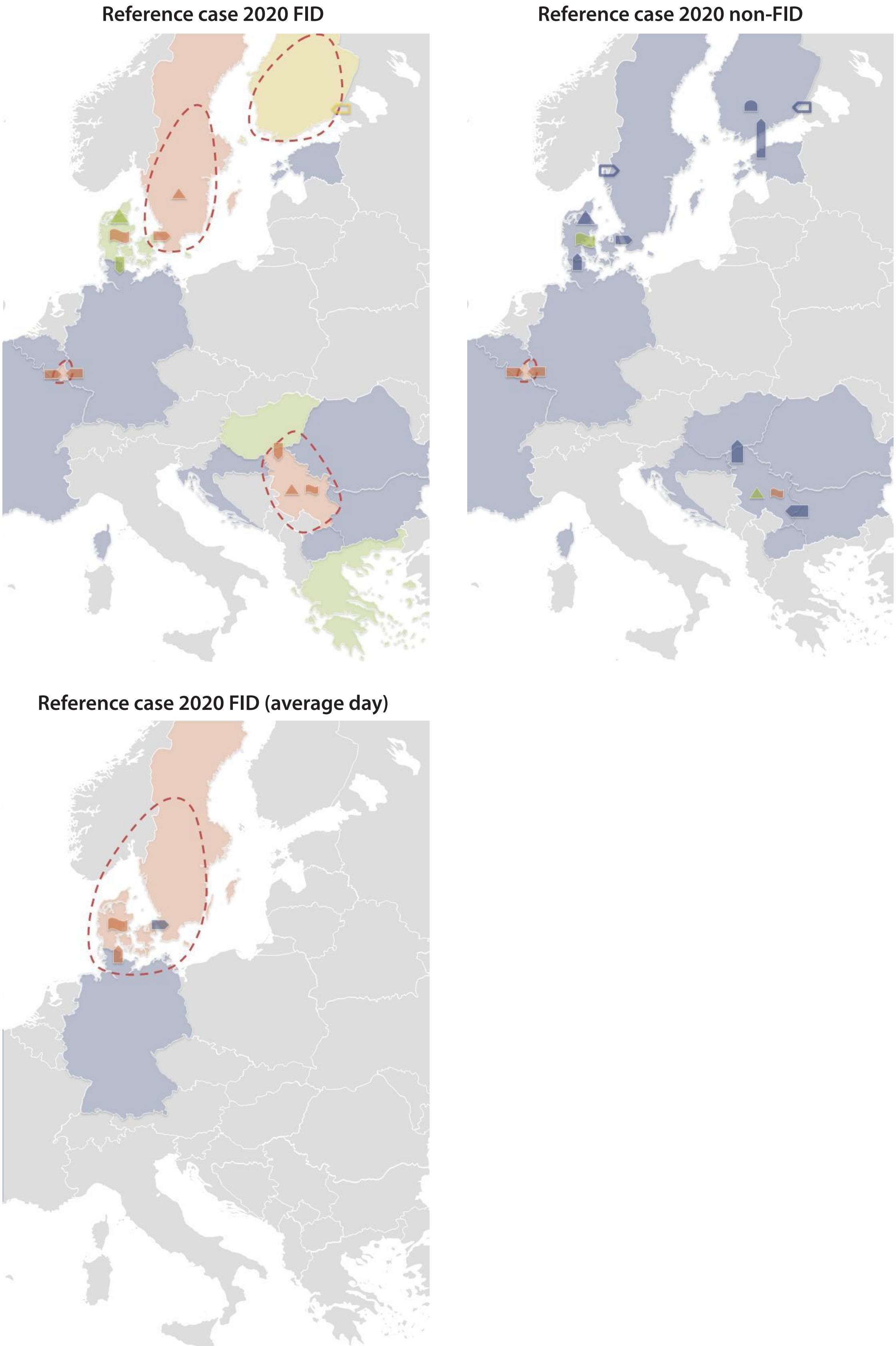


Figure 21: Reference Case



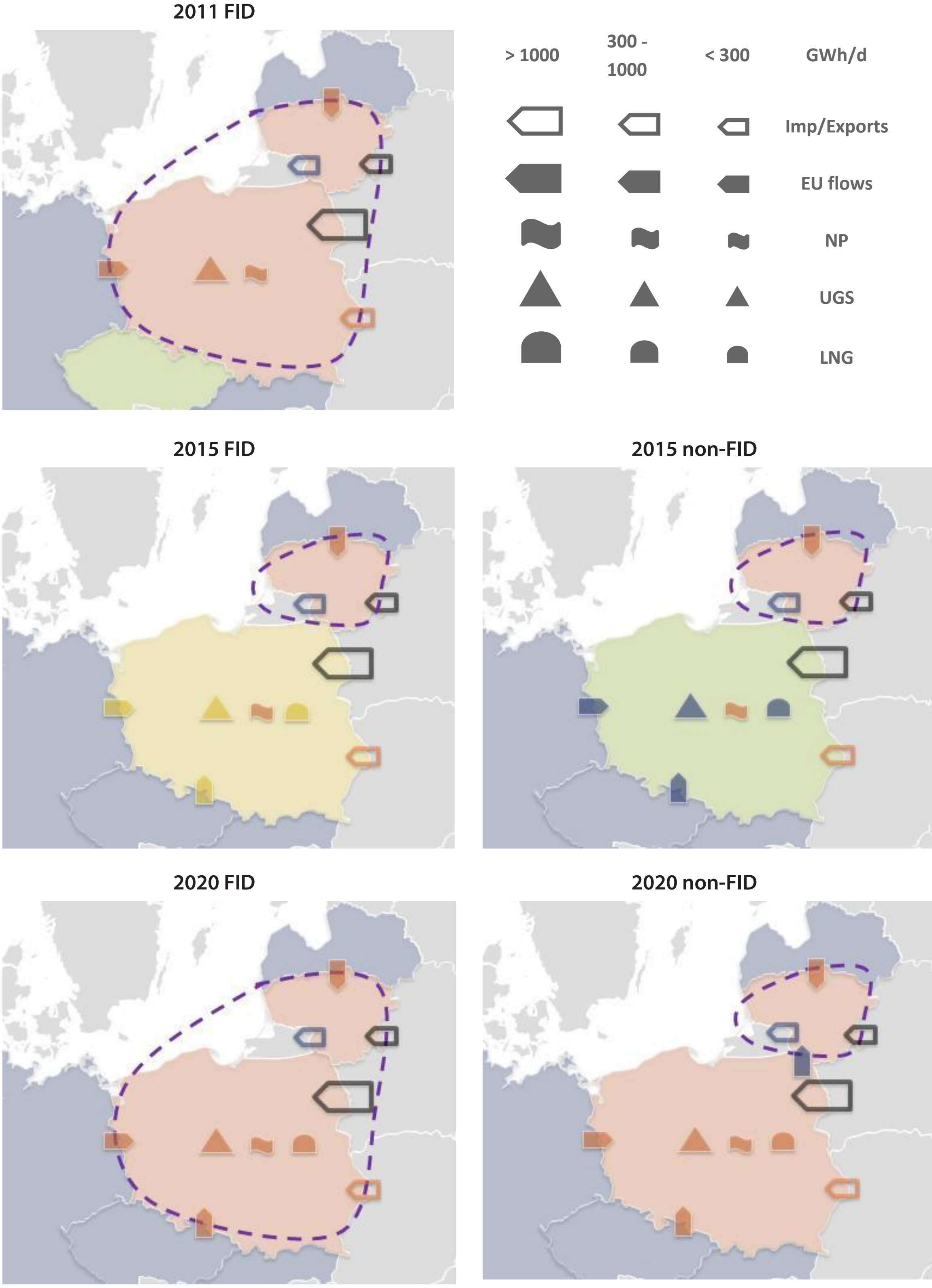


Figure 22: Belarus disruption

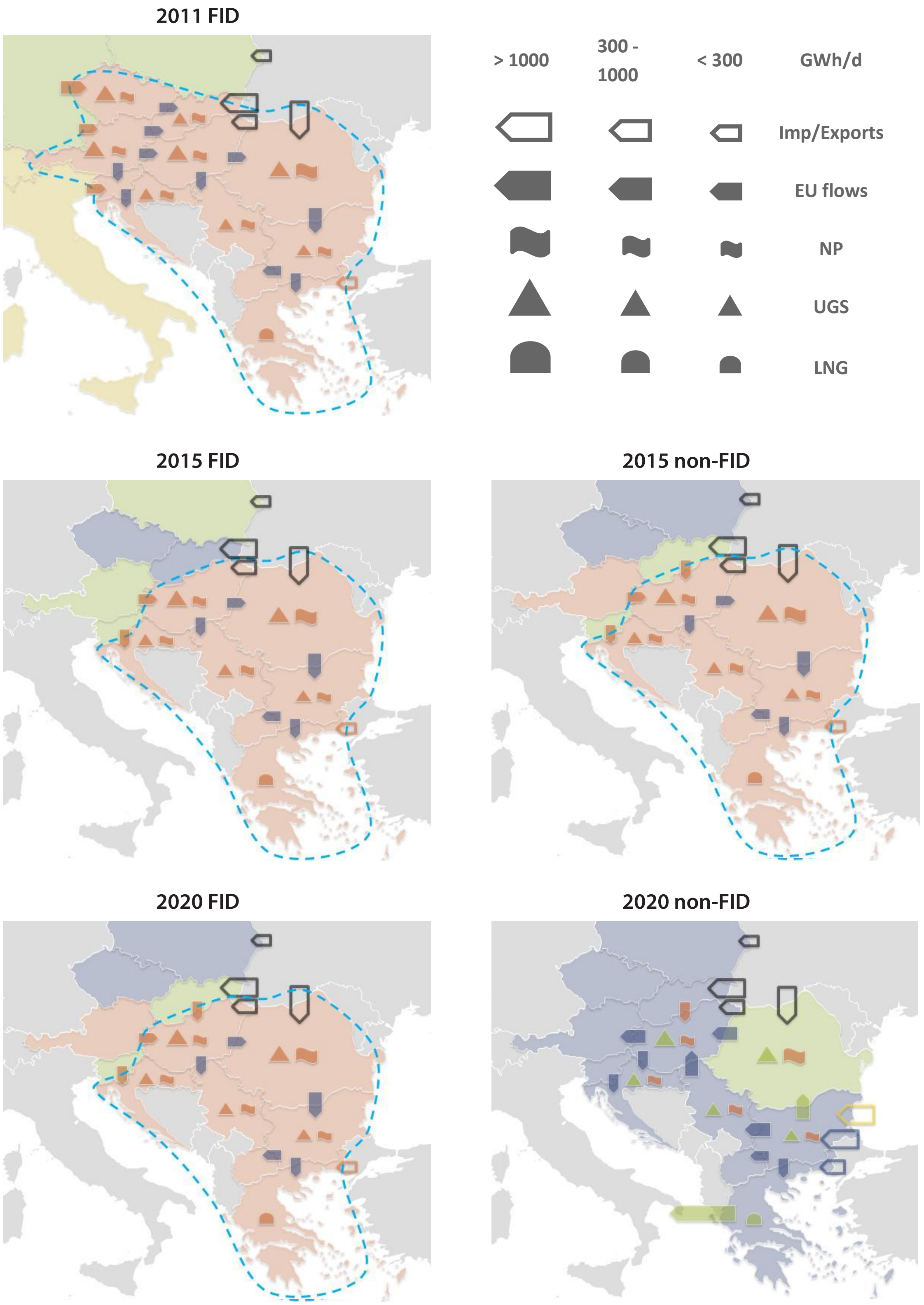


Figure 23: Ukraine disruption

- Key conclusions on Reference Case and disruption scenarios

From the presented analysis, it should be concluded that most parts of the European transmission system offer a reasonable level of flexibility under all modelled scenarios.

Regarding the Reference Case the natural trend is a decrease of such flexibility due to the simultaneous increase of demand and decrease of national production with particular impact on Scandinavia, Luxembourg, Serbia and Greece. Such trend could be reversed with non-FID projects coming on-stream except for Luxembourg.

LNG, Norway and North Africa disruptions should not limit the ability of European countries to cover their overall demand whereas Russian transit disruptions will not enable some regions (part of Baltic, Central and Eastern Europe) to meet their whole demand with only FID projects. Nevertheless such disruptions could be well managed by the other countries.

Non-FID projects could enable Central and Eastern Europe to face a transit disruption through Ukraine, additional ones will nevertheless be necessary to enable Lithuania and potentially Poland to meet their whole demand under a transit disruption through Belarus.

Low storage deliverability

- Impact of UGS projects on storage potential use under High Daily Demand

The graph below shows the evolution of the use of UGS in comparison with its maximum deliverability under the Reference Case High Daily Demand conditions (Storage being the last resort supply as defined under the section High Daily Supply).

The necessity to use UGS as supply of last resort to face High Daily Demand may reduce from now to 2015 offering more flexibility to the market in the use of storage. This trend will be sustainable toward 2020 only with non-FID storage projects coming on-stream. Otherwise, due to the Net Demand increase, this flexibility will be reduced.

- Network sensitivity to UGS deliverability limitation

Modelling as shown that if the European gas market can be balanced with storage deliverability of at least 80% in 2011 and 70% in 2015, lower deliverability will cause imbalances as potential imports will be insufficient to compensate for the decreased amount of gas withdrawn from storage. This highlights a storage capacity or a supply gap, rather than a transmission capacity gap even if the need for additional imports may trigger new investments in transmission capacity.

In 2020, non-FID storage projects could largely reduce the risk of supply gap enabling the European network to be balanced with UGS deliverability around 50%.

- Key conclusions on low storage deliverability

This sensitivity analysis confirms the impact of the seasonal pattern of gas market where storage will continue to play a key role in order to face the need of additional gas during the winter in parallel to any additional need for supply flexibility. It is therefore necessary that storage use ensures sufficient deliverability throughout the winter. Storage use which is far more independent of climatic conditions will require all non-FID storage projects to come on-stream by 2020.

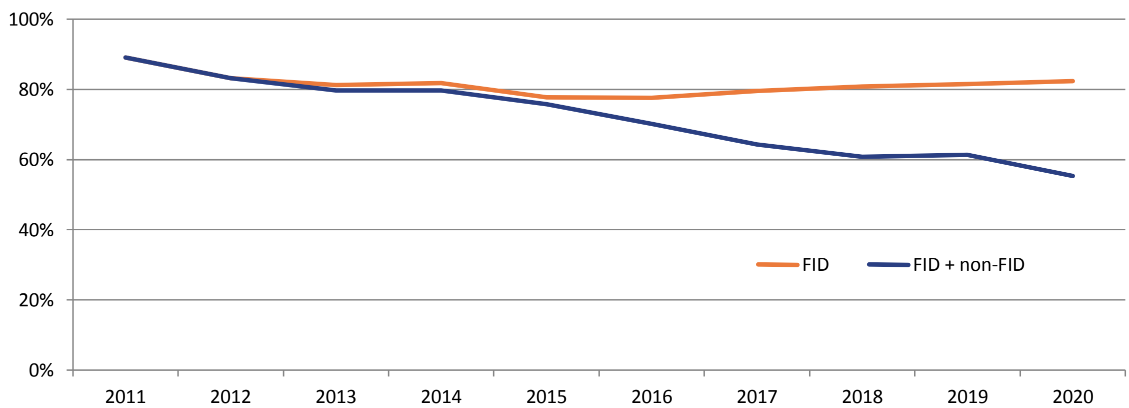


Figure 24: Evolution of UGS use as last resort supply

• Results of market integration scenarios

Ability to enjoy a diversified supply portfolio

Through this chapter ENTSOG makes the first outlook of European gas market integration. Then the chosen criteria and the targeted level should be seen as a proposal aiming to fuel the discussion with stakeholders.

The following graph shows the ability of the European network to give end-consumers access to different supply sources such as the European production, Algeria, Caspian region, Libya, LNG, Norway and Russia. If LNG is counted as a single source, it actually offers a wider supply diversification than a pipe gas source due to the globalization of the LNG market. A given supply source is considered when superior to 5% of the country needs (demand plus exit flows to adjacent systems).

This graph results from the pooling of different simulations (i.e. one simulation per one source). This means that for a given country, the access to different sources may not be simultaneous as simulations only aims to test the ability to have access to predominant supplies one by one.

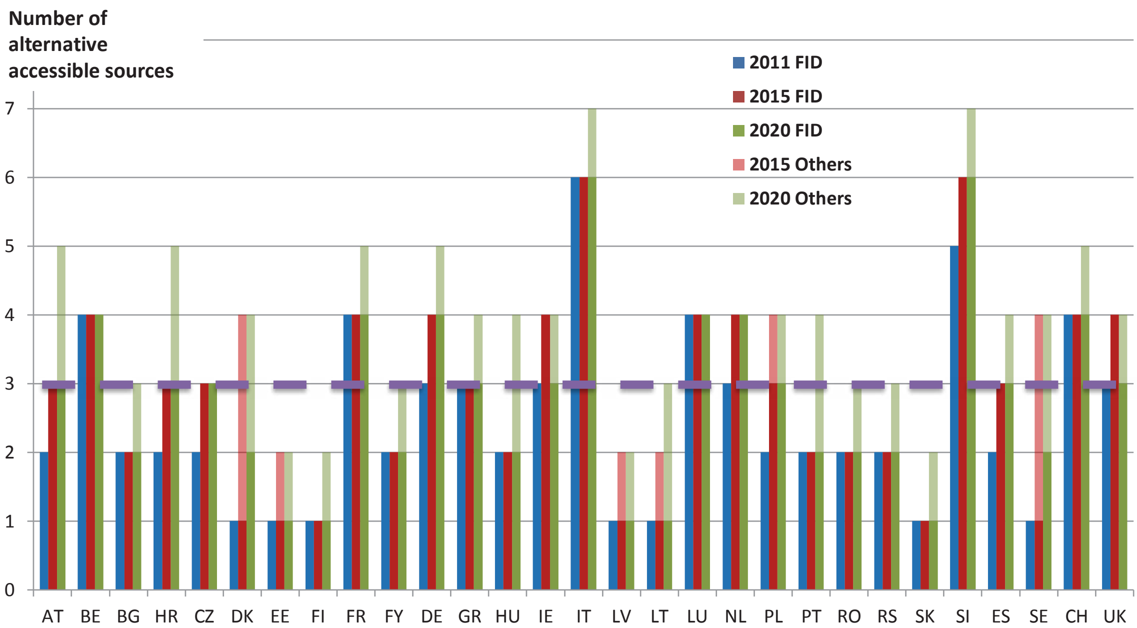


Figure 25: Market integration evolution – country outlook

The above graphs shows that from a pure infrastructure perspective, the market integration will increase in the time due to both FID and non-FID projects. The graph below shows the percentage of countries having access to three or more different supply sources:

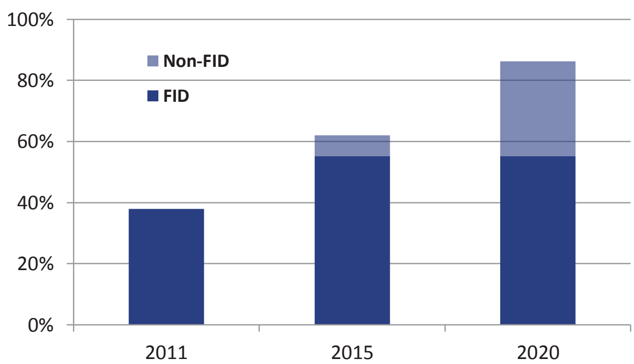


Figure 26: Market integration aggregated evolution

In 2020, with non-FID projects, 4 countries would still not have access to at least three different sources.

Potential influence of import sources

Following maps illustrate how far gas from one source may evenly spread into the European gas network. Such maps result from Average daily demand simulations.

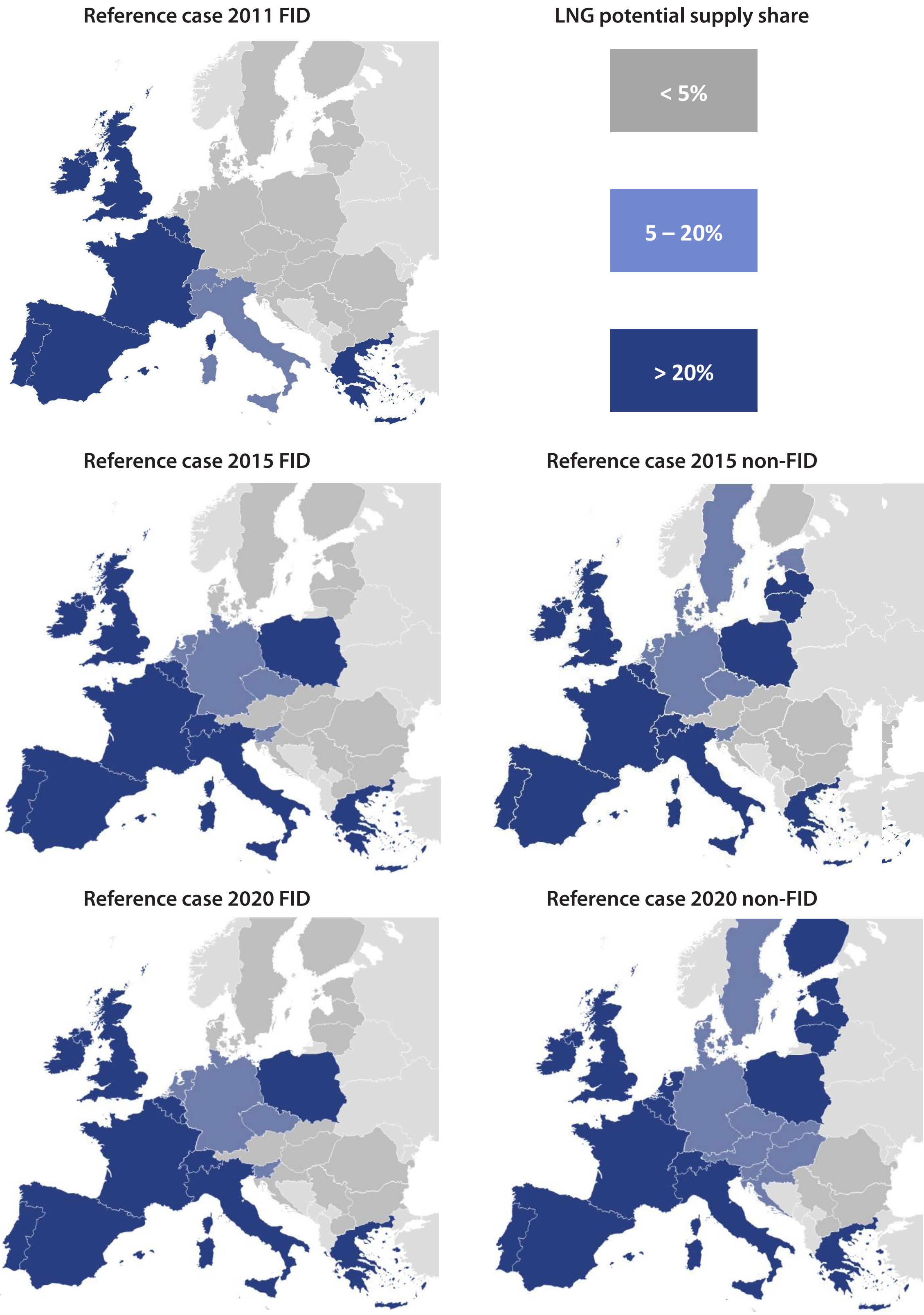


Figure 27: Evolution of LNG influence in the European gas network

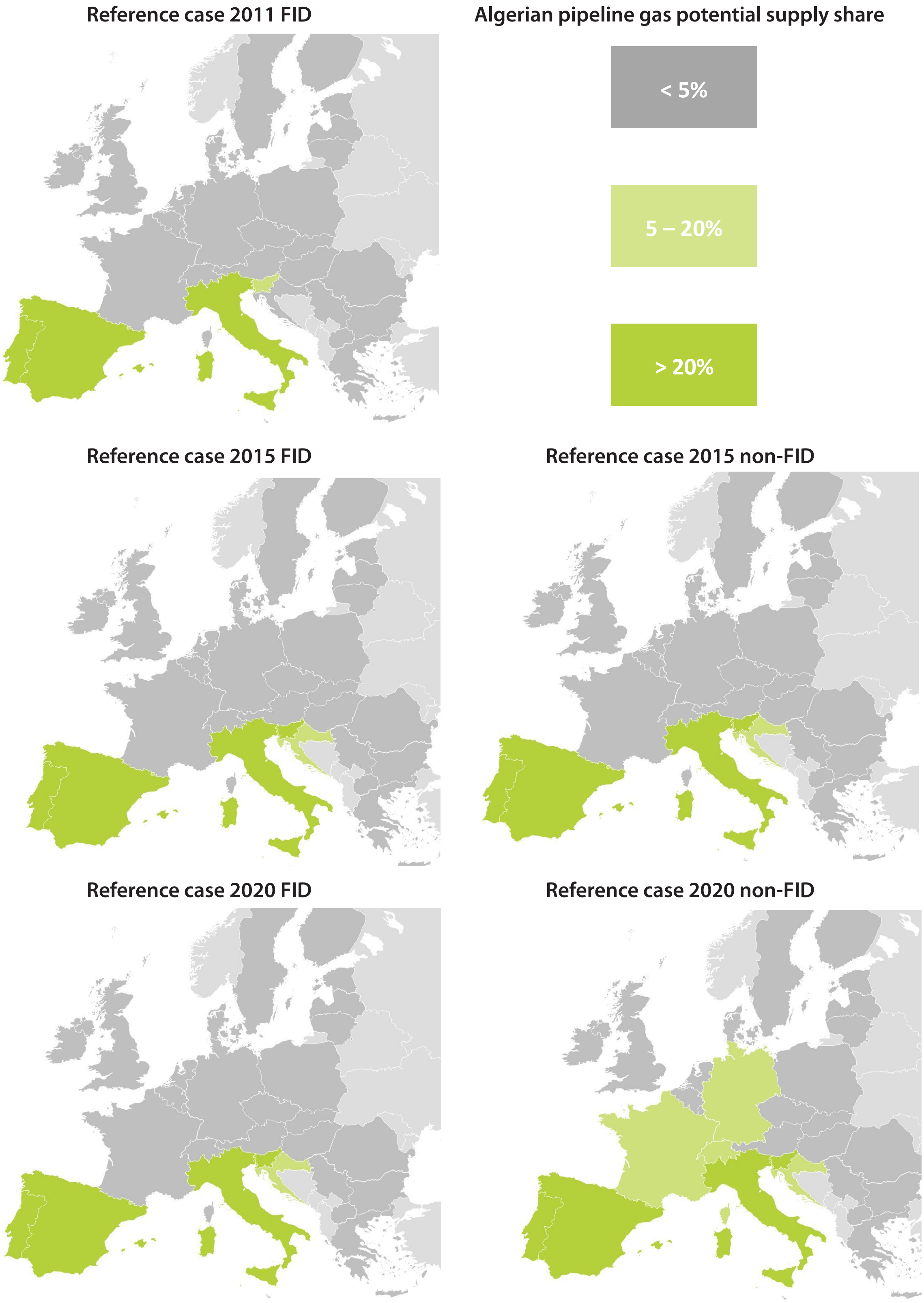


Figure 28: Evolution of Algerian pipeline gas influence in the European gas network

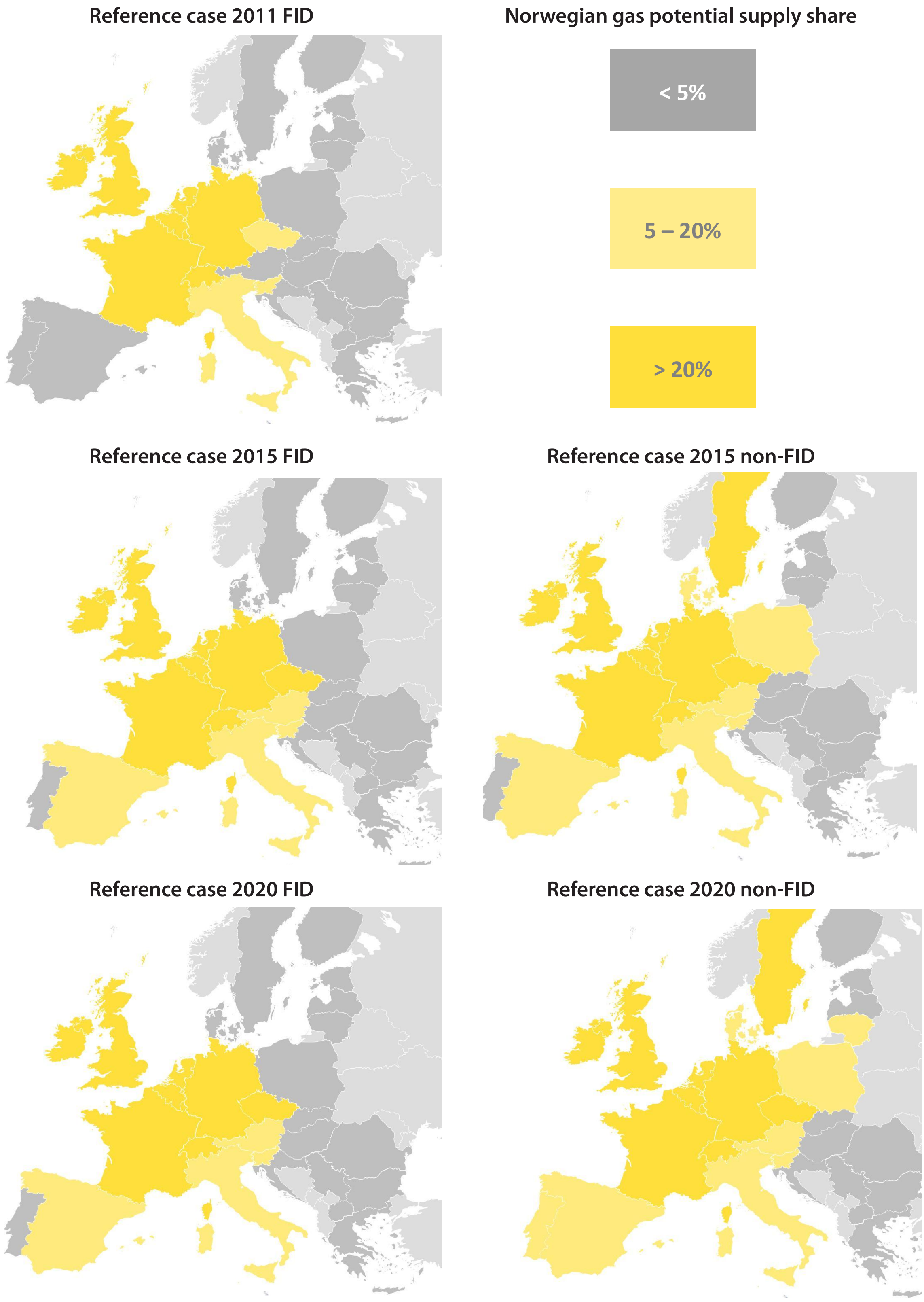


Figure 29: Evolution of Norwegian gas influence in the European gas network

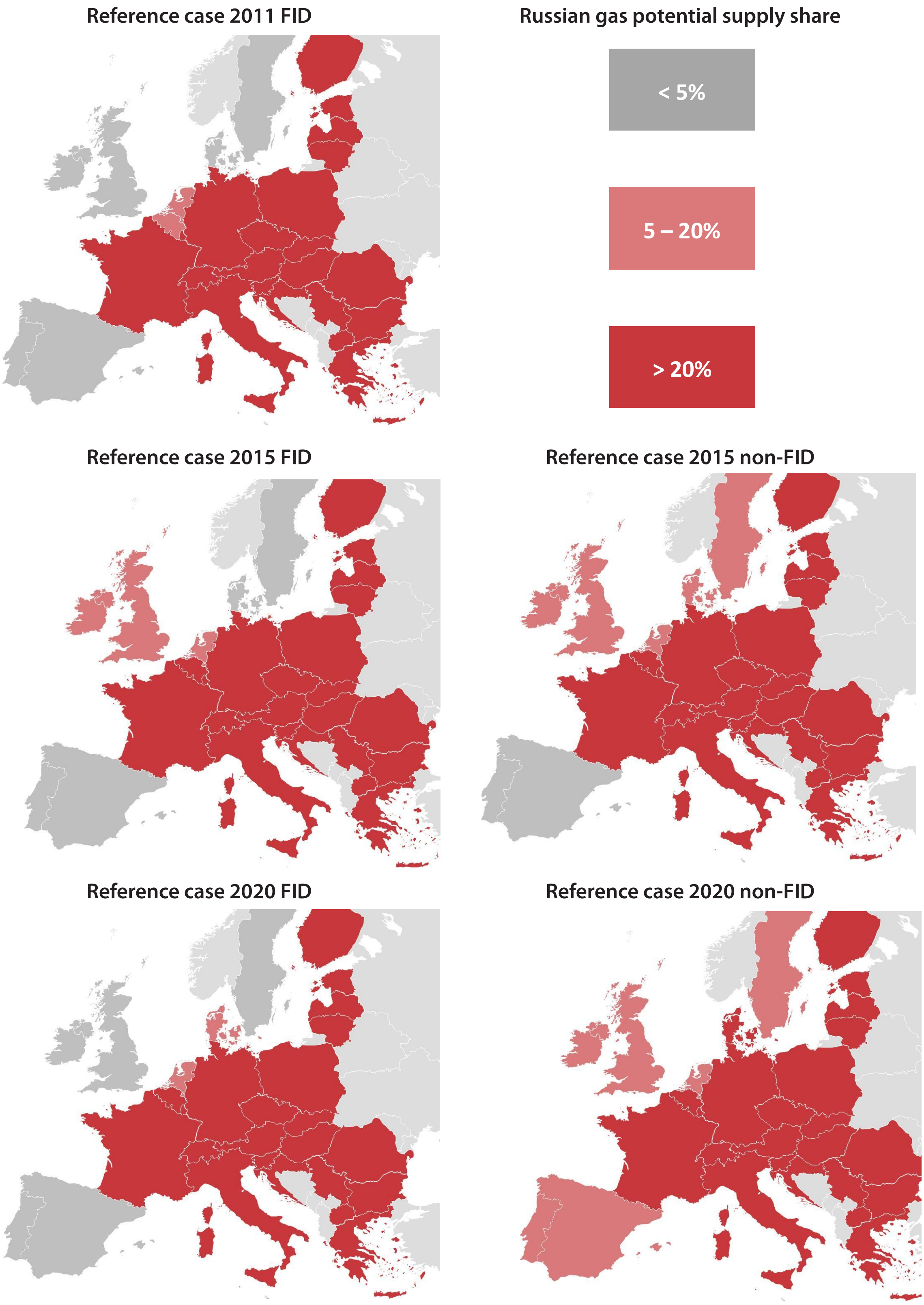


Figure 30: Evolution of Russian gas influence in the European gas network

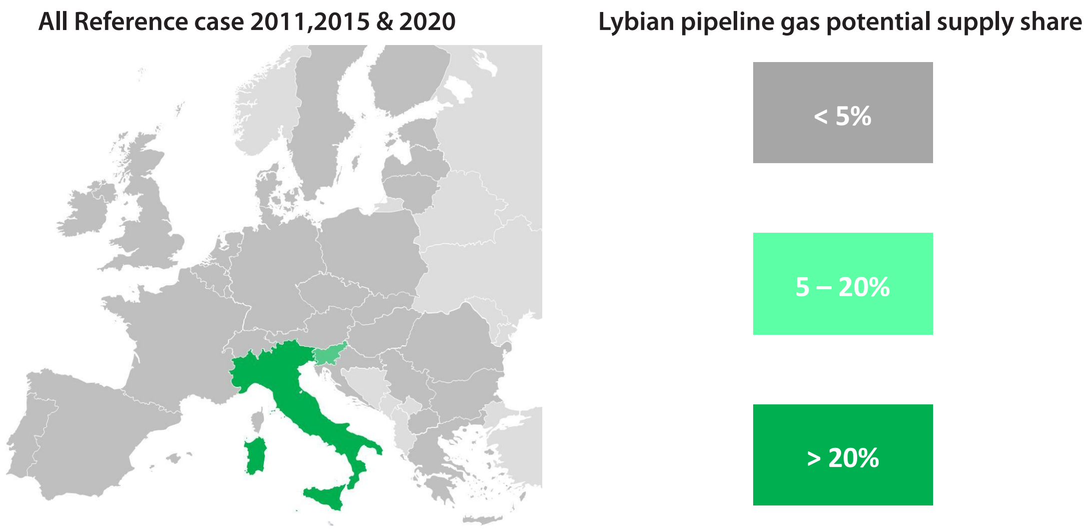


Figure 31: Evolution of Libyan pipeline gas influence in the European gas network

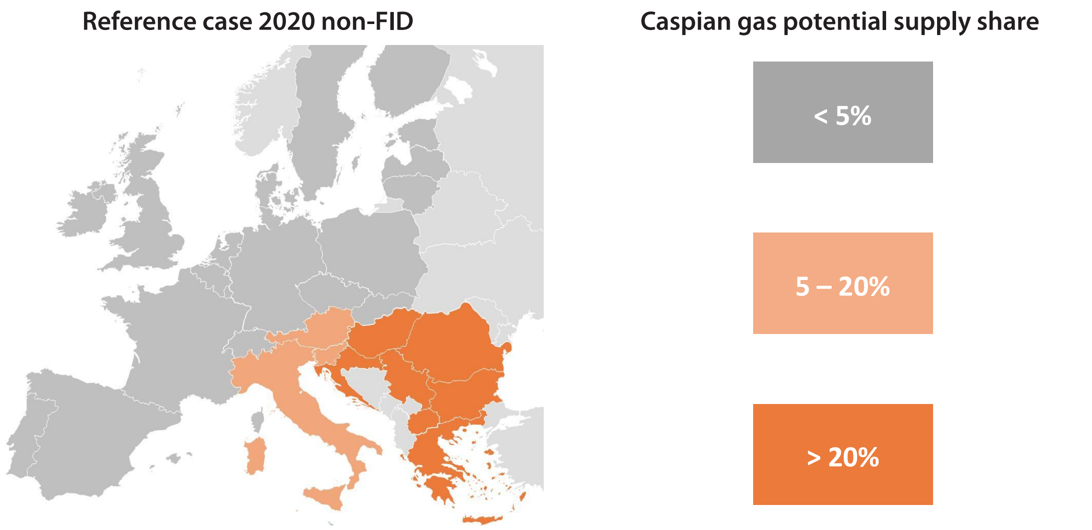


Figure 32: Evolution of Caspian gas influence in the European gas network

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 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.

Other limitations would certainly appear under additional climatic cases or simultaneous maximisation of several supply sources. Nevertheless this modelling is the first attempt to encompass market integration and still signals main trends. ENTSOG hopes that it will give the opportunity to stakeholders to better define the expected level of market integration and the way to describe it.

Supply considerations on market integration

Previous considerations show that from the infrastructure perspective, market integration may progress due to new infrastructure projects. However, in parallel, this may require additional supply in comparison with the considered potential supply within this report.

This is due to the fact that imports will, in the future, first replace the decreasing national production. More supply will thus be consumed closer to the import entry point decreasing its ability to get transported further into the European gas network without additional quantities. For Russia and Norway, such additional supply may not need additional import points than those included in the FID and non-FID projects as the import routes already provide a high level of flexibility in comparison with the potential supply. Situation could be different for North Africa, Caspian gas and LNG where such supply may reverse the role of some countries from final markets to "transit" countries. In such case, some investment may be required to send gas into the core of the European gas network where this gas coming from new supplies will be able to make use of the existing, well-meshed network already in place.

Key conclusions on market integration

ENTSOG analysis represents the first attempt to describe the level of market integration of the European gas network. If it should be seen as an experimental contribution, it nevertheless highlights heterogeneous situations but an improving trend among European countries and the need of additional imports to sustain this trend.

It should be also noticed that most of the infrastructure projects have some benefit both from a security of supply and market integration point of view.

Conclusions and the Way Forward

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Declining indigenous production, increasing as well as decreasing demand, and supply strategies different from those of the past mean that the transmission network must be able to accept and transport new and ever more diverse sources of gas from its delivery point to where it is needed regardless of the national boundaries. The flow patterns are much more variable and require greater flexibility of the European transmission network.

Considering the uncertainties that the European gas industry currently faces with regards to further development of the gas market, ENTSOG identified a wide range of scenarios to capture possible different futures.

From the point of supply, ENTSOG's findings confirm the current declining character of gas production in Europe signalling the need for increase of gas imports to cover the European demand in the future. With regards to non-EU supply, and based on information available in the public domain, there is potential for increase in imported volumes from all current supply sources (Algeria, Libya, LNG, Norway, Russia) even though the room for increase differs. There is also a high likelihood of introduction of new supply sources from the Caspian region, the extent of which will depend on the development of necessary infrastructure from the production to the European market as well as on the competition for the gas from other regions. Generally, the future potential of the producing countries will depend on the ability to exploit their gas reserves. This applies in the same way to the European potential of non-conventional gas sources.

Due to the uncertainties, it is difficult to draw clear conclusions; the supply figures as used in this Report nevertheless show that there may be significant supply flexibility in meeting the European demand, the level of which will depend on the demand development as well as on the realisation of the supply potential. The indigenous production will continue to play an important role in securing gas for Europe even if the decline in production is clear. Its annual share is expected to drop from about 37% to 22% considering the ENTSOG annual demand outlook. Development of all other identified gas sources is therefore required to cover the overall balance and contribute to the security of gas supply.

From the point of demand, the recent economic downturn has had a dampening effect on the annual gas demand and the future demand outlooks. In addition, stakeholders seem to input in their models differing views on the role of gas in meeting the environmental targets which significantly widens the demand outlook range. The difference between the lowest and highest outlooks for 2020 considered in this TYNDP [1] is about 20% (in absolute terms this means 1,141,599 GWh or approx. 104 bcm).

In absolute terms, the ENTSOG EU-27 demand outlook is the highest of all; nevertheless, there is a noticeable difference between the ENTSOG outlook produced in 2009 and 2010. It is also worth noting that ENTSOG's figures show very different gas demand development on the 10-year range at the national level ranging from a 25% drop in demand

[1] Outlooks produced by ENTSOG, Eurogas, IEA, and PRIMES (for the European Commission)

(Denmark) to a 75% increase in demand (Slovenia).

It is crucial to note that **infrastructure is designed according to the peak capacity demand** driven particularly by extreme climatic conditions and trading flexibility requirements as well as by supply disruption management. Forecasts of High Daily Demand, which are among the most important inputs into the modelling, were provided by TSOs only and it is unlikely that such forecasts will be available from other sources.

The **potential peak demand for capacity** is the core focus of the TYNDP report driving the definition of most scenarios and subsequent results. The potential future investment gaps identify where the potential peak demand for capacity may not be met. In addition, ENTSOG also addresses the potential capacity demand in market integration scenarios.

From the European perspective, this TYNDP shows that many investments are still needed to address the security, sustainability and competition in a satisfactory manner. The key conclusions on the results of the resilience assessment are presented below:

Key conclusions on Reference Case and disruption scenarios

Most parts of the European transmission system offer a reasonable level of flexibility under all modelled scenarios.

In the Reference Case, the natural trend is a decrease of such flexibility due to the simultaneous increase of demand and decrease of national production with particular impact on Scandinavia, Luxembourg, Serbia and Greece. Such trend could be reversed with non-FID projects coming on-stream except for Luxembourg.

LNG, Norway and North Africa disruptions should not limit the ability of European countries to cover their overall demand whereas Russian transit disruptions will not enable some regions (part of Baltic, Central and Eastern Europe) to meet their whole demand with only FID projects. Nevertheless such disruptions could be well managed by the other countries.

Non-FID projects could enable Central and Eastern Europe to face a transit disruption through Ukraine, additional ones will nevertheless be necessary to enable Lithuania and potentially Poland to meet their whole demand under a transit disruption through Belarus.

Key conclusions on low storage deliverability

This sensitivity analysis confirms the impact of the seasonal pattern of gas market where storage will continue to play a key role in order to face the need of additional gas during the winter in parallel to any additional need for supply flexibility. It is therefore necessary that storage use ensures sufficient deliverability throughout the winter. Storage use which is far more independent of climatic conditions will require all non-FID storage projects to come on-stream by 2020.

Key conclusions on market integration

This analysis represents the first attempt to describe the level of market integration of the European gas network and should be seen as an experimental contribution. It does however highlight heterogeneity of the current situation and an improving trend among European countries and the need of additional imports to sustain this trend.

It should be also noticed that most of the infrastructure projects have some benefit both from a security of supply and market integration point of view.

As demonstrated above, ENTSOG modelled the European network covering a wide range of scenarios which combine different values of specific parameters (available infrastructures, climatic conditions, supply disruption, storage deliverability and supply source mix). The results show that the European gas network is evolving from a quite deterministic design (answering the need of few integrated players having a good knowledge of both supply and demand and trying to optimize their transportation costs) based on main historical imports underlined by big trunk pipelines to a more integrated grid in order to face the increasing flexibility need of a wider range of stakeholders. As graphically schematized below, three main investment drivers may be identified as follows: new imports inducing the ability to send gas to the central part of the European gas network (1), a better integration of historic transit countries receiving gas from mainly one single source until now (2) and an adaptation of the central part of the European gas network to enable these new trends (3). All investment projects included in this TYNDP will help reduce the network clustering and achieve enhanced integration while contributing to the single European energy market objective.

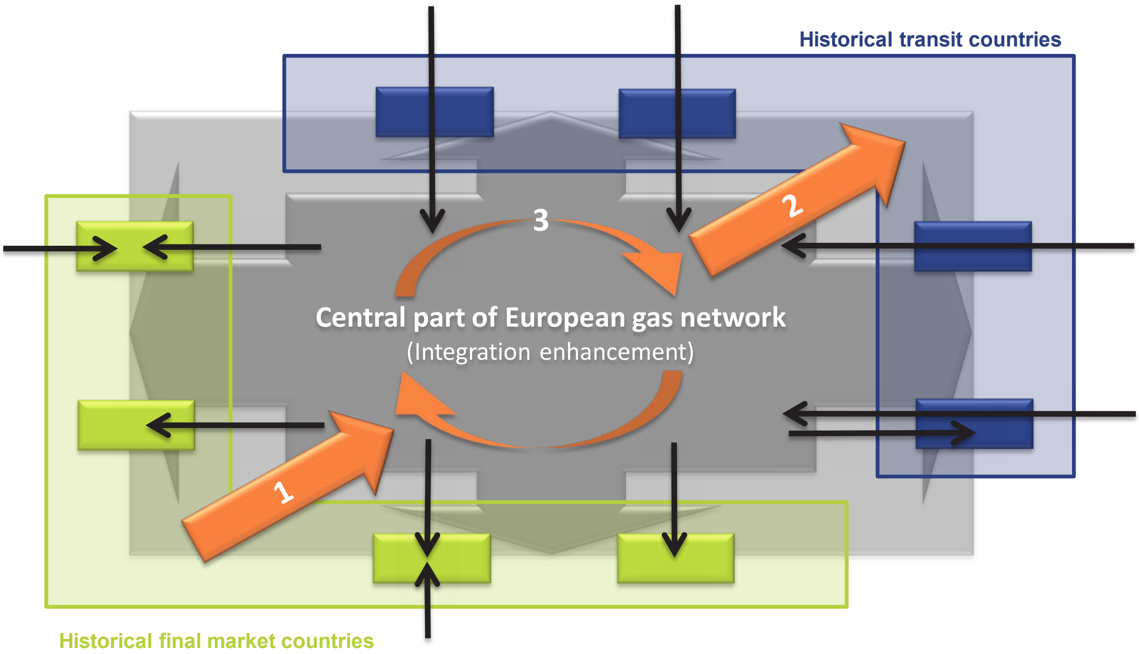

Figure 33: The development of the European network ('where history meets the future')

Above schema provides a simplistic view of the European gas network intending to better highlight the potential investment drivers.

A well-meshed network enables access to different supply sources and facilitates establishment of diversified suppliers' portfolios consequently leading to an increased security of supply.

ENTSOG would like to note that the Union-wide Ten-Year Network Development Plan aims at giving the European perspective of the network development both in terms of future projects and possible investment gaps. In order to achieve this panoramic view, the model does not consider all of the complexities of the European gas network. More specific assessments, such as in regional investment plans and national plans, will enable a deeper analysis of such complexities and may identify additional investment needs. The Union-wide TYNDP is thus complementary to the regional and national plans and constant interaction between all three is necessary. Consistency of the plans should thus be understood in terms of interaction rather than in the exact same input.

Way forward

ENTSOG believes that TYNDP 2011-2020 presents significant improvements compared to the pilot Report published in December 2009. ENTSOG is nevertheless aware that further improvements will need to be done in the future, in particular in the following areas:

- Process iteration to find the right contents addressing all stakeholders' expectations and interests
- Improvement of data accuracy in particular regarding data not directly relating to an individual TSO; all stakeholders' commitment is absolutely crucial for moving this task forward
- ENTSOG organization need to be further adapt to meet rising stakeholders' expectations regarding the development of TYNDP and other related reports
- Investigation of a greater number of scenarios to better assess network resilience

In summary, ENTSOG considers the TYNDP to be a 'living organism' and as such it will evolve along with the market dynamics it is expected to capture.

Afterword

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I hope you have enjoyed reading the European Ten Year Network Development Plan 2011-2020 and found the information on supply, demand and network resilience from security of supply and market integration perspectives interesting. The result is clear, resilience improves but without new investments the trend will reverse as both the dependency of Europe on imports and requirements for flexibility increase.

After the first edition, ENTSOG had collected many comment and recommendation. Even if ENTSOG had very soon agreed to be ambitious and face most of this feedback already in the second edition, the size of the resulting challenge may have not been foreseen immediately. Nevertheless, after dozens of meetings, more than hundred different simulations and thousands of hours spent by TSOs, the report has come alive. I believe it succeeds in meeting your previous expectations even if I know that your expectations will rise again.
This is normal, as a single report cannot answer all the questions at once. New answers could be part of Regional Investment Plans enabling to focus on regional issues or part of the third edition of the European Ten Year Network Development Plan (2013-2022) investigating resilience better and wider. ENTSOG believes the TYNDP to be a 'living organism' reflecting the market dynamism and growing on the acquired expertise and knowledge of ENTSOG as well as on your related feedback.

Now that you have read this TYNDP we hope you will take part in this continuous and challenging evolution process.

Stephan Kamphues
ENTSOG President

Definitions

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Term	Definitions
Average Daily Demand	means the daily demand on an average day and is calculated as the annual demand (ENTSOG scenario) divided by 365
Average Daily Supply	means a mix of supply sources that ensures the supply demand balance under the Average Daily Demand conditions ; the Average Daily Supply is equal to the Annual Supply divided by 365
Annual Supply	means a mix of supply sources that ensures the supply demand balance on annual basis; storage is considered as neutral in the Annual Supply (equal to zero)
Annual Supply Potential	means the ability of a supply source to deliver the identified volume of gas on annual basis
High Daily Demand	means the daily demand under 1in20 climatic conditions
High Daily Supply	means a mix of supply sources that ensures the supply demand balance under High Daily Demand conditions
Net Annual Demand	means the difference between the annual demand (ENTSOG scenario) and the national production forecasts; underground storage is considered as neutral
Net Daily Demand	means the difference between the High Daily Demand and the daily national production
Technical capacity	means the maximum firm capacity that the transmission system operator can offer to the network users, taking account of system integrity and the operational requirements of the transmission network (Art. 2(1)(18), REG-715)
Transmission	means the transport of natural gas through a network, which mainly contains high-pressure pipelines, other than an upstream pipeline network and other than the part of high-pressure pipelines primarily used in the context of local distribution of natural gas, with a view to its delivery to customers, but not including supply (Art. 2(1)(1), REG-715)

Abbreviations

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Abbreviation	Full Name
bcm	Billion normal cubic meters (normal cubic meter (Nm3) refers to m3 at 0°C and 1.01325 bar)
CIS	Commonwealth of Independent States
CS	Compressor Station
ENTSOE	European Network of Transmission System Operators for Electricity
ENTSOG	European Network of Transmissions System Operators for Gas
ERGEG	European Regulators' Group for Electricity and Gas
ETS	European Trading Scheme
EU	European Union
FID	Final Investment Decision
GIE	Gas Infrastructure Europe
GLE	Gas LNG Europe
GTE+	Gas Transmission Europe +
ID	Identification
IEA	International Energy Agency
IP	Interconnection Point
ISD	Infrastructure – Supply – Demand
LNG	Liquefied Natural Gas
Mcm	Million normal cubic meters (normal cubic meter (Nm3) refers to m3 at 0°C and 1.01325 bar)
MS	Member State
MS	Metering Station (when used in relation to infrastructure project)
OECD	Organisation for Economic Co-operation and Development TYNDP: Ten Year Network Development Plan
OGP	International Association of Oil & Gas Producers
REG-715	Regulation (EC) No 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the natural gas transmission networks
REG-SoS	Regulation (EU) No 994/2010 of the European Parliament and of the Council of 20 October 2010 concerning measures to safeguard security of gas supply and repealing Council Directive 2004/67/EC
SoS	Security of Supply
TSO	Transmission System Operator
UGS	Underground storage (facility)

Country Codes

Country Code	Full Name	Country Code	Full Name
AL	Albania	**MK**	FYROM
DZ	Algeria	**ME**	Montenegro
AT	Austria	**LY**	Libya
BY	Belarus	**MA**	Morocco
BE	Belgium	**NL**	Netherlands, the
BH	Bosnia Herzegovina	**NO**	Norway
BG	Bulgaria	**PL**	Poland
HR	Croatia	**PT**	Portugal
CZ	Czech Republic	**RO**	Romania
DK	Denmark	**RU**	Russia
EE	Estonia	**RS**	Serbia
FI	Finland	**SK**	Slovakia
FR	France	**SI**	Slovenia
DE	Germany	**ES**	Spain
GR	Greece	**SE**	Sweden
HU	Hungary	**CH**	Switzerland
IE	Ireland	**TN**	Tunisia
IT	Italy	**TK**	Turkey
LV	Latvia	**UA**	Ukraine
LT	Lithuania	**UNMIK**	UNMIK
LU	Luxembourg	**UK**	United Kingdom

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Report from the Commission to the Council and the European Parliament on the implementation of the European Energy Programme for Recovery
Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the implementation of the Trans-European Energy Networks in the period 2007-2009, incl. the Annex

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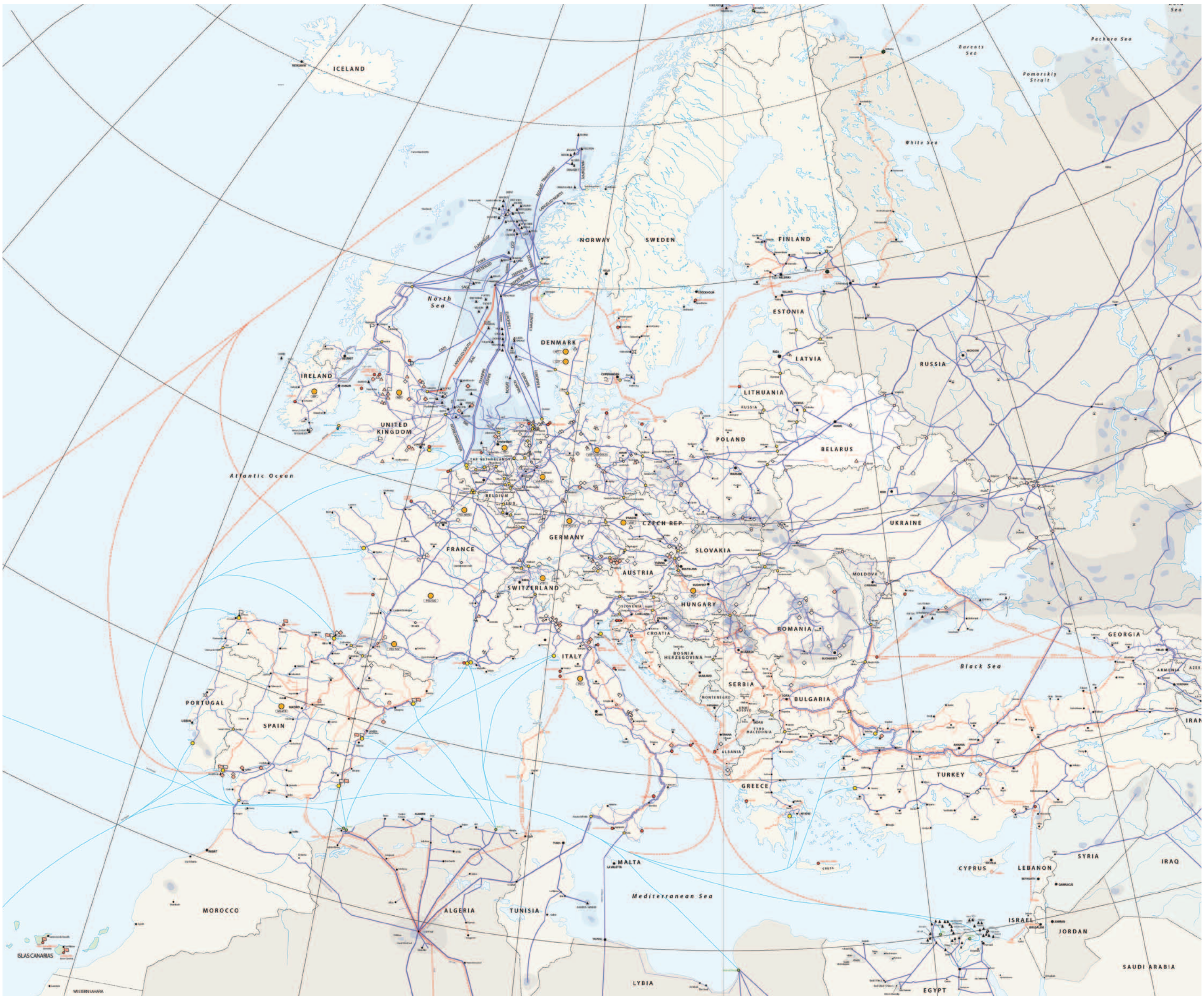

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