THE "VERTICAL CORRIDOR"

FROM THE AEGEAN TO THE BALTIC

An IENE Study Project
(M26)

May 2015

Athens, Greece

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1. Introduction

Even before the unveiling of EC's proposals for the creation of a European "Energy Union" on Feb. 25, 2015, where emphasis was placed on gas interconnections and alternative supply routes, the need to reinforce gas connectivity across the European continent was a clearly defined energy strategy goal for the EU. A strategy goal which acquires special significance when it comes to SE Europe whose economies and energy markets, whether electricity or gas, appear to be cut off from mainstream European developments.

In the case of gas SE Europe has emerged over the last few years as a region of special significance in view of Brussels' decision to promote at all costs the South Corridor as an alternative route, for supplying European gas markets with Caspian gas. Indeed plans have progressed satisfactorily and the first such route, the TAP pipeline, is now under way with construction slated to start later this year or early in 2016. This pipeline will connect with the other major components of the South Corridor, the Azeri - Turkey backed TANAP pipeline (which will bring gas from Baku up to Greek- Turkish border in Thrace) and will transport gas through the plains of Northern Greece to Albania and from there underwater via the Adriatic to South Italy. Apart from transiting gas to major European proper markets, it has been agreed that TAP will provide some limited quantities to Greece (+ 1.0 BCM) and Bulgaria (+ 1.0 BCM) and develop the Albanian gas market with the construction and operation of at least one exit point with a minimum technical capacity of 2 mcm/day.At a later stage it could branch off to supply certain countries in West Balkans (i.e. Kosovo, Montenegro, Croatia). Whatever the outcome of these plans one thing is certain. TAP with its initial intake of some 10.0 BCM's will bring to the region certain much needed additional gas volumes, thus helping to enhance gas market liquidity.

The availability of these extra gas quantities is key in the planning and promotion of further gas interconnections which is a perquisite in EU's efforts and aspirations to develop an integrated gas market in the region. In addition the interconnections now on the drawing board, which are all reverse flows, include the Greek- Bulgarian interconnector (IGB) , the Bulgarian-Serbian one (IBS), the Bulgarian- Romanian one (IBR) and the Romanian- Hungarian one (IRH) will ensure a significant improvement to the region's energy security situation as they will allow much easier flow, to and from, of adequate gas quantities. At the same time improvements and upgrading, regarding the existing Greek- Turkish interconnector (IGT) and the Greek- Bulgarian pipeline at Sidirokastro, to increase capacity and in the case of the latter to acquire reverse flow capability. Between them these gas interconnectors, including the TAP Albania- Italy connection, will be able to move around some 40 BCM's once TAP's first phase is completed, starting from 2019.

With this panorama of new gas pipelines and interconnectors in place, it is not hard to develop a strategy for the movement of gas in a North- South and South- North direction, in contrast to the prevailing horizontal expansion as currently foreseen. This is precisely what the political forces of Greece, Bulgaria and Romania expressed in their joint statement of December 9, 2014 which foresees the development of a so called "Vertical Corridor" which will initially connect the gas networks of the three countries and potentially further provide for a route northwards involving Hungary and from there to the Baltic. The outcome will be a system of gas pipelines and interconnectors which will facilitate gas movement over an extended geographical region and is therefore of key strategic importance, as it literally lies between East and West.

In order to understand better the philosophy and the utility of this new gas corridor the full text of the December 9 agreement follows:

«Joint statement by the Ministers of Energy for the natural gas "Vertical Corridor"

The Ministers responsible for Energy of the Hellenic Republic, the Republic of Bulgaria and Romania (hereinafter, referred to as "the Sides") reaffirm their *commitment to promote secure, sustainable energy supplies at affordable and competitive prices, on the basis of the EU's energy strategy for completing EU's internal energy market, ending the isolation of Member States and promoting diversification of routes, sources and counterparts, inter alia through the development of the "Southern Corridor."*

The Sides acknowledge the importance of a regional approach to address and overcome common challenges and express their willingness to enhance cooperation and work together with a view to increasing the energy security of their respective countries, the broader region and Europe as a whole. They will endeavour, as a strategic priority to advance greater access to diversified supplies and establish the prerequisites for a more connected, competitive, liquid and inclusive energy market, with more gas-to gas competition.

Towards these goals the Sides support the development of a new Vertical Gas Corridor connecting Greece, Bulgaria and Romania, with a view to ensuring uninterrupted bidirectional supplies, while promoting the EU's Priority Corridor "North South" ("NSI East Gas") and "Southern Corridor", through the swift realisation of the Projects of Common Interest and by overcoming the missing links necessary for the completion of an interconnected internal market with the financial support of European institutions.

The Sides underline the importance of facilitating access to diversified supplies both through interconnectors and LNG terminals as well as to storage facilities; they note the critical importance of LNG as flexible, diversified source and route for energy security.

The Sides stress that their cooperation is inclusive to other Member States of the European Union and Energy Community with a view to strengthening the "Southern Corridor" and enabling the flow of gas from the Aegean and Black Seas.

The Sides call on the Commission to support their initiative for closer regional cooperation and promote the projects necessary for its effective and efficient realisation in the context of the Trans European Energy Infrastructure policy and through financial instruments from European institutions.

Experts from the countries represented in this Declaration will start discussions immediately on the regulatory and technical aspects regarding the realisation of the Gas Corridor between their respective countries."

In view of the fact that apart from the above political statement no other supporting documentation exists describing the technical and operational characteristics of the "Vertical Corridor", and as part of its mission IENE took the initiative to carry out an initial "concept development" study with the explicit purpose of (a) decoding the political message behind the above ministerial declaration and (b) highlighting the key elements of the proposed corridor both in terms of design and operation. What follows is a detailed analysis at both technical and economic level of the main parameters involved for the implementation of what appears to be a very challenging project.

The present study attempts an all round investigation of the existing and prospective gas infrastructure of the region and its relevance to the development of the "Vertical Corridor" system of gas pipelines. Although the technical aspects of the "Corridor" are not insignificant, it is the political implications of the project and the necessary agreements at diplomatic level which presentthe main challenges for a successful launching of this ambitious project. At first glance the main difficulties for the project's implementation appear to lie more on its operational framework than in its construction phase. Since as it becomes very clear from the analysis which follows the construction of new components of this system, whether pipelines, compressor stations, branches or metering stations, is minimal. Whereas the modus operandi for what is likely to be a rather complex web of pipelines is what will require most attention and a very precise set of intergovernmental agreements.

2. EU Energy Strategy and Security of Supply

The EU imports more than half of all the energy it consumes. Its import dependency is particularly high for crude oil (more than 90%) and natural gas (66%). The total import bill is more than €1 billion per day.

Many countries are also heavily reliant on a single supplier, including some that rely entirely on Russia for their natural gas. This dependence leaves them vulnerable to supply disruptions, whether caused by political or commercial disputes, or infrastructure failure. For instance, a 2009 gas dispute between Russia and transit-country Ukraine, left many EU countries with severe shortages. Recent events in Ukraine have propelled energy security back to the top of the EU's foreign policy agenda. Russia's actions have spurred sharper consideration of the need for energy diversification, with Moscow closing gas supplies to Ukraine and the debates sharpening over Moscow's decision to scrap the "South Stream" pipeline and replace it with Turk Stream. Instability in the Middle East and North Africa further compounds the challenge of securing reliable sources of alternative supplies.

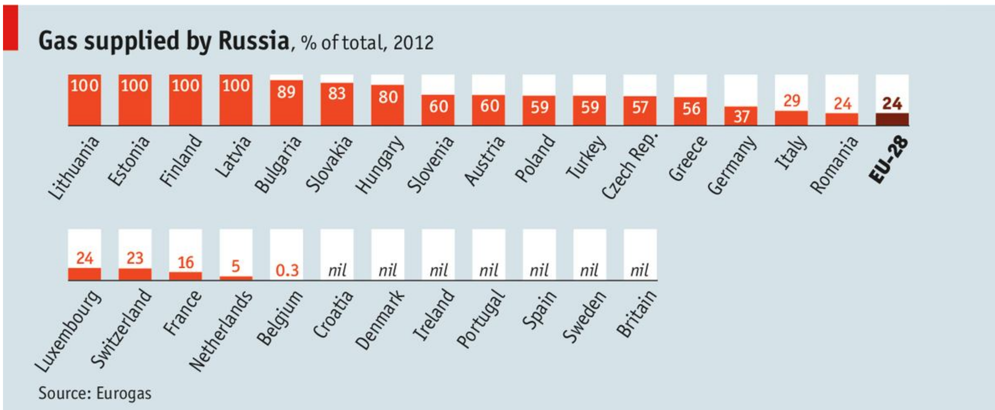


Figure 1: Gas Supplied by Russia (Source: Eurogas)

In response to the above concerns, the EU launched its EU energy security strategy in 2014. It lays out measures such as promoting energy efficiency as well as increasing indigenous energy production or completing missing infrastructure links to redirect energy to where it is needed during a crisis.

Figure 2: Gas Pipeline routes

As part of the Strategy, the EU in the summer of 2014 conducted so-called stress tests to analyze the ability of Europe's energy system to cope with a possible severe gas disruption during the winter of 2014/2015.

The so-called energy security stress tests were carried out by 38 European countries, including all EU countries. They simulated two energy supply disruption scenarios for a period of one or six months:

- a complete halt of Russian gas imports to the EU
- a disruption of Russian gas imports through the Ukrainian transit route

The tests showed that a prolonged supply disruption would have a substantial impact on the EU. Eastern EU countries and Energy Community countries would be particularly affected. If all countries cooperate with each other however, most consumers would remain supplied even in the event of a six month gas disruption.

Based on the analysis of the stress tests, it transpired that a number of short-term measures could help the EU ensure secure supplies of energy:

- the EU should follow a market-based approach to guarantee secure supplies. Interventionist measures by governments should be avoided
- countries should increase energy coordination with each other, including the maximisation of interconnector capacity and the removal of restrictions in cross-border energy trade
- short-term behavioural changes should be enacted to boost energy efficiency and lower demand
- the EU's Gas Coordination Group should continuously monitor developments in gas supply

The Strategy also addresses long-term security of supply concerns and proposes actions in five key areas:

- Increasing energy efficiency in orderto reach the proposed 2030 energy and climate goals. Priorities in this area should focus on buildings and industry, which use 40% and 25% of total EU energy respectively. It is also important to help consumers lower their energy consumption, for example with clear billing information and smart energy meters.
- Increasing energy production in EU countries and diversifying supplier countries and routes. This includes further deployment of renewables, sustainable production of fossil fuels, and safe nuclear power generation where this option is chosen. It also entails negotiating effectively with current major energy partners such as Russia, Norway, or Saudi Arabia, as well as new partners such as countries in the Caspian Basin region.
- Completing the internal energy market and building missing infrastructure links to quickly respond to supply disruptions and re-direct energy across the EU to where it is needed.
- Speaking with one voice in external energy policy, including having EU countries inform the European Commission early-on with regard to prospective agreements with non-EU countries that may affect the EU's security of supply.

- Strengthening emergency and solidarity mechanisms and protecting critical infrastructure. This includes more coordination between EU countries to use existing storage facilities, develop reverse flows, conduct risk assessments, and put in place security of supply plans at regional and EU level.

Over the last three to four years, the EU has agreed on a number of new policy goals that promise to strengthen Europe's presence in international energy policies. These include an EU Energy 2020 strategy, an Action Plan on climate diplomacy, and an Energy Roadmap for 2050 that presents scenarios for the next four decades. In January 2014, the European Commission published its proposed energy and climatepolicyguidelines up to 2030. The latest upgrade includes a European Energy Security Strategy published at the end of May 2014. This promises political commitment to accelerate progress on a range of energy strategies, in particular as a response to Russia's actions in Ukraine.

In preparation for the crucial UN Climate Change Conference (COP 21) in Paris in December 2015, world leaders met in Lima on September 23, 2014, to discuss climate change priorities. They referred to the Ukraine crisis as a valid reason for the EU to bolster its efforts to increase energy efficiency.

EU leaders expressed their support in principle in March 2015 on the European Commission's proposals regarding measures aimed at reducing dependence and building a so-called Energy Union. The strategic framework for the Energy Union sets the vision for the future and integrates a series of policy areas into one strategy; it intends to give coherence to common action, and it will open a new integration phase in the EU. According to summit's conclusions, "it was agreed by the EU members to accelerate infrastructure projects, including electricity and gas interconnections in order to ensure energy security and a well-functioning internal energy market". The Energy Union has five "dimensions": Energy security, internal energy market, energy efficiency, climate, and research and innovation.

Apart from seeking to make supply contract details more transparent, the European Union would seek to improve EU resilience by speeding up the installation of new interconnections between member states, as part of a broader strategy on infrastructure projects to boost energy security. Interconnectivity is vital for Energy Union, which aims to create a bloc where surplus energy can easily be moved across borders to make up shortages.The Energy Union was given political impetus after the Ukraine crisis exposed Europe's energy dependence and vulnerability. Shortages caused by Russia turning off the taps in 2006 and 2009 have prompted the Union to develop plans which go beyond to encompass issues such as climate change. The proposed "Vertical Corridor" is in line with this new strategy, since when completed it will enhance interconnectivity among member states and will further contribute towards the establishment of a highly liquid and transparent regional market.

3. The South Gas Corridor in the Post Nabucco Era

3.1 The South Corridor

Europe sees an important opportunity to meet its energy needs by developing the Southern gas corridor, at the core of which are gas supplies from the Caspian area (including Azerbaijan and most likely in the far future from Turkmenistan, Kazakhstan and Iran) and possibly from the Middle East (Iraq). According to the current state of play in South Eastern Europe, forecasts predict that the demand will grow up to 2025 at a rate of 1% each year.

Six of the SE European countries (Greece, Croatia, Bulgaria, Romania, Turkey and Serbia) already use natural gas, having well established markets, with supplies coming primarily through imports from Russia and, in the case of Turkey, from Iran and Azerbaijan also. Greece and Turkey, which have well developed LNG import and storage terminals, also import from Algeria, Nigeria, Qatar and other LNG suppliers. Two countries have a significant proportion of their demand met from domestic supplies (Croatia, Romania) and three others cover small percentage shares from domestic gas (Bulgaria, Serbia, Turkey). In projecting future demand for gas in the region, one of the main issues is the extent to which availability of gas would make possible the displacement of other fuels in various categories of demand, such as power generation and residential, commercial and industrial applications. Relative prices and competing fuels lie at the heart of analysis, although potential growth in demand for gas will also be driven by other factors, including environmental aspects and national policies.

COUNTRY	GAS PRODUCTION (bcm/year)	GAS CONSUMPTION (bcm/year)
ALBANIA	0.03	0.03
BOSNIA & HERZEGOVINA	0	0.2
BULGARIA	0.2	2.6
CROATIA	1.9	3.0
CYPRUS	0	0
F.Y.R.O.M.	0	0.1
GREECE	0	3.5
MONTENEGRO	0	0
ROMANIA	10.9	13.5
SERBIA & KOSOVO	0.35	2.5
SLOVENIA	0.003	0.85
TURKEY	0.7	47.8
TOTAL	**14.08**	**74.08**

Table 1: Natural Gas Production and Consumption in SE Europe-2013 (Source: IENE)

Basic Characteristics of the South Corridor Projects (July 2013)

Project	Capacity (bcm/y)	Distance (kms)	Gas Origin	Estimated Project Cost (in Billion Euro)	Sponsors	Anticipated Start Up Date	Project Status
ITGI	10-16	796	Shah Deniz II	1.70	DEPA. EDISON	-	Temporary on hold, pre FID activities completed
TAP	10 – 20	880	Shah Deniz II	1.50	EGL, STATOIL, E.ON	2017	Selected by SDC on June 27,2013
TANAP	16 - 24	2.000	Shah Deniz II	8 - 10	SOCAR (80%) BOTAS (20%)	2018	Construction started
South Stream	63	2.950	-Russian Fields	16.0	Gazprom, ENI, Wintershall, EDF	2016	Cancelled
Turk Stream	63	1.070	-Russian Fields	10.0	Gazprom, BOTAS	2016	Feasibility study stage
IAP	5	516	Shah Deniz II and other	0.620	Plinacro, BH-Gas, Governments of Montenegro and Albania	2019	Feasibility study stage

Table 2:Basic Characteristics of the South Corridor Projects (July 2013)

It is generally assumed that the natural gas sector will grow faster in the SE European region mainly because the main driver for gas consumption growth is power generation which is emerging as one of the faster developing sectors of the broader SE European Energy market. While each single SEE gas market is relatively small, a regional approach provides a sound basis for development. Romania is the biggest gas producer of the region with 10,9 bcm annual production (2013), while the consumption of the SE region (excluding Turkey) is around 26,6 bcm (2012). The three most gas dependent countries of the SE European region are Turkey, Bulgaria and Greece. Indigenous production in SE Europe (excluding Turkey), stands at 13,5 bcm/yr, and is sufficient to cover around half of current demand of 26,6 bcm (2012). However, not all countries in the region are gas consumers. This is especially true in the Western Balkans which in the vast majority of their geographical expanse do not have any gas infrastructure.

Today, the TANAP and TAP system is consider to be the central link in the EU-backed Southern Gas Corridor, a jigsaw of existing and planned pipelines designed to diversify Caspian energy export routes and reduce European dependence on Russian gas. Initially, the 3,500km SGC network will transport gas from the BP-led Shah Deniz field in Azerbaijan, but could in future draw supplies from other Caspian and central Asian countries and even the Middle East, transforming the energy map of the whole region.

3.2 The Trans Anatolian Gas Pipeline (TANAP)

The Trans Anadolu Gas Pipeline (TANAP) is a joint Azeri – Turkish project. It will tie into the existing South Caucasus pipeline that already supplies Azerbaijani gas to Georgia and east Turkey, and transport gas over a distance of 1,850km to Turkey’s western border with the EU. From there, gas is expected to tie in with the planned Trans-Adriatic Pipeline crossing Greece and Albania to Italy. The construction of TANAP started in March 2015 and it will be completed by 2019 while the total cost is estimated at $10 billion.

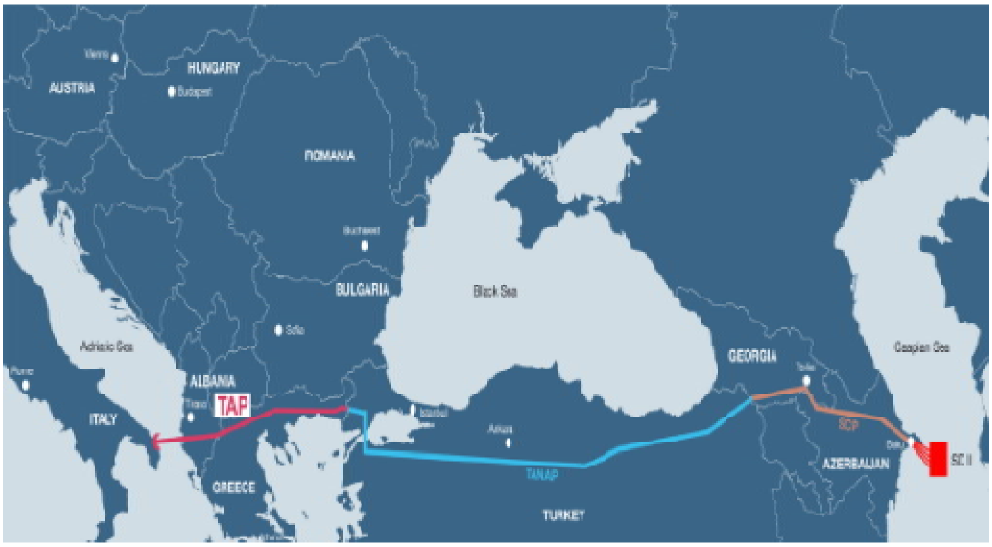


Figure 3: TANAP and TAP

In December 2011, Azerbaijan and Turkey signed a memorandum of mutual understanding to create the consortium to build TANAP. In June 2012 the intergovernmental agreement on TANAP was concluded. The pipeline, about 2.000 km long, is planned to be laid from the Georgian-Turkish border and up to the Turkish–Greek border(the pipeline which will transfer the gas from Azerbaijan to the Turkish border across Georgia is the South Caucasus Pipeline, which is being expanded and has a different ownership structure to TANAP).At the first stage, the carrying capacity of TANAP will be 16.0 bcm of gas per year,6.0 bcm of which will be directed to Turkey's domestic market by the Turkish consumers and 10.0 bcm will be delivered to European countries via TAP. At a second stage, it is planned to increase deliveries up to 24.0 bcm's. The gas pipeline is planned to be put into full operation in 2019 and from the beginning will be dedicated to transport gas produced from the Shah-Deniz Phase-2 field.

3.3 Trans Adriatic Pipeline (TAP)

TAP was eventually selected by the Shah Deniz consortium, in fierce competition with the proposed northern route (known as Nabucco West) to carry gas into Europe from Turkey's western border. The Trans Adriatic Pipeline (TAP in tandem with TANAP) will connect existing and planned grids for natural gas transport in Southeast Europe with gas systems in Western Europe via Greece, Albania, the Adriatic Sea and Italy. The pipeline will therefore give Europe better access to the major reserves of natural gas located mainly in the Caspian region. The pipeline is designed with an initial 10 bcm/yr transport capacity and will be 48 – inches in diameter. It will have a combined length of 764 km onshore and 105 km offshore. It is estimated that the construction of the pipeline will cost about 5,3 billion dollars. In February 13, 2013, the governments of Greece, Italy and Albania confirmed their full support and commitment to the Trans Adriatic Pipeline (TAP) project by signing in Athens a tri-lateral intergovernmental agreement (IGA).

The natural gas reverse flow feature of TAP for the underwater Albania-Italy section is an EU requirement set out in Regulation (EU) No. 994/2010 concerning measures to safeguard security of gas supply. It will also enable the region to connect to new gas sources, such as those in Northern Africa as well as to other more diverse sources, such as the partially liquid gas market in Italy. In a second stage there are plans for the pipelines extension to West Balkan countries (Montenegro, Bosnia and Croatia) via the propose IAP pipeline. TAP has been selected as a Project of Common Interest (PSI) and as such has the support of European Union.

On May 17, 2013, the relevant regulatory authorities in Italy, Greece and Albania, and the European Commission formally approved the Trans Adriatic Pipeline's (TAP) application for Third Party Access (TPA) exemption for the initial capacity of 10bcm/yr. The decision means that

TAP can make available its full capacity for export of gas volumes from Azerbaijan to Europe for a period of 25 years. In addition, the Commission has approved exemptions from regulated tariffs on both TAP's initial and expansion capacity, as well as exemption from ownership unbundling for 25 years. TAP's reverse flow capacity from Italy to Greece is regulated.

European Union internal market regulations typically require third party access to all energy infrastructure, including gas pipelines. However, national regulators can grant exemptions to this rule for a limited period of time, in order to facilitate the funding and construction of major infrastructure projects such as cross-border pipelines (interconnections). Provided that all conditions have been met, the European Commission can decide to issue a decision, offering an exemption from certain provisions in its regulatory framework.

3.4 IAP Pipeline

IAP is a proposed natural gas pipeline to be developed in the Western Balkans. It will run from Fier, in Albania, through Montenegro and Bosnia and Herzegovina to Split in Croatia. In Fier, IAP will be connected with the planned Trans Adriatic Pipeline. IAP is considered to be a part of the TANAP-TAP pipeline system. Trans Adriatic Pipeline AG has signed various MoUs with developers of the IAP project, including Plinacro (Croatia), BH-Gas (Bosnia and Herzegovina), and with the governments of Montenegro and Albania.

In Split, the pipeline will be connected with the existing gas transmission system of Croatia. In addition, it may be connected with other new gas infrastructure, including the proposed Adria LNG terminal in Krk. The length of the pipeline will be 516 km (321 mi). The IAP will have a reverse flow capacity, and its capacity would be 5.0 billion cubic metres of natural gas per year. The ministerial declaration on the IAP project was signed on 25 September 2007 in the framework of the Energy Community. The West Balkan countries prefer the construction of the Ionian Adriatic Pipeline (IAP) to start in lockstep with that of the Trans Adriatic Pipeline (TAP) in 2016 so that natural gas is estimated may start flowing through IAP in 2020.

3.5 Turk Stream

In a move that took the EU by surprise, Russia scrapped the $30bn South Stream gas pipeline to Europe in favour of another project, the Turk Stream pipeline to ship gas exports to a new trading hub in western Turkey. The EU, having raised obstacles regarding South Stream on the basis of its regulatory framework may now have to figure out itself how to move Russian gas from the Greek-Turkish border into Europe. Turkey says that TANAP is not a rival to Turkish Stream and has pledged full support for the design and implementation of the project.

Figure 4: The Turkish Stream Route

"Turkish Stream" is the working name of the proposed natural gas pipeline from Russia to Turkey across the Black Sea which will substitute the now defunct South Stream. This new project was announced by Russian president Vladimir Putin on 1 December 2014, during his state visit to Turkey. According to Gazprom, the project does not have an official name yet. Landfall will be near the village of Kiyikoy in Turkey's European sector, and a delivery hub for Turkish consumers will be close to the town of Luleburgaz. The pipeline will terminate in the Turkish-Greek border in the area of Ipsila. Gazpromsuggested that its European client companies, should build their own link from the as-yet unbuilt gas hub at the Turkish-Greek border to transit some 50 bcm via the new route to various European destinations. A new pipeline will need to be build which will cross North Greece and from there via the Adriatic Sea to Italy.

The total planned capacity of the pipeline is reportedly 63 billion cubic metres per annum (2.2 trillion cubic feet per annum) of natural gas. Turkey would use about 14 billion cubic metres per annum (490 billion cubic feet per annum)for domestic consumption with the rest of the gas to be exported to Europe. Turkey’s future take from Turkish Stream is currently being supplied through the Trans Balkan pipeline which ran across Moldavia, Romania and Bulgaria. The future of this pipeline remains uncertain.

3.6 East Med Pipeline

Currently, no countries in the region export natural gas. Israel will most likely start exporting gas to Egypt as early as the second half of 2015 through existing infrastructure. By 2019 Cyprus may also be capable of exporting gas to Egypt via underwater pipelines from Aphrodite field to Damietta LNG terminal. Natural gas development in the region is expected to encounter several challenges. Major investments in infrastructure for natural gas transfer and processing will be required. The setting of environmental and safety regulations could also prove challenging. Additionally, in order to export gas new infrastructure would also have to be laid by developers and the governments of the region. Natural gas can be exported either in liquid form or via pipeline. The construction of a

Figure 5: The East Med Pipeline

subsea pipeline to Greece, the East Med pipeline, is an interesting optionand pre-feasibility studies confirm its technical viability and indicate its potential commercial attractiveness.

The broad concept developed by Greece's Public Gas Corporation DEPA aims to open the East Mediterranean gas corridor which is promoted by the EU. The East Med pipeline consists of an off-shore/onshore pipeline that will connect the East Mediterranean gas resources to the European system, commencing around Cyprus' off-shore fields. According to a recent DEPA study, the pipeline will be able to carry around 8 bcma. The initial design of the pipeline foresees a first leg of 150 km connecting the Cyprus/ Israeli gas fields to Cyprus, a second leg from Cyprus to Crete of 633 km and a third leg from Crete to mainland Greece of 405 km, i.e. a total of 1.188 km.

3.7 Key Gas Infrastructures (Interconnectors, FSRU)

3.7.1 Interconnectors

Greece, Bulgaria, Romania and Serbia plan to expand their gas infrastructures, especially with gas interconnectors, in order to avoid future gas disruptions and increase their energy security. This network of gas interconnectors will supply the region with new natural gas quantities coming from the TAP pipeline, the liquefied natural gas terminal in Revithoussa (currently the only LNG terminal in Greece) and possibly from one of the planned floating LNG terminals (FSRU) in Northern Greece.

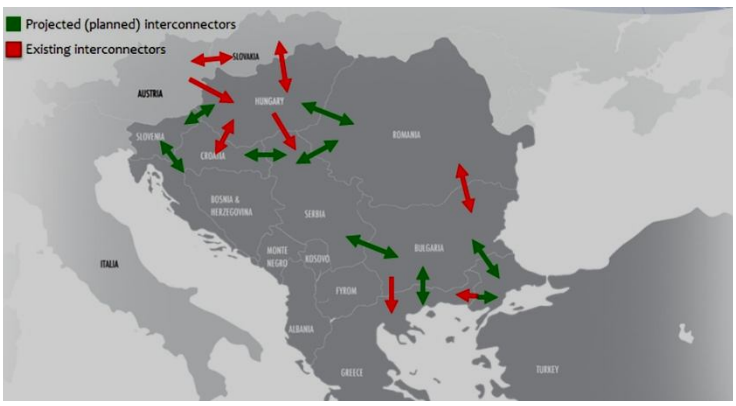


Figure 6: Gas Interconnections in SE Europe

The Interconnector Bulgaria and Romania (IBR)

Bulgaria commenced construction of a gas interconnection with Romania, on August 2011. The total project value is approximately €24 million, €9 million of which are EU funds, €11 million come from Bulgaria, and the rest is to be provided by the Romanian Transgaz. The total length of the pipeline between Giurgiu and Ruse is 25 km with 15,4km in Bulgaria and 2,1 km beneath the Danube. Following a number of technical delays, the Bulgaria-Romania gas grid interconnection is expected to start functioning in June 2015.

Bulgarian-Turkish gas interconnection (ITB)

The project has received a grant from the European Union's Connecting Europe Facility to partly cover the costs of its pre-feasibility study. The interconnector project with Turkey is described as being "key" to Bulgaria's energy diversification efforts in view of the fact that the Turkish system has six entry points for natural gas. The 77km-long gas pipeline (75 km on Bulgarian territory and 2 km on Turkish territory) will carry up to 3 bcm metres of natural gas a year initially, the pipe diameter being 28 inches (700 mm) and the working pressure 75 bar. No set date has been announced for the FID and its construction.

Bulgarian-Serbian gas Interconnection (IBS)

Interconnector Sofia-Dimitrovgrad (Serbia)-Nis (Serbia), will connect the national transmission networks of Bulgaria and Serbia. The aim is to ensure diversification of routes, intersystem connectivity and gas transmission. It is expected that construction of the pipeline will provide an option for delivery of up to 1,8 bcm/yr of natural gas, in both directions, with the opportunity to further increase the volumes up to 4,5 bcm/yr. The total length of the route is 150 km, of which around 50 km are on Bulgarian territory. Possible pipe diameter is 28" and the working pressure at 55 bar. No set date has yet been announced for the FID and the pipeline construction.

Greece Bulgaria Gas Interconnector (IGB)

The IGB, which will supply Bulgaria and hence, South Eastern Europe region, with up to 5 bcma, will be operational by 2018. The project includes the construction of a trans-border reverse flow gas pipeline with a length of 168,5 km (140 km in Bulgaria, 28,5 km in Greece), connecting the Greek gas network in the area of Komotini with the Bulgarian gas network in the area of Stara Zagora. The capacity of the gas pipeline is foreseen to be 3 up to 5 billion m3/yr, with a pipe diameter of 750 mm (32"). The FID is expected to be taken by June 2015 following the completion of the market tests in 2014 and the adoption of a revised schedule and budget to accelerate the project's realization. The IGB is a multi-source project, which will connect Bulgaria with both existing and new gas supply pipelines (i.e. TAP) allowing gas from the Caspian Region and the Middle East including from LNG to be transported through Turkey and Greece. IGB's regional significance has been reaffirmed by the EU, receiving a grant through the EEPR framework.

Gas Interconnectors in Romania

Hungarian link

Apart from the interconnector between Romania and Bulgaria (IBR) another key interconnector project is the creation of two-way flows on the Arad-Szeged pipeline from Romania to Hungary, which is currently only capable of importing gas into Romania. Transgaz is looking to complete the project by December 2016, with the condition that it can secure agreement with relevant Hungarian authorities.

Serbian link

At the same time Transgaz is developing plans to construct an interconnector with Serbia. This project could also potentially offer access to LNG imports via the proposed regasification terminal in Croatia. The Serbia interconnector is still in the early stages and the Romanian TSO is now looking to contact relevant authorities on the Serbian side to gauge the appetite for such a pipeline.

(Further information on the abovementioned interconnectors is to be found in Chapter 4)

3.7.2 Floating Storage and Regasification Units (FSRU)

The South Corridor and latest developments in the South Eastern European natural gas market are mainly characterized by (a) the prospective introduction of Azeri gas into the market by 2019 through the Trans-Adriatic Pipeline (TAP), (b) the new prospect of the South Stream pipeline (the Turk Stream), (c) the construction of several new gas interconnectors and (d) the new construction of LNG terminals. For that reason, countries such as Greece are eying opportunities to exploit the new emerging gas mix that will also be coupled with substantial amounts of Russian gas through the Turk Stream pipeline, as well as through independent LNG suppliers as a result of the liberalization of the regional markets.

More specifically on the LNG sector, apart from projects aiming at either enhancing the existing infrastructure or establishing new terminals, there are two noteworthy projects in Greece, regarding the construction of Floating Storage and Regasification Units (FSRU). They are to be located right beside the route of the TAP project and the Greek–Bulgarian interconnector IGB and the existing Greek–Turkey interconnector (IGT) in close proximity to the Bulgarian and Turkish markets, so as to be able to link with the planned interconnectors.

Firstly, the private Greek company GASTRADE, which received an Independent Natural Gas System license in 2011, is developing a 170.000 cubic meters storagecapacity FSRU (Floating LNG Storage and Regasification Unit) to be moored in offshore Alexandroupolis, which will be able to supply 6,1 bcm of natural gas annually. It will be able to accommodate imports from various LNG sources through long-term and spot purchases, including gas from existing and future Eastern Mediterranean fields, thus, adding to the liquidity of the local and regional markets.

DEPA is also laying down its own plans concerning a separate FSRU unit, a 3 - 5bcm per annum facility to be located near the port of Kavala and in a strategic location close to the aforementioned pipeline and interconnectors. The project aims for a 150.000 cubic meters storage capacity and DEPA already actively seeks international investor backing for this 400 million-dollar plan. Both FSRU projects are labelled as EU Projects of Common Interest and have received funding for studies from the Connecting Europe Facility. The implementation of such projects isimportant from a strategic sense, since it reinforce Greece’s role, as a potential gas supplier for the other countries in SE Europe.

(A detailed description of the above FSRU projects is provided in Chapter 5)

4. The Vertical Corridor

4.1 The Vertical Corridor Concept

By participating in large-scale projects such as the Southern Gas Corridor, the promotion of gas interconnections and the construction of FSRUs Greece hopes to improve its positioning in the region also as an energy supplier and facilitator and to enhance its role in the international energy scene, by becoming a 'hub' for Southeast Europe. This means that gas will be transferred through Greece to other countries from multiple entry and exit points and from different supply sources (Russia, Azerbaijan, Qatar, Algeria, Egypt, Iran etc). It is estimated that following implementation of the TAP whose maximum capacity will reach 20.0 bcm per year (after 2022) and by utilising the maximum capacity of gas interconnectors in North Greece (Sidirokastro, IGB, EGT) as exit points, the maximum export capacity of natural gas from Greece could theoretically reach some34.0bcm per year. In practice Greece could be expected to export some 9.0 bcm through mainly IGB and IGT. In parallel, by the time that the Turk Stream pipeline, which is the successor of South Stream, is constructed it could potentially also transfer through the Turkish-Greek border some 46.0 bcm. Greece, in order to be able to transfer part of this amount will need to develop the appropriate infrastructure.In this context, the utilization of the ITGI project has been mentioned (with maximum capacity 16.0 bcma). The following chart illustrates this optimistic but potential scenario regarding Greece’s gas export capacity.

Transfer Capacity of Gas Interconnectors in SE Europe	Maximum Capacity (bcm/y)
Greek – Bulgarian (Sidirokastro)	**3,00**
IGB	**5,00**
TAP	**20,00**
ITG(I)	**7,5 (+8,5)**
IBR (Bulgaria – Romania)	**1,5**
IRH (Romania - Hungary)	**1,75**
IBS (Bulgaria – Serbia)	**1,80**
Total	**40,55 (+8,5)**

Table 3: Capacity of Gas Interconnectors in SE Europe

In that case most of the above amount of gas (at least 30 – 36.0 bcm per year) will be directed to Italy (through TAP and IGI Poseidon) while the rest of the exit points in the Greek – Bulgarian borders could transfer in their maximum capacity up to 8.0 bcm per year after 2020. According to DESFA (the Greek Gas Transmission System Operator) the two interconnectors (Sidirokastro and IGB) are technicaly feasible to operate only as exit points using their reverse flow capacity since gas demand in Greece would be easily met through other entry points such as the Greek – Turkish interconnector (TGI – maximum capacity 7,5 bcm), the LNG terminal in Revythoussa, the FSRU in North Greece(6,1 bcm for the FSRU project in Alexandroupolis and 3-5 bcm for the FSRU's project in Kavala) and the TAP pipeline. In view of the above facts and if the most of the abovementioned projects are implemented, the the Greek national grid could be a starting point of a gas system which will carry significant gas quantities in a vertical axis (south to north) and in a constant flow to Bulgaria and Romania and from there to a number of other countries such as Hungary, Serbia, Moldavia, Ukraine. The above concept which is known as the Vertical Corridor and it is supplementary to the South Corridor, has been adopted by the governments of Greece, Bulgaria and Romania and will contribute significantly to the gas interconnectivity in SE and Central Europe, especially after the cancelation of the South Stream project. TheVertical Corridor is emerging as a project to fill the gap of interconnections needed to link SE Europe's isolated markets and provide reverse-flow options for existing routes.

The Vertical Corridor concept is not a single pipeline project in the traditional sense, as all South Corridor pipeline projects are, but a gas system that will connect existing national gas grids and other gas infrastructure in order to secure easy gas transiting then contributing to energy security and by enhancing market liquidity. Such a gas system (which will consist of national grids, underground gas storage facilities, interconnectors, LNG terminals) will form an importantcorridor fromSouth to North whose operation will be fully aligned with EU Directives and European energy policy. Initially the Vertical Corridor will manage the transportation of some 3.0 – 5.0 bcm per year commencing from the Greek national grid. Greece will satisfy its domestic gas demand from four (4) different entry points (TAP, Revythousa, Kipoi, FSRU) while there will be some excess gas quantities that can be exported.

A great advantage of the Vertical Corridor is that the countries that take part in the Vertical Corridor are members of the European Union and therefore their interests and aspirations coincide with those of the EU as well as comply with the EU regulatory regime. On the other hand, the project can be implemented in short period of time and at a relatively low cost since, apart of the interconnectors between the three countries (Greece, Bulgaria, Romania) which are already at an advanced level of planning, only few improvements and upgrades in the national grids should be made in order for the system to become functional.

The support of the Vertical Corridor at governmental level is highlighted by the joint statement signed on December 9, 2014 by the energy ministers of the three main countries, Greece, Bulgaria and Romania as quoted in the Introduction of this study. Through this joint statement the three countries expressed their support for the project, classified as an EU Project of Common Interest (PCI), whose development will connect missing pipeline links between the three countries. The three countries also requested EU political and financial support for the realisation of the Vertical Corridor and the European Commission has already expressed its backing of the initiative taken by Greece, Bulgaria, and Romania, noting that it fully supports the EU’s overall strategy for diversified energy sources and routes.

Figure 7: Basic Components of the Vertical Corridor

4.2 The Components of the Vertical Corridor

The main components of the Vertical Corridor are the gas interconnectors which will ensure the uninterrupted and constant flow of gas from Greece to Bulgaria and Romania of first stage and then to the other countries of the region, such as Hungary, Slovakia etc.

Status of the Main Pipelines and Gas Interconnectors	Year
Greek – Bulgarian (Sidirokastro)	in operation
Bulgaria - Turkey	2017
TAP	2018
Greek – Turkey (ITG)	in operation
IGI Poseidon	NA
IGB	2017
IBR	2015
Turk Stream	2016-17

Table 4: Gas Pipelines and Interconnectors status

According to latest information made available by DEPA, the Greek-Bulgarian Interconnector (IGB) will be ready and operational by 2018. A final investment decision on the 183-kilometer interconnector is very near and will be taken in the first half of 2015 while the project has secured the necessary environmental licenses in Greece and Bulgaria. IGB with an initial capacity of 3.0 bcm per year and with a maximum capacity of 5.0 bcm will be the cornerstone of the Vertical Corridor and the first link transferring gas from Greece to Bulgaria, Romania, Serbia, Hungary and elsewhere in the region.

IGB is planned to connect also with the Trans Adriatic Pipeline (TAP). In January, 2014, a Memorandum of Understanding and Cooperation was signed between TAP and ICGB - the company in charge for the development, financing, construction and operation ofthe IGB. The memorandum aimed in establishing technical cooperation in order to further develop the region's strategic infrastructure.

Latest studies by DEPA suggest that the two Greek interconnectors with the Bulgarian border (IGB, Sidirokastro) could satisfy the gas demand in Bulgarian and Romanian markets. Bulgaria and Romania'sgas imports in 2013 reached 5.0 bcm (2.4 bcm for Bulgaria and 2.6 bcm for Romania). Greece's transfer capacity through the above two interconnectors could reach 8.0 bcm per year in their maximum capacity and thereby Bulgaria and Romania could decrease their gas imports from Russia through Ukraine. Therefore, Greece can cover part of Bulgaria's domestic consumption whose gas demand according to current estimates would not by 2019 exceed 3,5 bcm and furthermore it could send annually 1,5 bcm to Romania through the Bulgaria – Romania interconnector (IBR) covering more than 50% of Romania's gas imports from Russia.

The Gas interconnector between Romania and Bulgaria (IBR) will allow the transport of gas quantities from Greece to Romania via Bulgaria's national network, which has a transfer capacity of 18,7 bcm annually. The Ruse-Giurgiu pipeline (IBR) is under construction and it is projected to be operational by the end of 2015. Once completed, the pipeline will be capable of transporting 1.5 billion cubic metres of gas in both directions, although capacity from Romania to Bulgaria will initially be limited. Capacity will not be offered as a bundled service, meaning shippers will have to form agreements with Romanian TSO Transgaz separately. Bulgaria's economy ministry said that eight companies have so far expressed interest in using the interconnector in at least one direction.

The pipeline will have a length of 25km and will link the Romanian side in Giurgiu with the Bulgarian in Russe. The 15 km of the pipeline located on Bulgarian territory and the remaining 7.5 in Romania will cross the Danube (2.5 Km). The pipeline is almost completed but according to official sources of the Romanian government, but construction is not yet over due to certain technical problems which have arisen.

It should be noted that the IBR interconnector has limited transfer capacity and cannot transfer large amount of gas quantities from Bulgaria to Romania and then to other countries. Much bigger gas quantities can be transferred in the future from Greece to Romania through the TransBalkan pipeline, in a reverse flow mode.The Trans Balkan pipeline now transfers the Russian gas through Ukraine to a number of Countries such as Moldavia, Romania, Bulgaria, Greece and Turkey. It should be noted that more than 40% of Turkey’s gas import from Russia could be shipped through Trans-Balkan pipeline. In practice through this pipeline Turkey covers some 16% of its needs. The maximum capacity of the Transbalkan pipeline is 27.0 bcm per year. However, its transfer capacity has been significantly decreased at 18.0 bcm per year with 2.1bcm going to Moldavia, 2.8bcm to Romania, 2.7bcm to Bulgaria, 2.3bcm to Greece and the rest 7 – 8.0 bcm to Turkey.

The main reason for such a decrease was the construction of the Blue Stream pipeline between Russia and Turkey which replaced some gas quantities transferred by the Transbalkan pipeline. Most of the above countries have set a target to disengage from the TransBalkan pipeline and the Russian gas which flows through Ukraine. In 2014, Turkey denounced an agreement with Russia about the use of the Trans-Balkan gas pipeline while Romania announced plans to stop importing gas by this pipeline after 2016. How fast this will actually happen depends a lot on the IGB construction and the ability of Greece to pump adequate gas quantities to Romania and Bulgaria replacing the Russian Gas to both countries(approx. 5-6.0 bcm) and how fast Romania will develop its new gas fields in the Black Sea. It is also of a great importance to establish how feasible will be the modification of the TransBalkan pipeline in order for it to work in a reverse flow mode.

The use of the Transbalkan pipeline in a reverse flow capacity requires bilateral agreements between Russia and the countries crossed by the pipeline. In addition, the pipeline’s capacity to start transiting in the reverse direction, i.e. south to north, also depends on the results of market tests for establishing prospective demand patterns.This would still require negotiations on whether it will be compatible with Third Package regulations for Gazprom to “reverse flow” gas from the new pipelines through the Trans-Balkan pipeline to Bulgaria, Romania and other countries of the region. Therefore, although the modification of the pipeline in a reverse flow mode is technically feasible, however there are significant political and regulatory problems to be overcome in order for this scenario to be implemented.

Nevertheless, even if the reverse flow capacity of the TransBalkan pipeline is not finally realized, Greece with the appropriate gas infrastructures, will be able to move a gas amountof 5.0 – 8.0 bcm/year from south to north in physical flow or doing swaps,amounting to some 5.0 -8.0 bcm/year from south to north.

4.3 The Components and the Web of interconnectors

At present three countries have shown interest in participating in the Vertical Corridor project, i.e. Greece, Romania and Bulgaria. The ministers of the above three countries signed on December 9, 2014 a joint declaration in order to support the development of the missing gas links (such as interconnectors, underground gas storage facilities and development of the national gas grids) between the three countries.

Upon the implementation of the above infrastructure the corridor will be able to cover fully the gas imports of Bulgaria and Romania. According to estimates Bulgaria's gas imports until 2020 will not exceed 3.5 bcm, while the dependence of Romania on Russian gas will decrease to 1,5 bcm yearly until 2020 (as Romania is expected to cover most of its gas needs from indigenous gas production). Given the above facts the Vertical Corridor with a maximum transfer capacity of 8.0 bcm could cover fully the gas imports needs of Romania and Bulgaria.

Therefore, other countries have expressed interest on Vertical Corridor's gas such as Serbia and Hungary which may benefit from some gas quantities. The remaining gas quantities of the Vertical Corridor (2,0 - 2,5 bcm) could be pumped through interconnectors in Hungary and in future (when a gas interconnector will be settled between Serbia and Bulgaria) and in Serbia.

In 2010Romania and Hungary completed the construction of the IHR gas interconnector (Arad-Szeged Interconnector) with a maximum capacity of 4,4 bcm from Hungary to Romania. For the time being the interconnector can send gas only from Hungary to Romania and not reversely. According to information coming from the national companies of Romania (Transgaz) and Hungary (MOL),the reverse flow capacity of this interconnector will be implemented until the end of 2015 with a maximum capacity of 1,75 bcm per year from Romania to Hungary. Through this interconnector, Hungary will be able to secure an amount of 1,0-1,5 bcm from Greece, by using the Vertical Corridor.

As mentioned above a future interconnection between Bulgaria and Serbia (IBS) will allow the further diversification of gas supply in Serbia which, as far as imports are concerned, is fully depended on Russian gas. The IBS interconnector has been declared by the Bulgarian and Serbian

Governments as a project of a great importance which is affecting the energy security of both countries. Serbia too can benefit from the Vertical Corridor with a quantities of 0,5 – 1,0 bcm per year.

Other countries that could benefit from the Vertical Corridor include FYROM through the Bulgarian national network, Moldova through Romania’s network and possibly Ukraine.

4.4 Interconnection points (IPs)

In this section the capacities of all of the region’s IPs are presented in a graphic form making easier the comparison of the technical capacity of the IP’s, the part booked and the part actually used during the two-year period from October 2011 to September 2013.

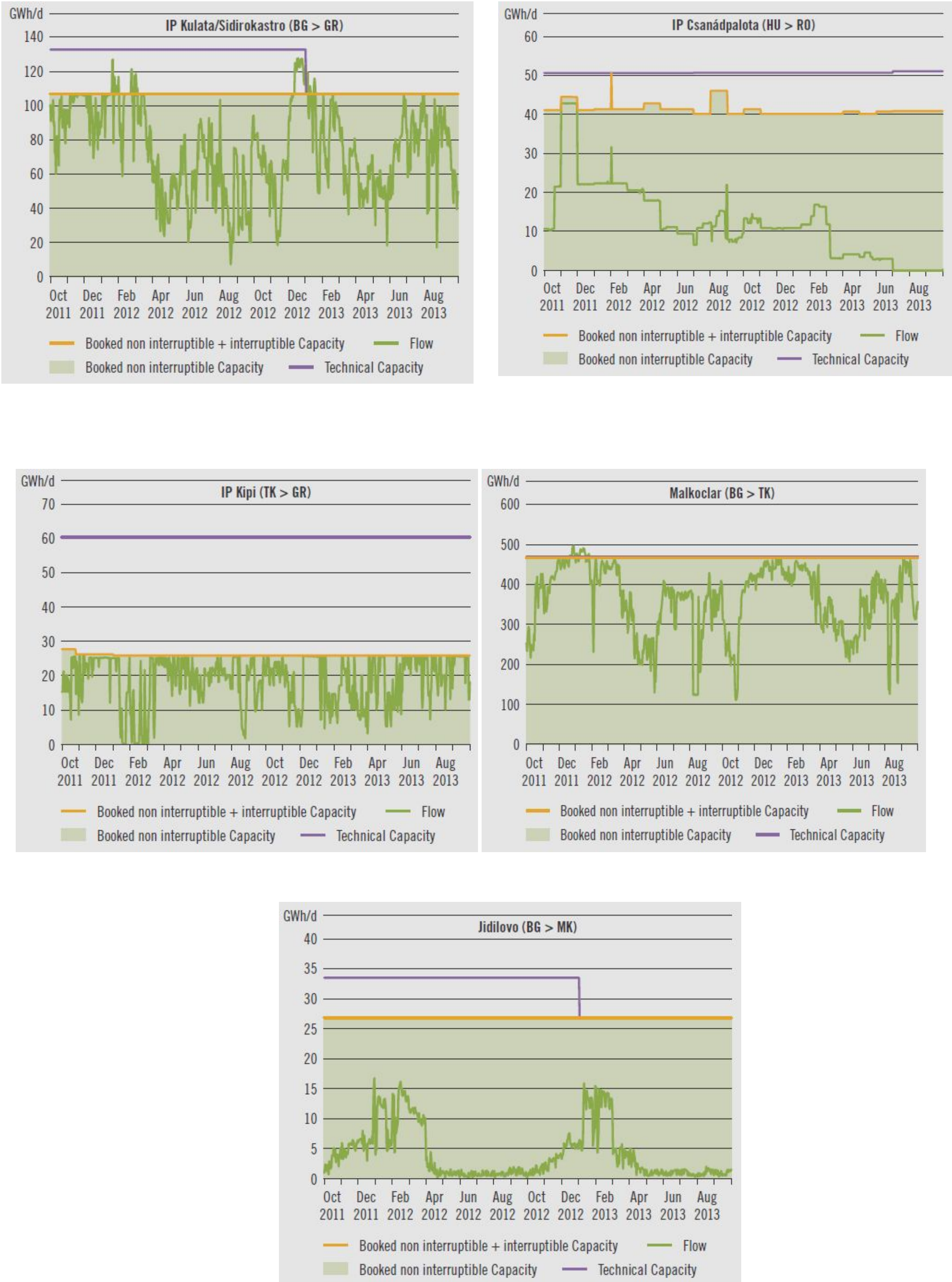
Several IPs have exhibited a high percentage of spare capacity. In this category belongs the supply Import Point from non EU members at Kipi (TK > GR) as well as the IPs of Csanádpalota (HU > RO), of NegruVoda 1 (RO > BG) and of Jidilovo (BG > MK).

Figure 8: Main Gas Pipelines and IP's in Romania, Bulgaria and FYROM

Map point	IP	Operators	Direction	Status	Technical Capacity [bcm/y]
51	Kulata / Sidirokastro	**Bulgartransgaz / DESFA**	Bidirectional	**existing**	4,9
222	Kipi	**BOTAŞ / DESFA**	TR > GR	**existing**	2,3
52	Malkoclar	**Bulgartransgaz > BOTAŞ**	BG > TR	**existing**	17,6
50	Zidilovo	**Bulgartransgaz / GA-MA**	BG > MK	**existing**	1,0
64	Giurgiu / Ruse	**Transgaz / Bulgartransgaz**	Bidirectional	**under construction**	BG > RO: 1,5 RO > BG: 1,0
57	Csanadpalota	**FGSZ / Transgaz**	Bidirectional	**existing**	HU > RO: 1,9 RO > BG: 0,1

Table 5: Interconnector points (IP's) in SE Europe

Figure9: Booked gas capacities in the region IP's from 2011 to 2013



4.4.1 IGB

The Gas Interconnector Greece - Bulgaria (IGB) is a proposed gas pipeline, which will provide a direct link between the national natural gas systems of Greece and Bulgaria, acting as a strategic gas transportation infrastructure providing diversification of gas supply to the Bulgarian and South East Europe gas market and security of supply to Greece.

The IGB will have an Entry Point in the vicinity of Komotini and an Exit Point in the vicinity of Stara Zagora.

The project enjoys the full support of two countries, which have signed an intergovernmental agreement for the realization of the pipeline. The Interconnector Greece - Bulgaria highlights the important role of Greece in the energy scene in Southeastern Europe.

Figure 10: Schematic presentation of the IGB

<u>Shareholders</u>

The IGB Pipeline originally obtained intergovernmental support by the Republic of Greece and the Republic of Bulgaria via a Memorandum of Understanding signed in 2009. The Project has been designated as a

Project of National Priority under Bulgarian Council of Ministers` Decisions No. 615/14.07.2009, No.452/07.06.2012 and under Greek Law 4001/2011.

More specifically, on July 14, 2009 a Memorandum of understanding was signed between the Bulgarian Energy Holding EAD, Edison (Italy) and DEPA, which defines the principles for the development and realization of the project. The joint venture company "ICGB AD - Interconnector Greece - Bulgaria" was then incorporated in January 2011, with its mission being the design, development, finance, construction and operation of the pipeline, as the owner of the pipeline. IGI Poseidon S.A. and Bulgarian Energy Holding EAD each hold a 50% stake in the company.

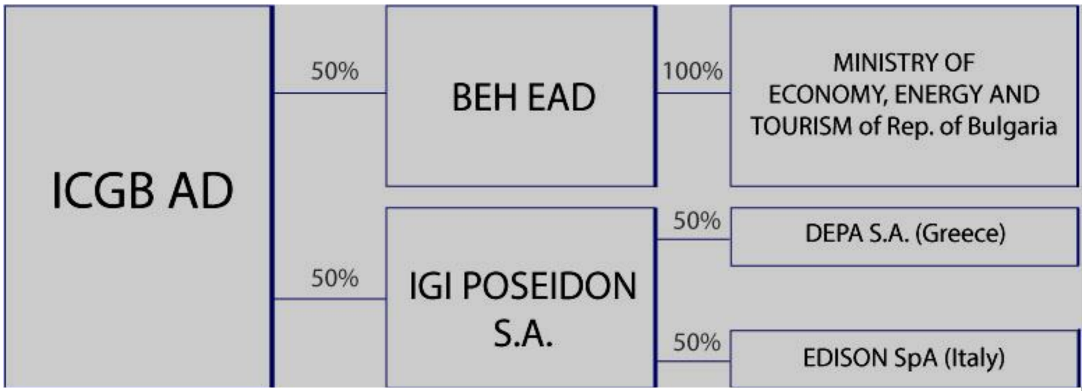


Figure 11: Schematic presentation of the ICGB AD Structure

Realization

The IGB Project has obtained a positive Environmental Impact Assessment on both the territory of the Republic of Bulgaria and the territory of the Republic of Greece.

Considering the present status of permitting procedures, regulatory, commercial and financing activities being implemented in accordance with EU, Greek and Bulgarian law, and with the participation of a number of third parties, the Shareholders target:

- Completion of design phase**: 2015**

- Detailed design and construction: **2016 - 2018**
- Commercial operation: **2018**

EU Support

The project is in line with the joint EU strategy for market-based security of supply, which calls for bidirectional interconnection of national grids and specifically for the creation of a Southern Gas Corridor. The IGB project is expected to achieve real diversification of sources of supply of natural gas to Bulgaria by introducing a new entry point.

The EU, by recognizing the strategic importance of the Greek-Bulgarian Interconnector as a project of European interest, included it among the projects of the Southern Corridor-financed from the resources of the European Energy Programme for Recovery (E.E.P.R.), granting funds totalling of 45 million euros.

Technical Characteristics

The capacity of the pipeline is stated to be 3.0 to 5.0bcm/year with reverse flow capability. The connecting points are to be Komotini, Greece and Stara Zagora, Bulgaria. The length of the pipeline will be 180 km (150 km in Bulgaria, 30 km in Greece). The proposed pipe diameter will be 32" (813mm).

The present process of design, permitting procedures and financial structuring envisages the development of the IGB pipeline with a transportation capacity of approximately 3.0bNcm/y of natural gas from Greece to Bulgaria with ~57 barg pressure at the Entry Point and ~42 barg pressure at the Exit Point. The IGB Pipeline will also be equipped to offer physical reverse flow.

The technical design of the pipeline has reflected the possibility to meet possible future market needs for a higher transportation capacity through an upgrade to approximately 5 bNcm/y, which could be achieved through the installation of a compressor station. The capacity upgrade will be subject to developments and upgrades in the neighbouring gas transportation systems, and will have to be economically justified.

Cost

According to latest DEPA estimates the pipeline will cost approximately 200 million Euro to construct.The IGB Project has also gained support from the international lender community. In October 2012, ICGB AD signed a Mandate Letter with the European Bank for Reconstruction and Development creating the framework for the negotiation of a long-term debt financing for the Project.

4.4.2 IBR

The gas pipeline interconnecting Romania and Bulgaria, linking southern Romania (Giurgiu) and northern Bulgaria (Ruse), is a 25 km bi-directional interconnector, which is expected to play a key role in reducing Bulgaria's dependence on a single energy source, together with the Gas Interconnector Greece-Bulgaria (IGB Pipeline).

Figure 12: The Bulgaria-Romania Gas Connection

Technical Characteristics

The total length of the gas pipeline is 25 km, of which 15 km on Bulgarian territory, 7,5 km on Romanian and 2,5 km Danube Undercrossing. The diameter of the pipe is Dn 500 mm and the working pressure Pn 40 bar. The maximum design capacity of the Interconnection is 1,5 bcm/year and the minimum 0,5 bcm/year.

According to ENTSOG, the maximum technical physical capacity will be 46,4 GWh/d from Bulgaria to Romania 28,4 GWh/d from Romania to Bulgaria.

In addition, two metering stations will be built for measuring gas from technical parameters.

Cost - Financing

Total project value is approximately €24 million; €9 million of which are EU funds, €11 million from Bulgaria, and the rest is to be provided by the Romanian Transgaz.

Realization

The gas interconnector between Romania and Bulgaria is expected to go on stream in 2015.Works on the pipeline began in 2012. Initially, the inter-connector should have been completed in 2013, but its launching was postponed to January 2014, and then the deadline was extended again due a series of technical problems resulting in delay of its commissioning.

More specifically, the construction of the terrestrial part of the interconnection lasted longer than expected as valuable archaeological findings were discovered during the mandatory archaeological survey of the gas route.

4.4.3 IBS

The project “Interconnection Bulgaria-Serbia” is the first interconnection between the gas transmission systems of Serbia and Bulgaria. The project establishes a connection between the Bulgarian and Serbian gas markets that currently are not connected.

From the Bulgarian side the project is to be realised by the Ministry of Economy and Energy in its capacity of a Beneficiary under a procedure of financial aid within Operational 46 Programme Development of the Competitiveness of the Bulgarian Economy 2007 – 2013, and Bulgartransgaz EAD extends expert and technical assistance.

In line with Regulation (EC) 347/2013 the Interconnection is one of the Bulgarian projects of common interest.

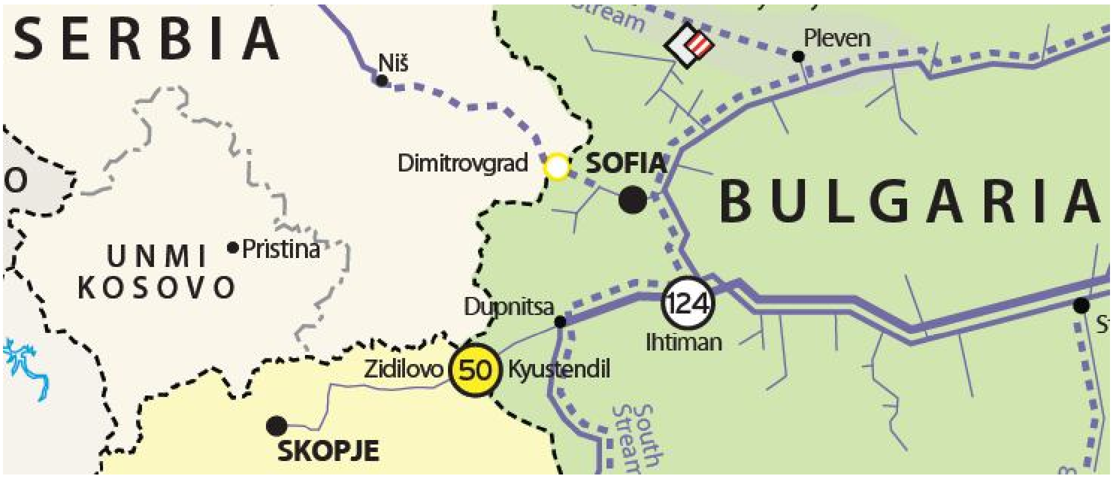


Figure 13: The Bulgaria – Serbia Gas Systems

The project's realisation will achieve diversification of routes, interconnection and natural gas transmission to Serbia using the planned new entry points with Turkey and Greece and the significant available capacity of the Bulgarian gas transmission system. At the same time, in the event of a crisis it could be used for natural gas supply from Serbia.

Technical Characteristics

According to preliminary technical information the length of the route Sofia - Dimitrovgrad -Nis is about 150 km of which about 62 km on Bulgarian territory. Design minimum annual capacity is around 1,8 bcm, and the maximum is 3,1 bcm. The diameter of the pipe will be Dn 700 mm or 28” (inches).

Schedule

According to the Gas Regional Investment Plan 2014-2023 of Entsog, if the Final Investment Decision is positive, then construction of the pipeline is expected to start in the second half of 2016.

4.5 Transmission Capacity and Operational Framework

The basic design principle is that the Vertical Corridor will use the existing national gas infrastructures. In the following section, the national transmission systems of Greece, Bulgaria and Romania are described. There is extensive reference to each part that form part of the system, analyzing entry points, production facilities, underground storage facilities, LNG terminals and compressors. The technical characteristics of the transmission systems help us understand the size of the systems, their transport capability on an annual basis and finally the role that they can play in the Vertical Corridor project.

4.5.1 Greece

The existing gas infrastructure in Greece consists of a transmission network, the length of which (excluding the distribution network) is 1.291 km, a compressor with power capacity of 13MW and an LNG terminal in Revithousa. The transmission network has 24 connections to distribution systems and 17 directly connected customers, 11 of which are gas-fired power generation plants.

Figure 14: The National Gas System in Greece

The Greek gas transmission system is composed of a north-south backbone linking the two main import points: the IP Kula / Sidirokastro at the GR / BG border and the LNG terminal on the island of Revythoussa, near Athens. An eastwards branch links this backbone to the third import point, the IP Kipi at the GR / TK border. Several more branches supply gas to industrial or urban areas and to individual customers, mainly power producers.

An extension to the centre of the Peloponese, in the south, is under construction, as well as an upgrade of the LNG terminal. Greece intends to upgrade its role in the regional gas market with the implementation of several interconnection projects that will link the country to its neighbours, most of them sponsored by third parties, likeTAP, IGB or projects that will increase the flexibility of its transmission network like new import points (FSRUs) or the South Kavala UGS in Northern Greece.

In 2013 gas was imported mainly from the Sidirokastro IP (66 %). LNG marked a steep decrease (16% in 2013 compared to 30% in 2012) because of the increase in the price of LNG and the reduction in the use of gas fired power plants. The remaining 18 % of gas was imported from Turkey.

The maximum natural gas volume in the high pressure pipeline of the National Natural Gas Transmission System (NNGTS) is estimated at 24,6 million Nm3, while the minimum volume can be 15,5 million Nm3.

Greece has 2 inter-TSO connections:

- Kulata / Sidirokastron – Bulgartransgaz (BG) (see point 51 on the map)
- Kipi – BOTAŞ (TK) (see point 222 on the map)

The table below presents the technical capacities of the three input points of Greece:

#	Entry Point	Technical Capacity (bcm/y)
1	Sidirokastorn	4,9
2	Kipi	2,3
3	AgiaTriada*	5,2

Table 6: The entry points of the Greek System

*Linked to the Revithousa LNG Terminal

After the second upgrade of the LNG terminal on the island Revithousa, currently in a construction stage, the technical capacity is expected to increase to 7 bcm/y. According to DESFA the project is to be completed in December 2016.

The table below present the firm capacity (technical, booked and available) of the Greek IPs in GWh/d, according to ENTSOG data:

Point	Operator	Direction	Firm technical capacity (GWh/d)	Firm booked capacity (GWh/d)	Firm available capacity (GWh/d)	Last update
Kipi (TR) / Kipi (GR)	DESFA	entry	60,33	25,93	3/2/1900	25/9/2014
Kulata (BG) / Sidirokastron (GR)	DESFA	entry	130,66	107,72	22/1/1900	25/9/2014
Revythoussa	DESFA	entry	139,29	26,93	21/4/1900	25/9/2014

Table 7: Firm Capacity of the Greek IPS (Source: ENTSOG)

4.5.2 The Gas Infrastructure in Bulgaria

The gas infrastructure of Bulgaria consists of a transmission network, the length of which (excluding the distribution network) is 2.645 km, an underground storage facility in Chiren and compressors with total power capacity of 263MW in the transmission network and 10 MW in the storage facility. The transmission network has 65 connections to distribution systems and 262 directly connected customers.

The gas network consists of the national gas transmission system that ensures natural gas distribution to the main bulk of Bulgarian users and the gas transmission network for transiting gas to Turkey, Greece and F.Y.R.O. Macedonia.

Bulgartransgaz EAD, which is the owner and operator of this infrastructure, had in 2012 total transported energy (in gas) 212.040 GWh, while the ratio of transported energy over the national market demand was 6 for the same period.

Figure 15: The Bulgarian Gas Network

National gas transmission network

The national gas transmission network is built in a ring-shaped form of high pressure gas pipelines with a total length of 1,700 km, three compressor stations with total installed capacity of 49 MW and 115 exit points within Bulgaria. Its technical transport capacity amounts to 7,4 bcm/ year, and the maximum working pressure is 54 bar.

Gas transmission network for transit transmission

The transit gas transmission network comprises high pressure gas pipelines of total length of 945 km with prevailing diameter of DN 1000 and six compressor stations with total installed capacity of 214 MW. Its total technical capacity for natural gas transit transmission amounts to 18,7 bcm / year and the maximum working pressure is 54 bar.

Underground gas storage (UGS) in Chiren

The underground gas storage Chiren has 22 exploitation wells, a compressor station with a total installed capacity of 10 MW and a storage capacity of 550 mcm natural gas. The withdrawal and injection capacity is between 1 mcm/day to 4,2 mcm/day and 1,5 mcm/day to 3,5 mcm/day respectively.

Inter-TSO connections

Bulgaria has 5 existing interconnection points and a new one under construction that connect the transmission system of Bulgartransgaz to the transmission systems of the adjacent operators:

- The interconnection point *"NegruVoda 1 (RO) / Kardam (BG)"* with STNG TRANSGAZ SA (Romania), which is an entry-exit point of Bulgartransgaz's National Gas Transmission Network.
- The interconnection point *"NegruVoda 2,3 (RO) / Kardam (BG)"* with STNG TRANSGAZ SA (Romania), which is an entry-exit point of Bulgartransgaz's Gas Transmission Network for Transit Transmission.
- The interconnection point *"Kulata (BG) / Sidirokastron (GR)"* with DESFA SA (Greece), which is an entry-exit point of Bulgartransgaz's Gas Transmission Network for Transit Transmission.
- The interconnection point *"Strandzha (BG) / Malkoclar (TR)"* with BOTAS (Turkey), which is an exit point of Bulgartransgaz's Gas Transmission Network for Transit Transmission.
- The interconnection point *"Kyustendil (BG) / Zidilovo (MK)"* with GA-MA (FYROM), which is an exit point of Bulgartransgaz's Gas Transmission Network for Transit Transmission.
- The new (under construction) interconnection point *"Ruse (BG) / Giurgiu (RO)"* with STNG TRANSGAZ SA (Romania), which is an entry-exit point of Bulgartransgaz's National Gas Transmission Network.

The table below presents the technical, booked and available capacity of the Bulgarian transmission system's interconnection points, according to ENTSOG data:

Interconnection Point (IP)	Direction	Firm technical capacity (GWh/d)	Firm booked capacity (GWh/d)	Firm available capacity (GWh/d)	Last update
Kulata (BG) / Sidirokastron (GR)	exit	**107,05**	107,05	**0,00**	20/2/2015
Kulata (BG) / Sidirokastron (GR)	entry	**10,42**	0,00	**10,42**	20/2/2015
Srtandzha (BG) / Malkoclar (TR)	exit	**470,00**	470,00	**0,00**	20/2/2015
Kyustendil (BG) / Zidilovo (MK)	exit	**26,05**	26,05	**0,00**	20/2/2015
Negru Voda I (RO) / Kardam (BG)	exit	**10,42**	0,00	**10,42**	20/2/2015
Negru Voda I (RO) / Kardam (BG)	entry	**211,00**	95,86	**115,14**	20/2/2015
Negru Voda II, III (RO) / Kardam (BG)	exit	**0,00**	0,00	**0,00**	20/2/2015
Negru Voda II, III (RO) / Kardam (BG)	entry	**607,30**	605,20	**2,10**	20/2/2015

Table 8: Firm capacity of the Bulgarian IPs (Source: ENTSOG)

4.5.3 The Gas infrastructure in Romania

Transmission System Operator

The gas transmission activity is carried out by Transgaz based on the gas transmission system operating licence no. 1933/20.12.2013, issued by the National Energy Regulatory Authority (ANRE) and valid until 8 July 2032. In order to be able to operate the NTS, which is state-owned, Transgaz pays a royalty fee every trimester, representing 10% of the income from gas domestic and international transmission. Transgaz S.A. had in 2012 total transported energy (in gas) 156.297 GWh, while the ratio of transported energy over the national market demand was 1,2 for the same period.

Figure 16: The Romanian Gas Network

Gas Infrastructure in Romania

The gas infrastructure in Romania consists of a transmission network, the length of which (excluding the distribution network) is 13.138 km (out of which 553 km are transit pipelines), production facilities, 8 storage facilities with total working capacity of 3,1 bcm and 5 compressor stations with total installed power of 32 MW. The transmission network has 870 connections to distribution systems and 232 directly connected customers.

The transmission system pipelines have diameters between 50 mm and 1.200 mm. The operating pressure varies between 6 bar and 63 bar, whereas the transit is carried out at 54 bar. The existing transmission system is very complex, with multiple operational interconnections, but it requires upgrading in terms of replacing old pipelines and increasing transmission capacities.

The supply sources and their share in covering gas consumption during 2005-2013 are as follows:

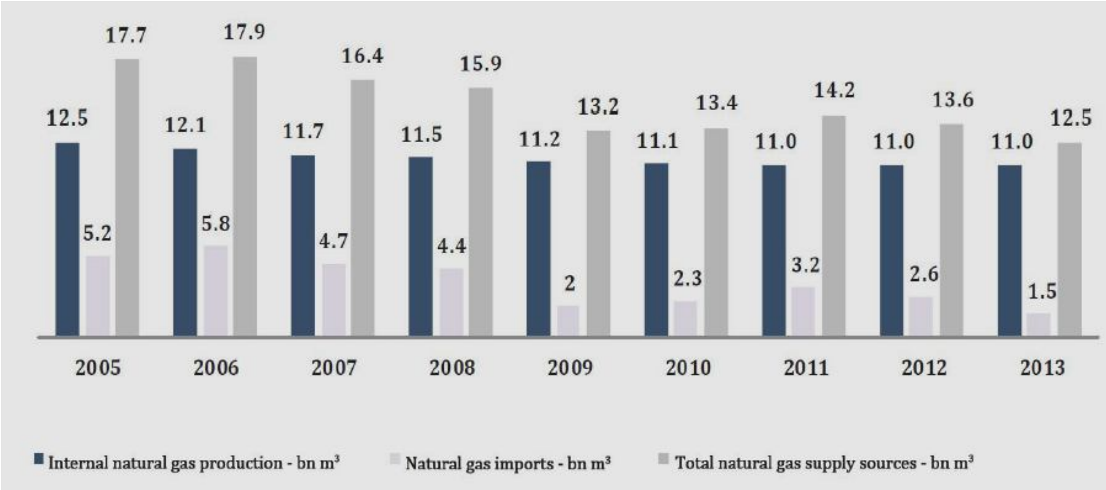


Figure 17: Gas supply sources over the period 2005-2013

The National gas Transmission System (NTS) was conceived as an interconnected radial-ring system with total design capacity of approximately 30 bcm/year.

<u>Gas Transmission Corridors</u>

The Romanian gas transmission system consists mainly of the following transmission corridors:

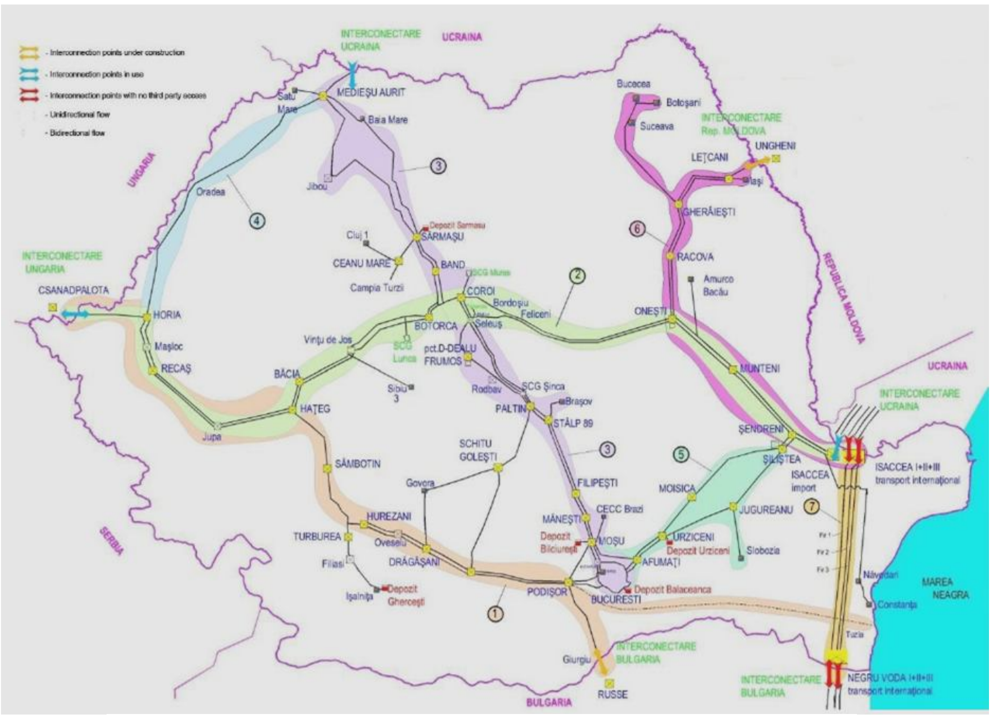


Figure 18: Romania's Gas transmission corridors of NTS

1. Southern Corridor: East-West

This corridor ensures gas import through the Csanadpalota interconnection point with Hungary, at a capacity of 1.75 bcm /year and taking over the domestic gas production from the sources in Oltenia. According to Transgaz, the development of this transmission corridor aims both at increasing transmission capacity of the cross-border interconnection points with Hungary (at 4.4 bcm/year at Csanadpalota - Horia) and with Bulgaria (to 1.5 bcm/year at Giurgiu-Russe).

2. Central Corridor: East-West

The corridor pipelines ensure gas import through the Csanadpalota interconnection point with Hungary, at a capacity of 1.75 bcm/year, gas import through the Isaccea interconnection point with Ukraine, at a capacity of 8.6 bcm/year and taking over the internal gas production from the sources in Ardeal.

3. Corridor: North-South

This corridor ensures gas import through the MedieşuAurit interconnection point with Ukraine, at a capacity of 4.0 bcm/year, taking over the gas production from the sources in Ardeal and storing gas in the internal underground storage facilities.

4. Interconnection Corridor: North-West

This interconnection corridor ensures transmission of imported gas from the MedieşuAurit interconnection point with Ukraine to the Csanadpalota-Horia interconnection point with Hungary.

5. Interconnection Corridor: South-East

This interconnection corridor ensures transmission of imported gas from the Isaccea interconnection point with Ukraine to the Bucharest consumption area and the related underground storage facilities (Bilciurești, Urziceni, Bălăceanca).

6. Eastern Corridor

This corridor ensures gas transmission from the Isaccea interconnection point to the North Moldavia consumption area. The development of this transmission corridor aims at ensuring physical bidirectional interconnection with the Republic of Moldavia (at Ungheni).

7. International Transmission Corridor

The international transmission of gas is carried out in the South-Eastern part of Romania, where the Romanian section of pipelines between Isaccea and NegruVodă is included in the Balkan corridor of international gas transmission from the Russian Federation to Bulgaria, Turkey, Greece and F.Y.R.O.M. The international gas transmission is carried out exclusively through pipelines that are not connected to the National Transmission System.

Figure 19: Pipelines used for international gas transmission between Romania and Bulgaria

The international gas transmission pipelines have a total design capacity of 27.7 bcm/year and a total technical capacity of 21.35 bcm/year, at the current operating pressure. The table below presents the technical characteristics of the three dedicated pipelines for the international gas transmission that are not connected to the National Gas Transmission System.

Pipeline	Diameter (mm)	Technical capacity (bcm/y)	Gas receiver
I	1000	5,27	Bulgaria
II	1200	10,00	Turkey, Greece and Macedonia
III	1200	10,00	Turkey, Greece and Macedonia

Table 9: Pipelines for international gas transmission

At present, the gas transmission through the above three dedicated pipelines is not subject to European regulations or third party access provisions and is carried out based on inter-governmental agreements and contracts concluded with the foreign partners, precisely with OOO "Gazprom Export" and Bulgargaz EAD.

Cross-border interconnection points

At present, the gas imports to Romanian NTS are ensured through three(3) cross-border interconnection points: Orlovka (UA) – Isaccea (RO), Tekovo (UA) – MedieşuAurit (RO) and Szeged (HU) – Arad (RO)-Csanadpalota, which have the following technical characteristics:

Interconnection Point	Diameter (mm)	Capacity (bcm/y)	Pmax (bar)
Orlovka (UA) Isaccea (RO)	1.000	8,60	55
Tekovo (UA) – Medieşu Aurit (RO)	700	4,00	70
Szeged (HU) – Arad (RO)- Csanadpalota	700	1,75	63

Table 10: The three IP's of Romania for gas imports

Romania has in total 9 inter-TSO connections as follows:

- Csanádpalota / FGSZ (HU)
- NegruVoda I / Bulgartransgaz (BG)
- NegruVoda II / Bulgartransgaz (BG)
- NegruVoda III / Bulgartransgaz (BG)
- MediesuAurit Import / Ukrtransgaz (UA)
- Isaccea Import / Ukrtransgaz (UA)
- Isaccea I / Ukrtransgaz (UA)

- Isaccea II / Ukrtransgaz (UA)
- Isaccea III / Ukrtransgaz (UA)

The firm technical, booked and available capacity of the interconnections for the period of March 2015 are presented in the table below:

Interconnection Point (IP)	Direction	Firm technical capacity (GWh/d)	Firm booked capacity (GWh/d)	Firm available capacity (GWh/d)	Period
Csanádpalota / FGSZ (HU)	entry	**51,15**	19,58	**31,58**	March '15
Csanádpalota / FGSZ (HU)	exit	**2,53**	0,00	**2,53**	March '15
Negru Voda I / Bulgartransgaz (BG)	exit	**151,59**	151,59	**0,00**	March '15
Negru Voda II / Bulgartransgaz (BG)	exit	**Confidential**	Confidential	**Confidential**	March '15
Negru Voda III / Bulgartransgaz (BG)	exit	**Confidential**	Confidential	**Confidential**	March '15
Mediesu Aurit Import / Ukrtransgaz (UA)	entry	**369,22**	64,89	**304,33**	March '15
Isaccea I / Ukrtransgaz (UA)	entry	**Confidential**	Confidential	**Confidential**	March '15
Isaccea II / Ukrtransgaz (UA)	entry	**Confidential**	Confidential	**Confidential**	March '15
Isaccea III / Ukrtransgaz (UA)	entry	**Confidential**	Confidential	**Confidential**	March '15

Table 11: Firm capacity of the Romanian IP's

Besides the inter-TSO connections mentioned above, there are two more under construction i. e. interconnection with the Republic of Moldova (Iasi-Ungheni pipeline) and the new interconnection with Bulgaria (Giurgiu-Ruse pipeline).

4.5.4 A Conceptual View of the Vertical Corridor

The Vertical Corridor is a project that will allow gas flows from Greece through Bulgaria, Romania and further to Hungary as well as Ukraine, including reverse flow capability from south to north and the integration of transit and transmission systems.

From the preceding description of national grid systems, shown above it is clear that Greece will be in a position to offer flexibility and access to diversified sources and alternative gas suppliers. The extension and upgrade of the existing Revythoussa LNG terminal in Greece and the addition of two new FSRUs (Aegean and Alexandroupolis) in Northern Greece, will help establish a distribution point for natural gas in the direction from south to north, running through Bulgaria, Serbia and Romania to Hungary and Ukraine. The new interconnections between

Greece and Bulgaria (IGB), between Bulgaria and Romania (IBR), Bulgaria and Serbia (IBS), - with reverse flow capacity to be implemented at existing interconnecting points- as well as the modernization and rehabilitation of the gas transmission infrastructure on the territory of Bulgaria are expected to contribute positively in the creation of suitable conditions which will allow the operation of the "Vertical Corridor" pipeline transmission system.

Bulgaria with its six inter-TSO connections and the sufficient transport capacity of its system can ensure the reliable flow of gas volumes from the south and their transmission mainly to Romania and Serbia. Romania with its large transmission system and the eight storage facilities has a capable infrastructure in order to forward the natural gas quantities either to Hungary through the IP at Csanadpalota or to Ukraine.

As the Vertical Corridor, is in effect a system made upon existing or planned gas pipelines, entry-exit points, and compression and metering stations- some of which are not yet in place- it is difficult to provide a precise description of its several route options and associated characteristics. However, for demonstration purposes it is useful to conceptualise some possible scenarios related to routes and entry-exit points. What follows are three (3) different options for moving gas through the "Vertical Corridor" system. Of course the following options, as presented below are by no means exhaustive on the ways in which the "Vertical Corridor" will be used in transporting gas from destination A to destination B.

Three Possible Routes

Option A- First route: Greece – Hungary

Such a route will start from the entry point of IGB interconnector in the vicinity of Komotini with gas being delivered to Bulgaria through the IGB. The exit point of IGB in Stara Zagora is connected to the Bulgarian National Gas Transmission Network (NGTN) which is built in a ring-shaped form of high pressure gas pipelines with a total length of 1,700 km and transport capacity to 7,4 bcm/year. Through the NGTN the gas is shipped to the entry point of IBR interconnector in Ruse (northern Bulgaria) and through the IBR (64), the gas passes to the Romanian national gas system. Leaving the Romanian exit point of IBR in Giurgiu, natural gas enters the Southern Corridor (East - West) of the Romanian Gas Transmission System (NTS). The Romanian south corridor pipelines will ensure gas exports through the Csanadpalota interconnection point (with Hungary), at a capacity of 1.75 bcm /year and deliveries to the Hungarian gas network.

Figure 20: First route: Greece - Hungary

<u>Option B - Second route: Greece – F.Y.R.O. Macedonia</u>

This route will start at Sidirokastron (GR)/ Kulata (BG) interconnection point (51) at the Greek - Bulgarian border. The gas then enters the Bulgarian Gas Transmission Network for Transit Transmission (GTNTT) which comprises high pressure gas pipelines. The GTNTT is connected with the Kyustendil (BG)/Zidilovo (MK) interconnection point (50) at the

Bulgarian – F.Y.R.O. Macedonian bordersand from there the gas is injected into the F.Y.R.O.M's national grid.

Figure 21: Second route: Greece - FYROM

Option C -Third route: Greece – Serbia

This route starts at the entry point of IGB interconnector, in the vicinity of Komotini. The gas then is delivered to the Bulgarian gas network. The exit point of IGB in Stara Zagora is connected to the Bulgarian National Gas Transmission Network (NGTN) which is built in a ring-shaped form of high pressure gas pipelines with a total length of 1,700 km and transport capacity to 7,4 bcm/year. Through the NGTN the gas is shipped to the entry point of the Bulgarian – Serbia (IBS) interconnector with entry point in Sofia (BG) and exit point at the Serbian city of Nis and from there to the Serbian national gas system.

Figure 22: Third route: Greece - Serbia

Operational Framework

Our conceptualization on the way in which the “Vertical Corridor” is to be used would not be complete without envisaging its operational framework. Therefore it is important to describe how capacity allocation will be decided, how gas transmission will be carried out and final volume deliveries will be made. The following are some notes on Vertical Corridor’s anticipated operational framework.

The capacity allocation at the interconnection points through the Vertical Corridor will be carried out via a platform. Such a platform has been developed by FGSZ, the Hungarian TSO, and is called Regional Booking Platform (RBP). RBP is already used for the allocation of the bundled firm capacities at the Csanádpalota interconnection point (HU-RO) according to the ascending clock-type capacity auction. TSOs allocate firm monthly capacities of the Hungarian exit and the Romanian entry point as well as firm monthly capacities of the Hungarian entry and the Romanian exit point at the IP of Csanádpalota as bundled capacity products. The standard capacity products and allocation mechanisms applied during the capacity allocation are in compliance with the stipulations of the CAM NC.

RGB is a solution for both TSOs and network users (producers, traders, shippers, large consumers). It is able to service a high number of IPs (peak service load designed for 300 simultaneous capacity auctions)and offers customizable functionalities for TSOs and network users. TSOs set up auctions online on RBP, where all auction features are flexible parameters (auction calendar, network user access control, price steps, currency etc.), as shown in the following graph:

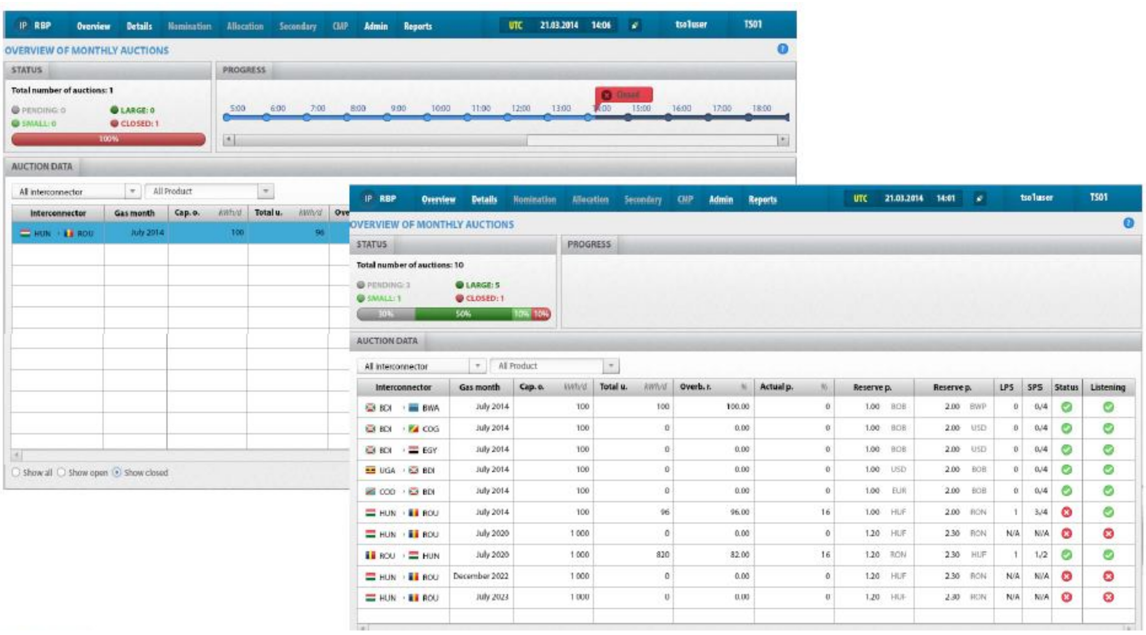


Figure 23: The Regional Booking Platform (RGB)

5. LNG as a Gas Supply Option for the Vertical Corridor

5.1 A Growing LNG Market

According to latest IEA analysis (Mid Term Gas Report 2014), a significant increase in global LNG export capacity is projected in the coming years, reaching a total of 550 bcm, as shown in Figure 5.1. According to the IEA, the international LNG trade is expected to increase from current levels of 322 bcm to 450 bcm in 2019, with LNG having a share of 11% of global gas demand.

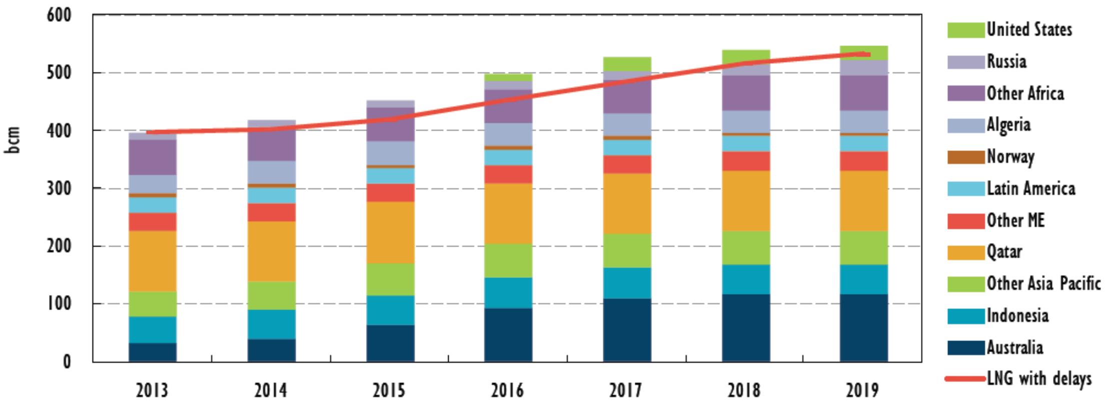


Figure 24: Export LNG Capacity (Source: IEA)

Meanwhile, the forecasts regarding the gas demand in Europe are characterized as pessimistic for the current period and include only a marginal recovery in 2019/2020 to 504 bcm, from a height of 567 bcm in 2010. The increase in imports is taken for granted as domestic production will decline. Production, derived mainly from the North Sea, will be reduced by at least 25 bcm, which means that imports will correspondingly increase. As shown in Figure 5.2, LNG imports, regaining much of the peak that was reached in 2010, are expected to increase by 50 BCM in 2018/2019.

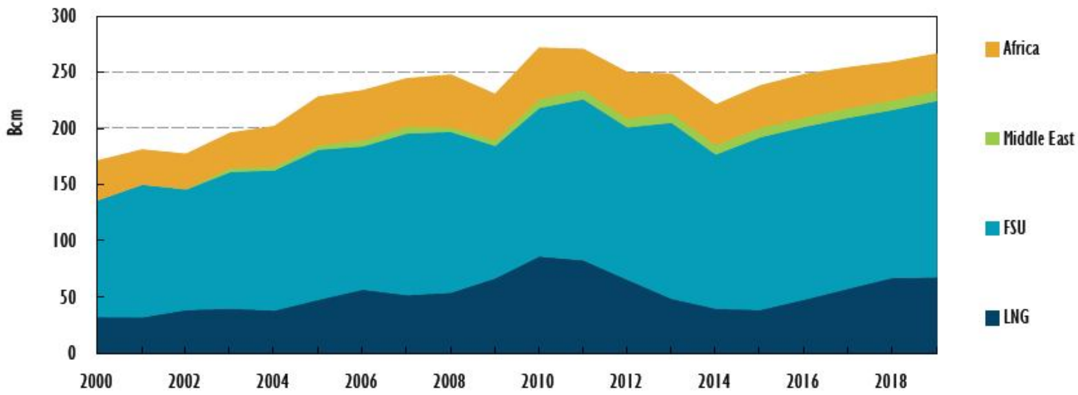


Figure 25: Natural gas imports in Europe (Source: IEA)

With the prospect that by 2020 the number of LNG terminals will have doubled in the SEE region, LNG is slated to play an important role in energy supply, gradually becoming from a supplementary fuel to thegas main fuel pipeline and input.

An important element in the development of regasification LNG terminals in the Eastern Mediterranean is the transit option that the terminals will provide the region. Due to the terminals' spare capacity, they can be used for re-export of quantities to neighboring countries and the Mediterranean in general (as already Spain and Portugal do).

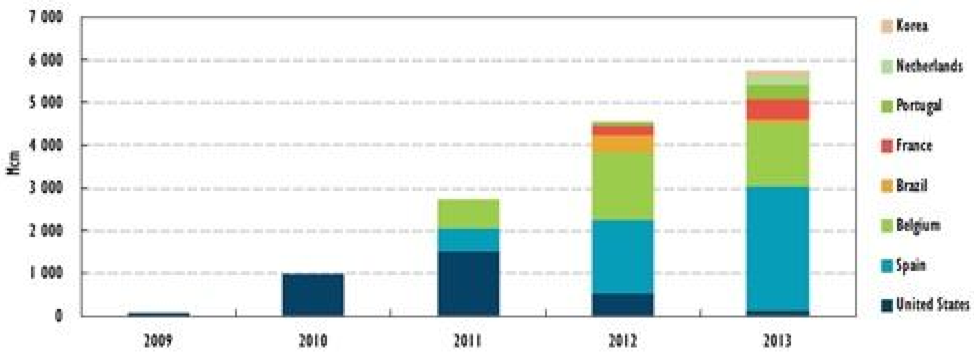


Figure 26: LNG re-exports, 2009-13 (Source: IEA)

Today in Europe, 22 LNG terminals are in operation, 6 are under construction and 32 projects are in the study or design phase. In the LNG map of Southeast Europe only two countries have presence, Greece and Turkey which between them share 3 land based LNG terminals. In the region it seems that there is intention for further investments in LNG terminals. The current, under study, projects are six including two in Greece, two in Turkey, one in Romania and one in Croatia.

5.2 Existing and planned LNG facilities in Europe

The following map illustrates both existing and under construction or study LNG terminals (gasification) in Europe.

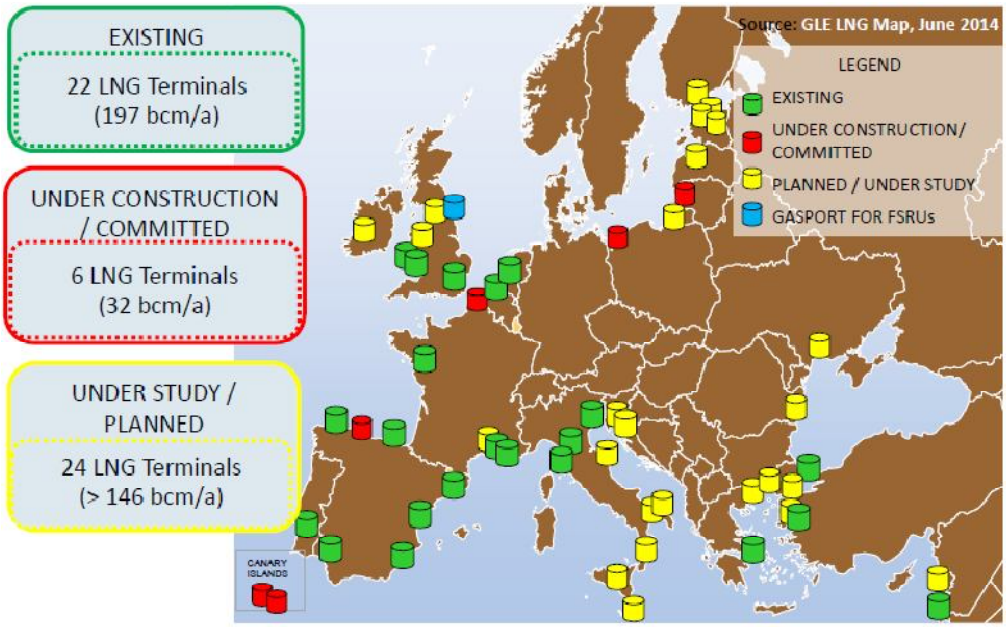


Figure 27: LNG Terminals in Europe (Source: GLE, 2014)

The following graph shows the probable development of the capacity of the European LNG facilities until 2022:

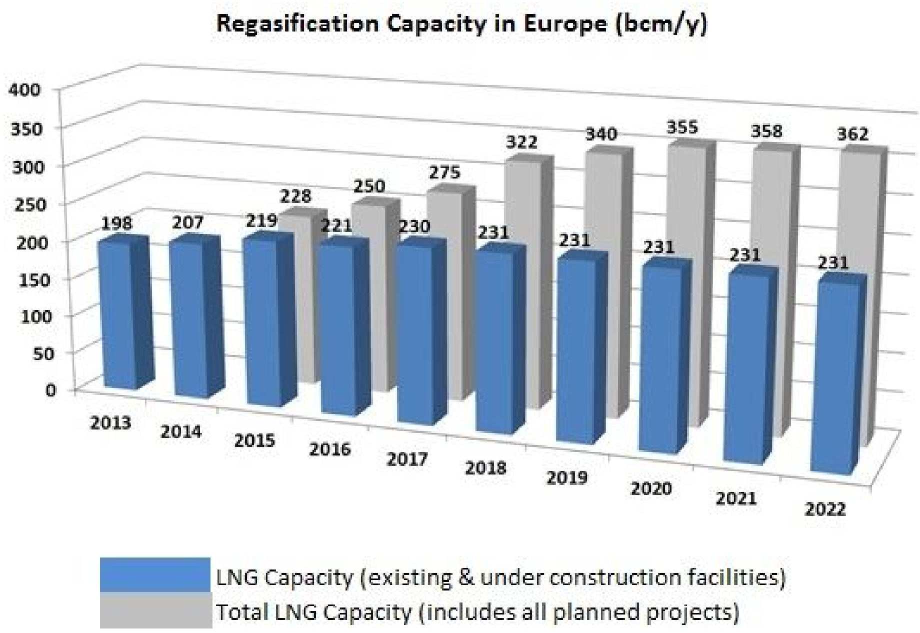


Figure 28: Regasification capacity of LNG facilities in Europe (Source: GLE, 2014)

5.2.1 Existing LNG facilities in SE Europe

Today, in Southeastern Europe, the only countries with LNG facilities are Greece and Turkey.

<u>Greece</u>

Greece has a liquefied natural gas terminal, which operates since 2000. The exact location of the station is shown in the following map:

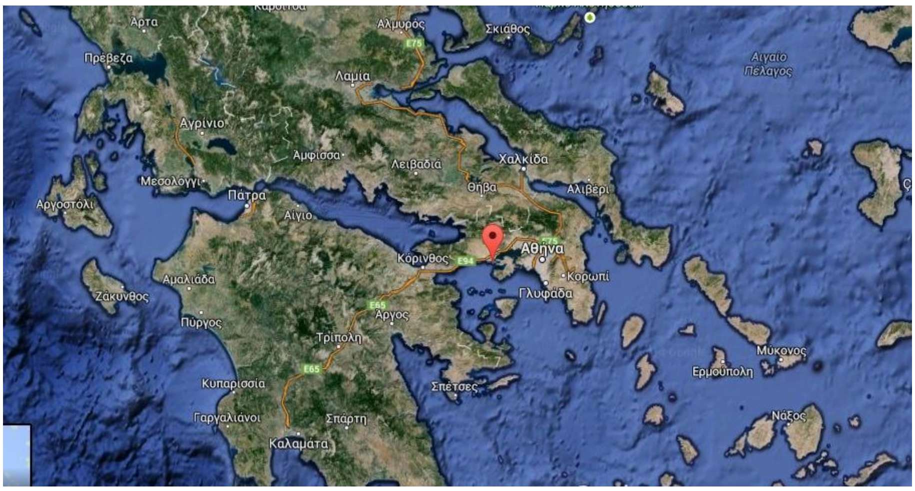


Figure 29: LNG terminal's position on Revithoussa

DESFA is the national natural gas system operator being responsible for the construction, operation and maintenance of the terminal.

Table 5.1 presents the profile of the LNG terminal on Revithoussa.

Location	Operator	Tanks	Max LNG unloading rate (m^3/h)	LNG Storage capacity (m^3)	Sustained Maximum Send out Rate (m^3 LNG/h)	Yearly Capacity (bcm)
Revithousa	DESFA	2	7.250	130.000	1.000	5,2
						Greece

Table 12: Technical characteristics of the LNG terminal on Revithoussa

With the expected second upgrade phase of the LNG terminal on Revythoussa island, a third LNG storage tank is being built with a capacity of 95,000 cubic meters of LNG, thus increasing the total storage capacity of the plant to 225,000 cubic meters. The regasification capacity will also increase to 1,400 cubic meters of LNG per hour from 1,000 cubic meters today.

Turkey

Turkey has two liquefied natural gas terminals.

The first one is the "Marmara Ereglisi" terminal and its position is presented on the map below:

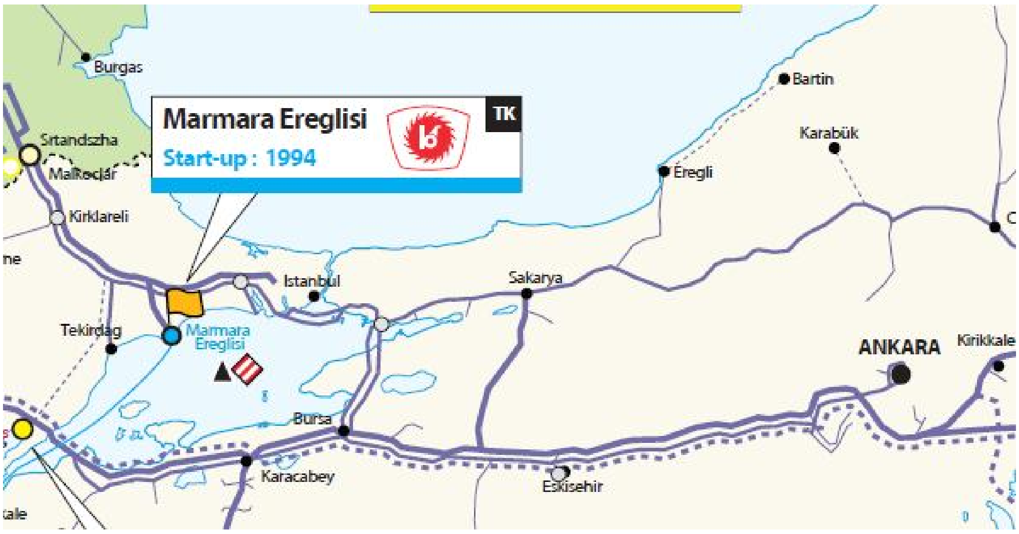


Figure 30: LNG terminal “Marmara Ereglisi” position

The terminal is owned by the state company Botas and started its operation in 1994. The station can receive LNG tankers with a capacity of up to 130,000 cubic meters. Subsequently, LNG is stored in the three tanks of the terminal, with a total capacity of 255,000 cubic meters of LNG. The maximum gasification capacity is 700,000 cubic meters of natural gas per hour, which enables the station to supply the transport system with 6,2 bcm natural gas annually. The following table summarizes the technical characteristics of the LNG terminal "Marmara Ereglisi":

Location	Operator	Tanks	LNG Storage capacity (m^3)	Gasification capacity (m^3 NG/h)	Yearly Capacity (bcm)
Marmara Ereglisi	Botas	3	3 x 85.000	700,000	6.2
					Turkey

Table 13: Technical characteristics of the LNG terminal

"Aliaga" is the second LNG terminal in Turkey and its position is indicated in the map below:

Figure 31: LNG terminal “Aliaga” position

The terminal is owned by the private company EreGaz, which put it into operation in 2006. The station can receive LNG tankers with a capacity of up to 265,000 cubic meters. Then, LNG is stored in the two terminal’s tanks, with a total capacity 280,000 cubic meters of LNG. The maximum gasification capacity is 680,000 cubic meters of natural gas per hour, hence the terminal can supply the transport system with 6 bcm of natural gas on an annual basis. The following table summarizes the technical characteristics of the LNG terminal "Aliaga":

Location	Operator	Tanks	LNG Storage capacity (m^3)	Gasification capacity (m^3 NG/h)	Yearly Capacity (bcm)
Aliaga	EnerGas	2	2 x 140.000	680,000	6.0
					Turkey

Table 14: Technical characteristics of the LNG terminal “Aliaga”

5.2.1 Planned LNG facilities in SE Europe

In the region of Southeast Europe there are plans for new LNG facilities, the design of which is in progress. Greece and Turkey are planning two new projects each, while Croatia and Romania aim to develop one each new LNG terminal respectively.

Greece

The two LNG projects include the FSRU Independent Natural Gas System in Alexandroupolis and one more FSRU in the Kavala Bay Area. Both projects were selected to be funded as PCI's by the European Commission on November 21, 2014.

The project in Alexandroupolis is being developed by the private company Gastrade SA. It consists of an offshore floating LNG storage and regasification unit (FSRU) and a pipeline system (submarine and onshore) through which the gas will be forwarded to the national transport system of natural gas. The floating unit will be permanently anchored at a fixed point and at a distance of 17.6 km southwest of the port of Alexandroupolis.

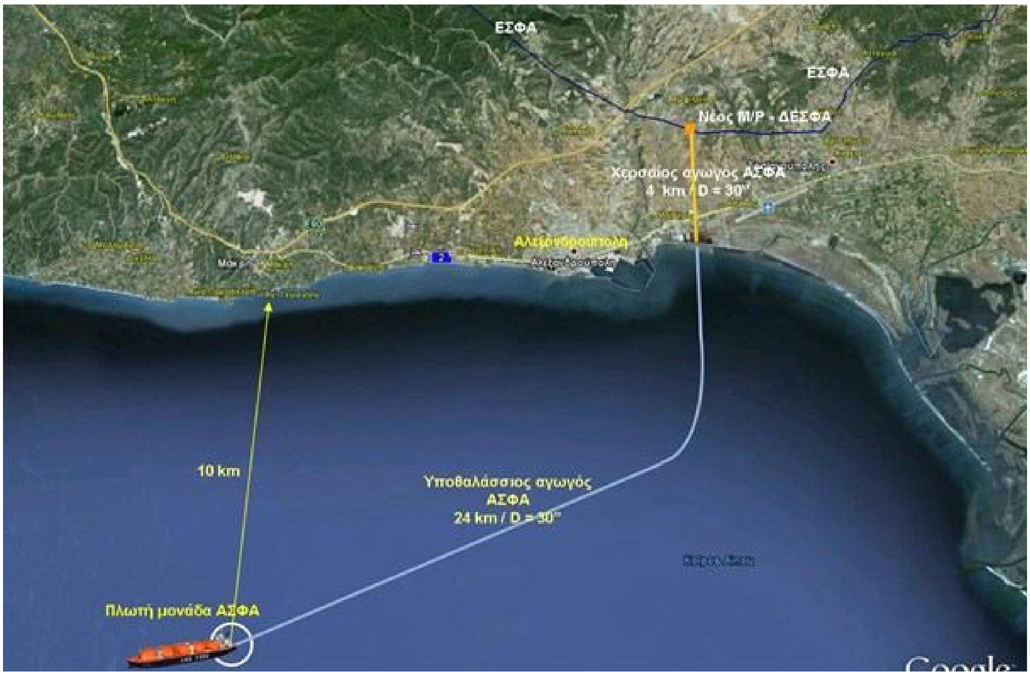


Figure 32: The independent Natural Gas System in Alexandroupolis (Source: Gastrade)

The independent natural gas system in Alexandroupolis will be able to supply up to 700,000 cubic meters of natural gas per hour or 6.1 bcm annually. Its storage capacity will be 170,000 cubic meters (m^3) of liquefied natural gas, as shown in the table 5.4 below.

The financial support by the EU, amounting to 1.755.000 €, refers to the Front-End Engineering and Design - FEED. The project is considered mature as it has already received many of the necessary licenses. The commercial operation of the independent gas system in Alexandroupolis is expected in 2017.

Location	Operator	Type	LNG Storage capacity (m^3)	Gasification capacity (m^3 NG/h)	Yearly Capacity (bcm)
Alexandroupolis	Gastrade	FSRU	170.000	700.000	6,1
					Greece

Table 15: Technical characteristics of the independent natural gas system in Alexandroupolis

The second FSRU project, known as Aegean LNG, is being developed by DEPA SA. It will be a new floating LNG storage and regasification unit (FSRU) and will be located in the Kavala Bay Area region, 9 km from the town of Kavala, as shown in the following map:

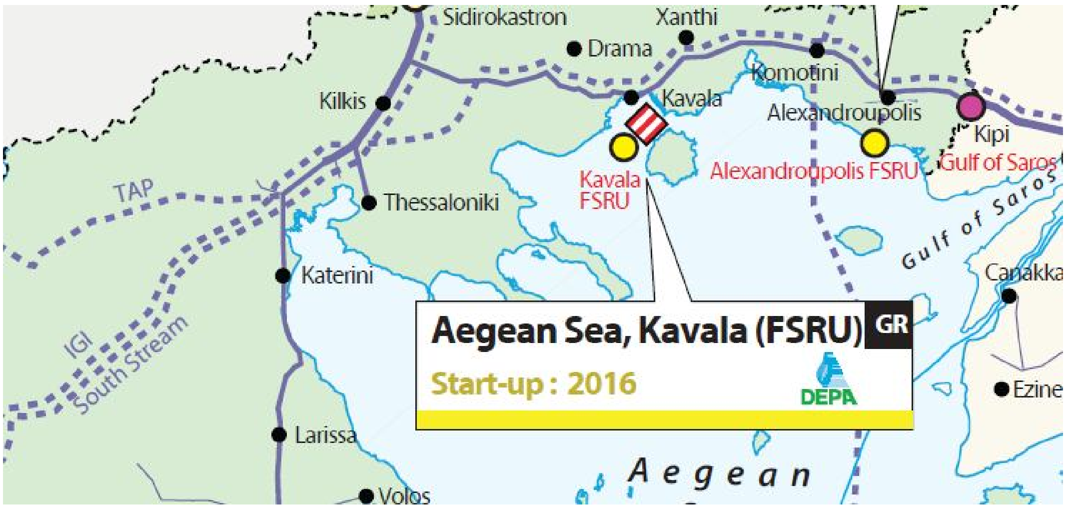


Figure 33: Position of the FSRU Aegean

The technical characteristics of the FSRU project in Kavala are summarized in table 5.5.

The project in the Kavala Bay Area has not progressed as much as the corresponding one of Alexandroupolis. The funding from the EU will be 252.500 € to cover the cost of the licensing process.

Location	Operator	Type	LNG Storage capacity (m^3)	Gasification capacity (m^3 NG/h)	Yearly Capacity (bcm)
Kavala Gulf	ΔΕΠΑ ΑΕ	FSRU	150.000	700.000	3 to 5
					Greece

Table 16: Technical characteristics of the FSRU project in the Gulf of Kavala

Turkey

According to GIE (Gas Infrastructure Europe), Turkey intends to proceed with the construction of two additional LNG facilities.

The first of them concerns a land based liquefied natural gas terminal in the Gulf of Saros, which is located in Thrace, thirty miles southeast of Alexandroupolis, as shown in the following map:

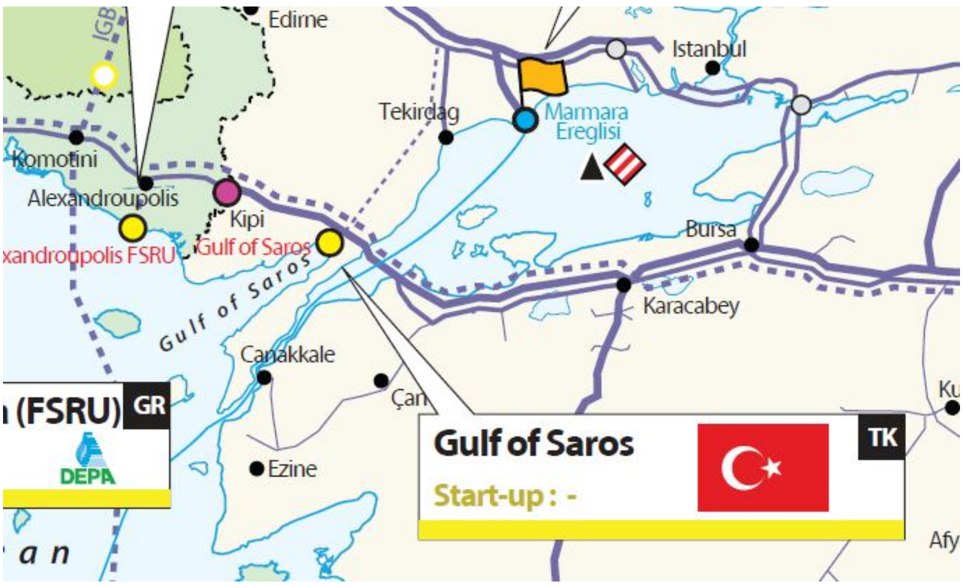


Figure 34: Position of the planned LNG terminal in the Gulf of Saros

The project will be constructed in cooperation with Qatar. The terminal is expected to have an annual capacity of 5 to 6 bcm natural gas.

The second LNG terminal is planned to be built in the district of Izmir Aliaga, where an LNG station, owned by EgeGaz already operates since 2006. Two private companies, KolinInsaat and Tayfun Liman AS, have already expressed their interest in the project. According to GLE (Gas LNG Europe), the new land based LNG facility is expected to operate with 4 tanks, being able to supply the transport system with 6,3 bcm annually.

Croatia

A proposed LNG terminal will be installed in the area of Omišalj, on Krk island in the North Adriatic, as shown in the graph below. LNG Croatia LLC is the company established to build and operate the plant.

Figure 35: Position of the Croatian planned LNG terminal

On November 21, 2014, the European Commission, included the Croatian LNG terminal in the list of selected actions that will receive financial support. EC approved to cover 50% of the total cost for the studies of the terminal amounting to 4.9 million €.

The development of the project will take place in 3 phases and will result in a gradual increase in the annual capacity of the plant, from 2 bcm in the first phase to 3 bcm in the second and finally to 6 bcm at the end of the third phase.

The LNG terminal is expected to serve LNG ships with capacity from 75.000-265.000 cm of LNG.

Romania

The Romanian LNG terminal is planned to be built near the city of Constanta (see Graph 5.13). The terminal is part of the AGRI project that aims to transport gas from the Caspian Sea to Europe. The AGRI project is managed by a consortium of companies: Romgaz (Romania), GOGC (Georgia), Socar (Azerbaijan) and MVM (Hungary).

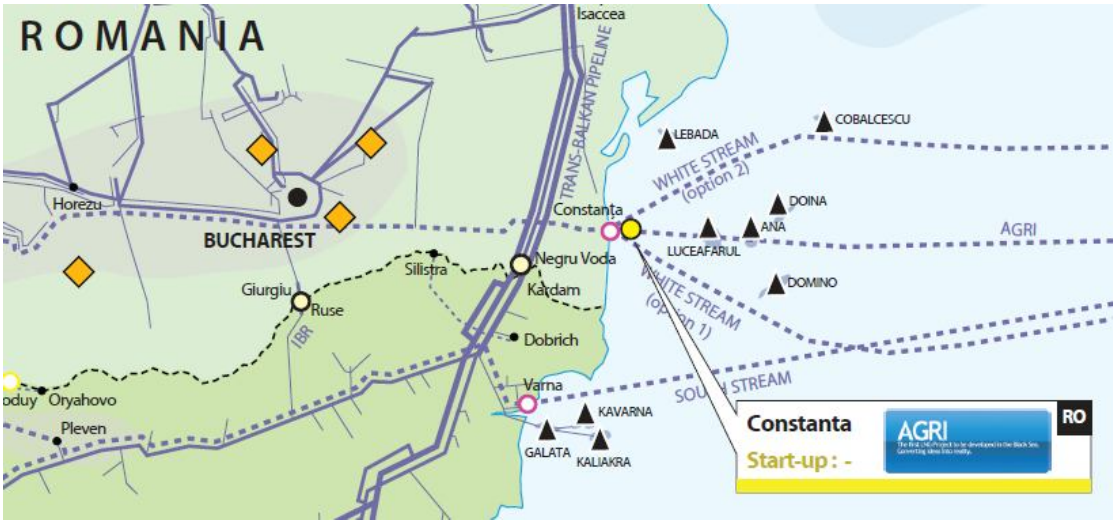


Figure 36: Position of the Romanian LNG terminal

The AGRI project, according to consortium's data, is expected to have capacity of 2 to 8 bcm annually and the estimated cost will range from 1.2 to 4.5 billion euros accordingly.

The role of LNG in SE Europe is strengthened

From the above information it is concluded that over the next 4-5 years the role of LNG will be significantly strengthened, mainly in the southern Balkans and Turkey. The storage capacity of the LNG tanks will double, which means that larger LNG quantities will be channeled into the region’s natural gas networks. Both the increase in tank storage and the much greater gasification capacity of the LNG terminals, will greatly enhance the operational security of both national gas systems in Greece and Turkey, contributing at the same time to security of supply of neighbouring countries (Bulgaria, FYROM, Serbia).

The two planned FSRU projects in the northern Greece are therefore considered crucial for the gas supply of the Vertical Corridor. The new gas quantities coming from these LNG facilities will help increase security of supply in the SE European region byproviding access to alternative gas suppliers, and hence they are considered of strategic importance. Furthermore, the new LNG capacity to be developed in Greece, either in northern Greece or the upgrade of the LNG terminal in Revithousa island, will provide flexibility to the countriesparticipating in the Vertical Corridor, offering them the option of spot gas trading, which is not feasible through the existing status of largely contracted quantities of pipeline gas.

6. Conclusions

The present study describes and analyses in detail the concept for a "Vertical Corridor" for gas transportation in SE Europe, as it was first presented and agreed in a joint statement on December 2014 by the Ministers of Energy of Greece, Bulgaria and Romania. As besides this statement and certain intergovernmental memoranda no other document exists describing the "Vertical Corridor" concept, IENE undertook the initiative, in co-ordination with Greece's Ministry of Environment and Energy, to prepare an initial concept development study.

The guidelines for the study were prepared by IENE and subsequently were adopted by the Ministry and then by DEPA, which was the study's main sponsor. These guidelines followed the spirit and letter of the joint Ministerial statement and as such formed the basis for expanding on the contents of the study. As the joint statement does not elaborate much on the concept of the Vertical Corridor nor does it present any technical information or describes the anticipated operational framework of what is in reality a rather complex regional gas transmission system, the study focused on the above three parameters i.e. the concept, the technical characteristics and the operational framework of the Vertical Corridor system.

Prior to describing and defining the "Vertical Corridor" concept the study establishes the prerequisites at EU and SE Europe level in terms of gas demand and energy policy priorities. These prerequisites take into consideration the latest developments related to planned gas pipeline infrastructure in the region in the post Nabucco era. A basic assumption in developing the "Vertical Corridor" concept is the desired- following latest EU policy objectives- interconnectivity of the gas system of all countries concerned (i.e. Greece, Turkey, Bulgaria, FYROM, Serbia, Romania and Hungary). Consequently the "Vertical Corridor" emerges as a broad gas interconnectivity concept which relates and covers the entire SE Europe region.

The components of the Vertical Corridor are fully described as they mostly consist of existing or planned and approved gas interconnectors and related infrastructure. In addition the gas supply options of the Vertical Corridor are explained in detail including inputs from major gas pipelines, storage facilities, and LNG sources. Furthermore, the study defines a proposed operational framework for use of the Vertical Corridor by the various TSO's but also by market players who will be moving around gas quantities, especially from South to North but also in other possible directions. Moreover, the development of a "Vertical Corridor" in SE Europe will facilitate the establishment of Gas Trading Hubs (and vice-versa) as described in detail in a study prepared by IENE (See "The Outlook for a Natural Gas Trading Hub in SE Europe").

In short the study's verdict is that the "Vertical Corridor" as a concept is technically and operationally sound and can be implemented under certain conditions. However, prior to setting a timetable and agreeing on a host of other related matters a proper feasibility study needs to be carried out following prior agreement between the parties concerned. In addition, those parties will have to move a step beyond joint statements by elaborating and signing a "Memorandum of Understanding" where all key technical and operational parameters of the "Vertical Corridor", as outlined in the present study, will be spelled out. The formulation and signing of such an MOU is of paramount importance and will in essence open the way for the project's realization.

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