The 2014 Ukrainian crisis: Europe's increased security position

Natural gas network assessment and scenario simulations

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EXECUTIVE SUMMARY

Main findings

This study assesses Europe's dependency on Ukrainian natural gas transit in face of the Ukrainian 2014/15 crisis. It argues that Europe is better prepared to confront a disruption through this import corridor than it was back in 2009. Security of supply has improved and so has the overall resilience of the EU network. Several factors contribute to this outcome:

- First, **Europe's demand has underperformed projections in the last 5 years**. This has resulted in infrastructure in place capable of meeting demand levels above current consumption by 100 to 200 bcm. In terms of security of supply, this results in additional spare capacity available in the event of an emergency.
- Second, **access to alternative supplies has improved**. This includes both Russian imports (e.g. Nord Stream), as well as alternative supply sources (e.g., LNG and storage). These developments compensate the decrease in EU indigenous gas production which could have posed a threat to Europe's security of supply.
- Third, **transmission capacity has increased in the 2009-14 period**. Greater cross border capacity allows larger gas volumes to be distributed across Europe in the event of a disruption. Improvements in network infrastructure allow better diversification within the EU Internal Energy Market (IEM).
- Fourth, since 2009, Europe has implemented more consistent and ambitious **security of supply regulation**.

Exposure to Ukrainian transit is **regionally limited** with only Bulgaria, out of EU-28, incapable of substituting imports during a short supply interruption.

Despite this optimistic outlook, Europe's security of supply position should be balanced by looking at the not so optimistic underperformance of its natural gas sector. Decreasing demand has increased energy security by incurring in a paradox according to which **the natural gas sector's decline feeds Europe's security gains**. This freeriding logic will not allow sustaining current margins on the medium term. The 2014/15 crisis in Ukraine should not only raise awareness about Europe's better off position, but also of the challenges that lay ahead to **maintain such security guarantees**.

How vulnerable is EU to interruptions in Ukrainian transit?

While being largely supplied by Russia, the EU is less vulnerable to a gas disruption through its main import route (Ukraine) than ever before. In 2013, Gazprom sales to EU-28 represented up to **29% of total EU consumption, and 14% of Europe's demand was served through Ukraine**. Dependence on this corridor is high, but has decreased for both Russia and Europe in the last decade. Between 2005 and 2014, transit through Ukraine to Europe has gone from levels of 121 bcm to levels of 57 bcm. The share of Russian gas to Europe transiting Ukraine has also decreased from levels of 80% in 2005, to levels of 50% in 2013 and 30% in 2014.

The risk of supply disruptions resulting from interruptions in Ukrainian transit is not only lower but also **regionally narrower**. **Compared to 2009, exposure is geographically more limited and applies only to smaller markets**. Out of the five EU largest natural gas markets with demand above 30 bcm/y (Germany, the UK, Italy, Netherlands, France and Spain), only **Italy** imported more than 15% of its consumption via Ukraine in 2014. **Germany** used to be the largest market with a large exposure to this route, but this has changed with the commissioning of the Nord Stream pipeline. The UK, Netherlands, France and Spain consume little or no gas transiting this route.

Countries showing a high dependency on Ukrainian transit are all **small gas markets with annual consumption below 10 bcm/y**. Bulgaria, Hungary, Austria, Slovakia and the Czech Republic import a large share of their consumption from this route, although only **Bulgaria** is unable to substitute these volumes. In addition, **Slovenia** and **Greece,** which show a lower dependency have some difficulties in substituting imports transiting Ukraine. Finally, **Serbia**, **Macedonia** and **Bosnia Herzegovina**, which were greatly affected by the 2009 disruption, remain to be highly reliant on Ukraine to supply their domestic markets.

Europe's increased supply security position

The EU energy network has seen key improvements since 2009 that place it in a better position to confront a supply disruption through Ukraine transit lines:

Overall lower EU natural gas demand. In the event of an emergency, lower consumption levels ease up supply tightness. In 2014 Europe's consumption was below 2010 levels by more than 80 bcm. This is similar to Germany's annual demand, which is Europe's largest natural gas consumer, and it exceeds any emergency measures consisting of disconnecting non-priority customers from the network to guarantee supply to protected customers.

Pipeline import capacity to replace Ukrainian transit is larger. This results mainly from the commissioning of Nord Stream, which allows greater route diversification on Central and East Europe. The pipeline has been particularly important for Germany that was one of Europe's largest importers of gas transiting Ukraine.

Large storage capacity additions provide a greater security margin for short term disruptions. Storage volumes in 2014 reached the highest levels ever recorded in Europe with +10 bcm more gas in stock than any previous year. To put this figure into perspective, non-delivered gas volumes to Europe in the 2009 crisis amounted to 5 bcm. During the 2006-13 period additional capacity amounted to 27 bcm and private investment amounted to €12,5 bn.

Regarding **LNG,** current market data indicates that the global market has recently become more flexible to adapt to emergencies. In 2014, Asian prices came down after 3 years highs. Low prices indicate a comparably low LNG demand resulting in a favourable situation for Europe's security of supply. During the 2007-13 period, private investment on infrastructure amounted to €8,4 bn and regasification capacity increased from 107 bcm/y to 213 bcm/y.

Added up, storage, LNG, and pipeline imports compensate for the 25 bcm/y decrease recorded in **EU indigenous production** in the 2009-13 period (84 bcm decrease if we look at the 2001-13 period). Additionally, these supplies compensate too for the recent reductions planned for Groningen production which is estimated to be limited by 20% to 33 bcm/y.

The availability of alternative supplies is complemented by additions in **transmission** and **cross-border interconnection capacity** which render greater diversification potential. Important examples are the OPAL and Gazelle pipelines and the Lanzhot and Baumgarten IPs. As a result, 2014 recorded larger transmission volumes in reverse flow direction in IPs traditionally used for shipping gas from East to West (e.g. at the Lanzhot in the CZ – SK border). In the 2006-13 period private investment for transmission infrastructure added up to €32 bn and the percentage of cross-border IPs implementing bidirectional flow capability increased from 15% to 40%.

Finally, the role of **EU regulation** has been key by providing a common legislative and regulatory framework for market participants. The EC has contributed to homogenising national security of supply provisions (e.g. N-1 standard), coordinating MSs policies and financing natural gas infrastructure for security of supply. A total budget of €3 bn has been allocated for the 2008-15 period (€1 bn under the EEPR program and close to €2 bn under the TEN-E/CER facility). The role of the EC as a financial institution has been important in German-Poland IP (Yamal pipeline), the Romania-Hungary IP, and the Greece-Bulgaria IP.

Scenario simulations show Ukraine, Bulgaria, Turkey and Macedonia would be hit hardest by a disruption

A numerical analysis of different Ukrainian disruption scenarios with the **TIGER model** enable detailed quantification of the gas system's resilience during a supply crisis. These scenarios vary both in regards to the duration of the disruption and the winter temperatures. Simulation results allow pointing out seven important findings:

First, **non-delivered gas during a modelled disruption similar to that of 2009 comes down from 5 bcm to 2,4 (2,9 bcm if we consider exceptionally low temperatures)**. This is mainly the result of Nord Stream displacing Ukrainian transit, and of Europe's overall lower natural gas demand. The result renders Europe less dependent on Ukraine and more capable of substituting imports transiting this route. At the same time non-delivered quantities to Ukraine continue to be similar to 2009. The slight decrease observed is not the result of greater diversification but rather of decreasing domestic consumption.

Second, modelling results indicate that **shortfalls are limited** compared to the 2009 crisis and that the **number of exposed countries remains constant despite changes in scenario durations.** During the modelled **2-week, 3-month and 6-month disruptions** demand is not fully satisfied to variable degrees in **Ukraine, Turkey and Macedonia** and **Bulgaria**. During a 6-

month disruption most critical supply cuts happen in December and January amounting to unserved demand of about 40% (Ukraine), 70% (Bulgaria) and over 90% (Macedonia).

Third, simulations including **cold spells** result in critical shortages in several countries. During the 2-week scenario this is the case for Ukraine (up to 49% of daily demand), Bulgaria (up to 74% of daily demand), Macedonia, Bosnia/Herzegovina, Greece and Turkey. When a cold spell is modelled during a 6-month disruption, substantial demand interruptions also take place in Italy.

Fourth, **LNG imports** play a key role compensating non-delivered gas. This is specially the case in South-East Europe, i.e., **Italy, Turkey and Greece,** although limitations in pipeline capacity reduce the compensation potential of this source. Results show that LNG imports compensate 2.5 bcm per month during a 3-month disruption, and 3.5 bcm per month during a 6-month disruption. Additionally, **LNG is crucial in the aftermath of the crisis** to re-fill storage facilities. This effect is particularly important during November and December of 2015, where storages are on a lower-than-normal level at the start of the winter.

Fifth, modelling results show too the key role **storage** plays during all modelled disruptions. In the 2-week case, **storage withdrawals in Ukraine and Italy (as well as Czech Republic, Slovakia, Hungary and Austria)** provide the largest additional gas supplies. In the 6-month scenario, the aforementioned countries provide again most of the additional volumes. But as dynamics in supply are more critical, those storages in countries farther apart, such as in Germany, would supply substantial amounts of additional gas too.

Sixth, a comparative analysis of compensation quantities shows the role different supply sources play. During a **6-month** disruption not delivered gas through Ukraine between November and April amounts to 51.4 bcm. This volume is compensated with **extensive storage withdrawal** of 21.5 bcm, **additional LNG imports** of 15.6 bcm and additional **European indigenous production** amounting to 1.8 bcm. Total **unserved demand** amounts to 12.4 bcm (Ukraine and Turkey included).

Seven, **disruptions extending up to a year** have severe effects on EU supply with large consumers facing shortages (e.g. Germany, Italy and Austria). This shows, first, Europe's inability to diversify away from Ukraine during longer periods of time and, second, the importance gas storage facilities play during shorter disruption. During a full year disruption Russia too would face great difficulties with 106 bcm of gas not being served to Europe (including sales to Ukraine and Turkey).

Russia and Ukraine's resulting position

The equilibrium Europe, Russia and Ukraine have historically maintained in terms of gas trade is at stake in face of events taking place in the region.

Russia has depended on Ukraine for a large share of its exports to Europe (Turkey included). Despite the corridor's lower utilisation in the recent years, Russia still relies on Ukraine for exporting natural gas volumes beyond **88 bcm** (in 2013, Gazprom's sales to Europe amounted to 163,3 bcm)..

Ukraine has traditionally depended on Russian supplies and continues to do so. According to modelling results, an interruption of these supplies during the winter season lasting for more than 2 weeks would result in **severe shortfalls**. Reverse gas flows from European countries help reducing the severity of the interruption but are not sufficient to fully substitute Russian deliveries to Ukraine.

So what? Challenges ahead for Europe and its energy sector

While the study points out the favourable security position Europe holds vis-à-vis Ukraine, it concludes too that factors contributing to this outcome are not all positive. Projections for infrastructure to be implemented during the 2009/14 period have not realised and have resulted in large infrastructure in place for storage, regasification and transmission. While energy security requires spare capacity being saved for emergency purposes, the current levels of spare capacity are not a result of polices or positive market dynamics, but rather of the sector's underperformance.

Today's low demand levels strengthen Europe's security of supply and wave off fears of a crisis similar to 2009 repeating. However, this advantage can be read in terms of adversity in the medium term. Low demand has resulted in the under-utilisation of gas infrastructure, which creates little incentives for investment on additional capacity and on existing assets. The absorption of this contraction in demand has been different in each segment of the network creating problems of its own.

- **Storage facilities** have decreased in number in 2013 and this trend can continue at current market conditions. In the medium-to-long-term this could result in a decrease of storage capacity which has been one of Europe's key security guarantees in 2014/15.
- **LNG terminals** have decreased regasification rates from 40% in 2010 to 18% in 2013. Changes in LNG markets might draw a more positive outlook in the medium term.
- **Transmission** operators face a different situation as the segment is mostly regulated within Europe. However changes in supply patterns within Europe (especially in East Europe) pose challenges to both regulation and investment.

As infrastructure operators adjust to current demand levels, questions regarding Europe's capacity to maintain current energy security levels will emerge. Can infrastructure operators generate cash flows to build, maintain and operate overcapacity under the current gas market design? In other words, are gas consumers willing to pay a risk premium for security of supply? In the current context, this insurance has run on the side of infrastructure operators who previewed much higher levels of demand. The unsustainability of this position suggests security of gas supply in Europe will remain to be hot topic in the coming years.

While the current study focuses on EU-Ukrainian transit dependence, its conclusions surpass Europe's borders. At the time of writing, Russia, Ukraine, and the EU are preparing tripartite talks to settle the terms of Russia's gas supplies to Ukraine once the "Winter Gas Package" expires in March 2015. While Russia expressed its intent to continue with 2009-2019 contracts, Ukraine anticipates the reversal of this framework. Kiev's ambitions to free itself these obligations look Europe as an alternative. This is a significant development for Europe that could bring additional changes to its gas industry as Slovakia's and other interconnections open up opportunities to re-arrange supply logistics in Eastern Europe.

Changes in East and South East Europe are likely to be affected too by Russia's expansion's plans and by its recent cancellation of the South Stream pipeline. The substitution for an alternative pipeline to Turkey continues to leave uncertainty for gas supplies to Europe's most exposed regions to supply interruptions.

INTRODUCTION

Setting up the scene

For those following the evolution of the energy sector, 2014 has been a year of changes. Tensions have increased, dropped and moved from one segment to another with deals that had been on the air for the last decades being formalised in the midst of these ups and downs. At the core of these turns have been the tense relations between Russia and Ukraine that raised fears of an interruption such as the one in 2009 repeating in 2014 and later in 2015. Numerous publications have evaluated such an event to assess its implications and to quantify its effects[4]. This study is part of these efforts. It aims at understanding Europe's security position in regards to natural gas imports transiting Ukraine. For this, it combines a detailed analysis of Europe's natural gas sector with scenario simulations prepared with the TIGER Model to quantify the consequences of such a disruption. Although it concludes Europe's security has increased since 2009, the study examines too the challenges ahead for sustaining these gains.

Russia has supplied Europe with natural gas since it first started serving Austria's OMV in 1968[5]. Historically this route has served to supply gas to Europe uninterruptedly overcoming the fall of the Soviet Union and the subsequent emergence of the independent republics of Ukraine, Belarus and Moldova. In the post-1989 period the transit system preserved its reliability despite the new borders in place. However, during the last decade, several interruptions have taken place[6] with 2009 being by far the most severe. Its duration was unexpected for all actors affected (e.g. Russia, Ukraine and Europe) and has left a vivid mark in Europe's imaginary changing its perception of Russia and Ukraine as reliable supplier and transit countries respectively.

The stability of transit through Ukraine in 2014 has indeed been a fragile one. It relied on the controversial agreements in place for the 2009-2019 period signed between Russia and Ukraine in the aftermath of the 2009 crisis. It was based too on several political clauses and discounts that did not contribute to shielding mutual understanding[7]. In face of the political transformation Ukraine had embarked on, these guarantees seemed insufficient. The 2014 Ukrainian Crisis had its immediate roots in the government transition from the so-called Maidan movement in 2013 and in the country's efforts to take distance from Russia's sphere of influence. In 2014, Russia's military forces invaded Ukraine's sovereign territory of the Crimean peninsula and later, the vast regions of Luhans'ka and Donets'ka oblast called for their independence driving the country close to a civil war. The crisis emerged as one of the most severe confrontations between Russia

[4] See Behrens, A. & Wieczorkiewicz (2014); ENTSOG (2014, 2014a), European Commission (2014a, 2014d), Hecking et al. (2014); Holz, F. et al. (2014), Kong Chyong (2014); Pirani (2014, 2014b); Pirani et al. (2014); Richter & Holz (2014); Zachmann (2014); Zapletnyuk (2014)

[5] See http://www.downstreamtoday.com/News/ArticlePrint.aspx?aid=10194

[6] Additional disruptions in natural gas supplies were also observed to Belarus (2004 and 2010), Moldova (2006) and Ukraine (2006, 2008, 2009). See Katja (2011).

[7] The so-called Kharkiv Accords, signed in 2010, in which Ukraine and Russia agreed on natural gas discounts and contracts in exchange for 25 years lease of Black See naval base. After the annexation of Crimea in March 2014, Russia this agreement unilaterally terminated. Source: http://tass.ru/en/russia/725964

and its western neighbours and immediately triggered a European response to impose travel restrictions and wider economic sanctions. A first round of measures was passed in March 2014 and a second round was approved in July aiming at limiting Russia's finance and trade operations[8]. These events, together with the natural gas cuts Russia imposed on Ukraine and the latter incidents with Poland[9], and Hungary[10] (which suspended reverse flows to Ukraine in September), raised alarms about further interruptions taking place both in 2014 and currently in 2015.

Europe's diplomatic initiatives have helped maintaining an open dialogue between Ukraine and Russia. Linked to these efforts is the gas 'Winter Package' which brought Russia and Ukraine back to supply and transit obligations in face of the winter season. Supply through this corridor has continued into 2015 with minor complaints from signing parties[11].

Participants in EU natural gas networks saw these agreements with relief but had little time to sit back. In the background to the crisis, oil prices had come down from initial levels above $100/bbl to levels below $ 50/bbl in January 2015 creating a new horizon for the sector and the world economy in 2015. LNG markets (which are and will be affected by this decrease) also experienced a similar drop as Asian demand underperformed expectations in the second half of 2014. Prices, which had been close to the $ 20/mmbtu mark since the Fukushima accident, plummeted below $ 10/mmbtu altering the balance between world importers and offering an unexpected security margin for Europe.

Within this context of dropping oil prices and deteriorated relations with both, Ukraine and Europe, Russia announced a U-turn in its natural gas export strategy shifting its expansion towards the East. The long awaited agreement with China had been successively delayed for more than a decade, and its final form includes the Power of Siberia pipeline (38 bcm to start deliveries on 2019) and the Altai pipeline which has been announced for additional 30 bcm but has yet to be confirmed. These projects signal Russia's acknowledgement of Europe's limitations as a gas market based on its contracting demand and the adversity posed by EU institutions. The intuition was confirmed when Gazprom further announced the abandonment of the South Stream project for a pipeline to Turkey of a similar volume (63 bcm/y) labelled "Turkish Stream". Although these steps have opened a way outside dependency vis-à-vis Europe, the strategy was announced in the context of EU-US sanctions and overall decreasing oil prices. As a result, the Russian Ruble lost 40% of its value to USD by the end of 2014 showing the over reliance its economy has on energy exports.

Overall, Russia's new export strategy signals its need to settle adversities with Ukraine. By dropping the South Stream project, Russia comes to accept its dependence on Ukrainian until any alternative corridors are built. This leaves open the question about how the restoration of

[8] See : http://europa.eu/newsroom/highlights/special-coverage/eu_sanctions/index_en.htm
[9] In September 2014 Gazprom unexpectedly reduced supplies to Poland by more than 20 % as stated in their contracts; http://www.ft.com/cms/s/0/5533134a-38f6-11e4-a53b-00144feabdc0.html
[10] Hungary's TSO justified the halt of reverse flows to enable pipelines for the upcoming inward supplies to Hungary's system; http://www.ft.com/cms/s/0/7c5d2bf0-4552-11e4-ab86-00144feabdc0.html#axzz3S6Fgi4vB
[11] Gazprom accused Ukraine of siphoning the gas supplies; http://edition.cnn.com/2009/WORLD/europe/01/03/russia.ukraine.gas.gazprom/index.html?eref=edition

regular trade agreements will be staged. The deal reached in October 2014 comes to an end by March 2015 and its renegotiation depends on the new positions both Ukraine and Russia are willing to assume. While Russia has stated its willingness to go back to contracts in place for the 2009-2019, Kiev does not welcome the restoration of past agreements. At the same time, Ukraine's autonomy in term of gas supply has greatly changed as its gas storage facilities are emptying, While it was able to cope with the winter with a limited reliance on Russia, it is not clear it will be able to continue with this strategy. In between, Europe continues its efforts towards reaching an agreement firstly in regards to the armed conflict but also in regards to gas trade. While it is at the far receiving end of Russia's gas, the evolution of its natural gas network, and furthermore of its energy mix (not to say its position as a geopolitical actor in the region), heavily depend on the road events will finally take.

Structure of the report

The inspiration for this study is scattered all throughout this context. As initial events raised concerns about a potential supply disruption, part of the research assesses Europe's exposure to such an event and quantifies the results of several possible disruption scenarios. The study also includes a critical assessment evaluating the sustainability of Europe's increased security position. It is divided into four parts:

- Part I: Europe's exposure to a supply disruption through Ukraine.
- Part II: Gas market simulation of disruption scenarios (TIGER Model).
- Part III: Improvements in the natural gas network leading to Europe's increased security position (2009-14).
- Part IV: The implications of the crisis for Ukraine.

Several works have explored Europe's exposure to supply cuts through Ukraine providing the public sphere with valuable and consistent analyses[12]. This report is in line with these works. Having reviewed these publications the authors of this study considered several issues still remained to be addressed. This work aims at complementing the mentioned works by providing further analysis on the evolution and future of Europe and its energy sector.

The study includes a simulation of modelled scenarios derived with the TIGER model by the Institute of Energy Economics at the University of Cologne (EWI). Several features of this analysis are worth mentioning:

- It is based on up to date data on EU gas demand, production, prices, pipeline transit, cross border capacities, storage and LNG imports. These figures provide a detailed analysis of Europe's dependence on the Ukrainian corridor.
- The study includes modelling scenarios that take into consideration the current state of the EU network. Notably the work represents a perfectly competitive and rational

[12] See footnote 4

behaviour of all market participants to show how supply sources vary during a disruption. This data pictures the emergency response provided by domestic production, storage withdrawals, LNG imports and pipeline transit during modelled disruptions. In addition, modelling results incorporate current debates on regulation and geopolitics. An example are simulations on OPAL's TPA exemption and its implications for transit and security of supply.

- The assessment includes a review of the changes in the EU gas network during the 2009-14 period. This encompasses changes on EU regulation, infrastructure, transit capacity and flow dynamics (e.g. reverse flows) that have redefined Europe's position vis-à-vis Russia and Ukraine.

Part I: Europe’s dependency on Ukrainian transit

SECTION I: CONTRACTING DEMAND, EUROPE’S FIRST SECURITY GUARANTEE

The 2014/15 winter arrived at a time when European natural gas demand is at its lowest over more than a decade. During the last four years leading up to the 2014/15 winter, consumption has decreased at variable pace with 2014 recording a steep decline. This decreasing trend has marked the sector’s fall to pre-2000 levels. While it poses challenges of its own for the natural gas industry and for the overall EU energy system, it has resulted in a positive outcome for Europe’s energy security. Everything else equal, lower demand results in lesser pressure on supply to compensate missing gas deliveries resulting from a transit disruption.

The following section sets the tone of the report by referring to the most important event shaping the EU natural gas sector in the 2009-14 period. The decrease in domestic gas demand has resulted in a beneficial security position for the EU vis-à-vis transit through Ukraine. While security of supply requires the market to save part of its capacity for emergencies, decreasing demand results too in available capacity. They are, indeed, two different logics but they result in the same phenomenon: free infrastructure capacity. For this it is important to distinguish between spare capacity and underutilised capacity. The key difference is that while sustainable security of supply mechanisms are based on spare capacity that is paid for, underutilised infrastructure resulting of low demand is not valued by the market. Because of this, the latter can result in security of supply gains but not in sustainable ones. Europe’s increase of security in the post 2009 period is partly, but not only, the result of freeriding on the natural gas sector’s decline.

This first part of the study explores the different dimensions of Europe’s reliance on Ukrainian transit. In this context, spare capacity resulting from low demand levels is key for Europe’s increased security position. Part III of this study looks at the different segments of the EU natural gas sector to evaluate how each one has absorbed the decrease in demand and how this is likely to change Europe’s security in the next years.

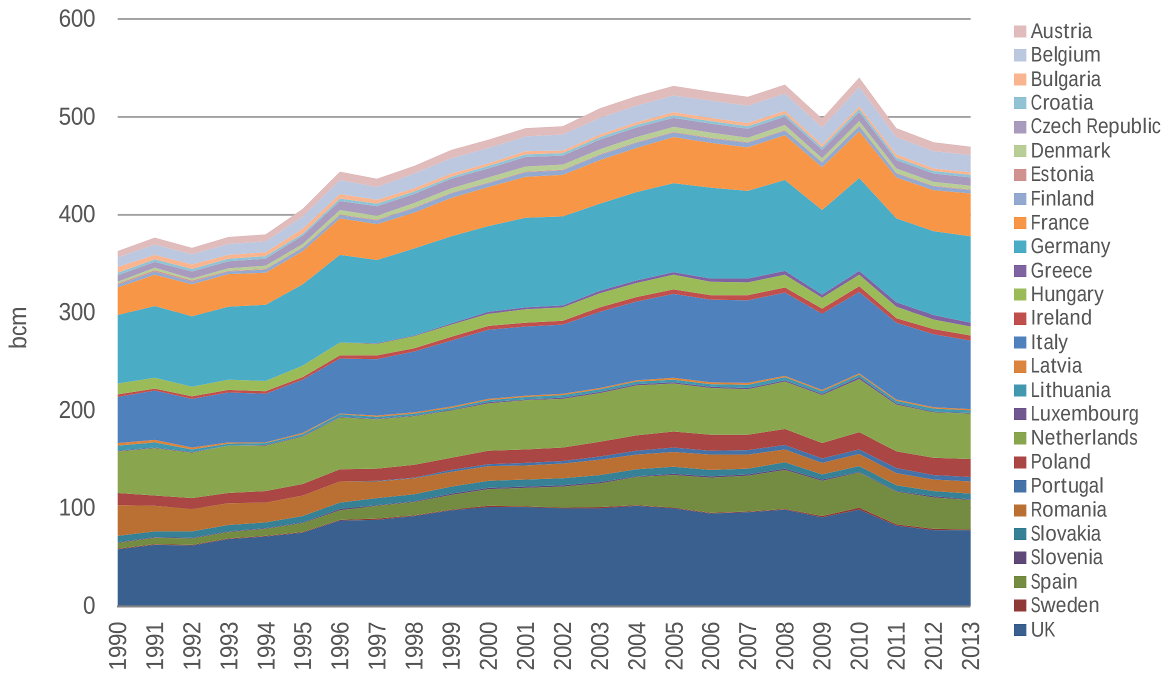
Overall, the sector’s response to lower demand is based on a market-logic. Despite demand having recorded several consecutive decrease years since 2005, the sector has responded to price signals. Consumption levels are not an optimistic figure, but the sector’s reaction to market fundamentals is a positive outcome as it shows the IEM’s capacity to adapt to changing environments. Europe’s energy sector transformation, which started in the 1990s, partially derogated security of supply functions to market participants. Their ability to responds to market signals, even if not positive ones, is already a good sign for Europe.

In this section the different factors behind Europe’s demand contraction are discussed together with the implications for security of supply.

The evolution of EU natural gas demand

Natural gas demand has increased steadily over the last 20 years until the 2008 financial crisis. The evolution between 1990 and 2013 is represented in Figure I. Consumption in 2009 decreased by 7% compared to 2008 dropping in EU-28 from 533 bcm to 498 bcm[13]. A short a recovery took place in 2010 leading to a historic **demand peak of 540 bcm** but further decreases have been recorded in the following years (2011: -10%; 2012: -3%). **Between 2010 and 2013 demand decreased 13%, from 540 to 470 bcm**. The year 2011 recorded the largest downfall and 2013 seemed to mark a break in this downward move with demand stabilising around -1%[14]. However, during 2014 further decreases have been recorded.

FIGURE I: NATURAL GAS DEMAND IN EU-28, 1990-2010 (BCM).

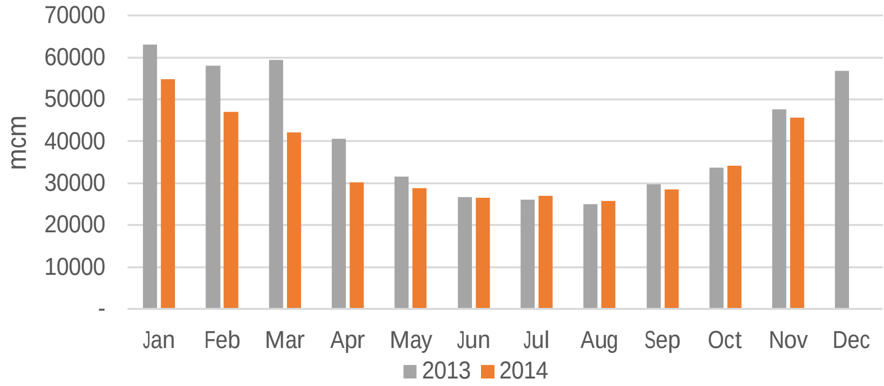


Source: IEA Natural Gas Information (2014b) data is used for OECD-EU. Eurostat data [nrg_124a] is used for non-OECD-EU.

During 2014 EU demand has continued its downfall, recording a further contraction. The main reason for this decrease is 2014 has been one of the warmest years in recent times[15]. Excluding the month of December (for which there is no data at the time of writing), 2014 has resulted in a **decrease in OECD-EU demand of -11%**[16] compared to the same period of 2013. Figure II below represents available demand data for this period. It is notable how a further decrease continues during the first half of the year while it stabilises during the summer months.

[13] Unless otherwise pointed out, figures for EU-28 demand are aggregated as described in Figure I.
[14] The variation in demand in 2013 compared to 2014 varies depending on the source (Eurogas, -1.4% for EU-28; Cedigaz, -1.1% for EU-28; BP, -1.1% for EU-28; IEA, -0,7% for OECD Europe, Turkey Switzerland and Iceland)
[15] See, for example: http://www.ft.com/cms/s/0/e92579ae-8580-11e4-ab4e-00144feabdc0.html
[16] IEA natural gas monthly figures: http://www.iea.org/statistics/relatedsurveys/monthlygasdatasurvey/

FIGURE II: OECD-EU MONTHLY NATURAL GAS CONSUMPTION, 2013/14 (MCM).



Source: IEA Monthly Gas Data

This trend is not even amongst MSs with countries experiencing greater falls than others. This is mainly explained by the fact that the reasons behind this contraction are different in each country. Hence, their demand evolution is also different. In the 2010-13 period demand contraction has been more acute in UK (-17%), Spain (-17%), Italy (-15%), Netherlands (-15%). Single digit decreases have been recorded in France (-9%) and Germany (-7%). In 2013 an upwards trend was recorded in several countries (France +4%; Germany +3%; Netherlands +1%), with others experiencing further contraction (Spain -8%; Italy -6%; UK -0,4%).

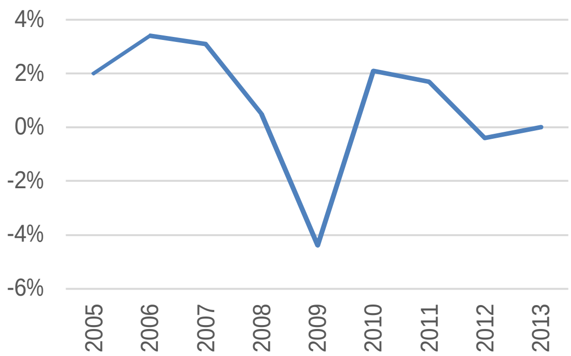
Reasons behind the contraction

The causes behind this contraction relate both to Europe’s economic evolution and to the state of the EU energy sector. A careful analysis reveals how the decrease in natural gas consumption is related to policy interactions within the EU. Variations in security of supply conditions partially result from policies adopted outside the natural gas sector. Several factors can be pointed out explaining the drop in EU natural gas demand.

First of all, economic performance has been modest and negative at times with various periods recording a negative GDP evolution. This has resulted in gas consumption experiencing a downfall during the period (see Figure III for a broad evolution of EU’s GDP). In addition, natural gas demand has also been affected by mild temperatures. Figure IV below represents heating degree-days showing the downward trend in the 1980-2008 period which has driven down gas consumption for heating purposes. Although it does not reflect a detailed evolution of temperatures in the post-2007 period, the plotted trend shows the general decrease in heating degree days that is currently taking place in Europe.

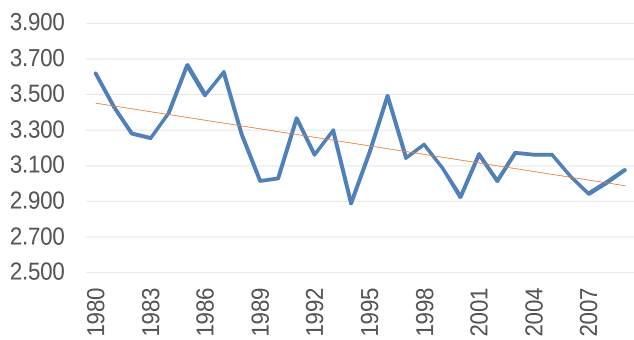
Regarding the EU energy sector, natural gas has under-performed in power generation when compared to RES and coal (see Figure V). This is a result of RES promotion policies and low carbon prices that have allowed cheaper coal to be called ahead of gas for dispatch. Figure VI represents German coal and gas prices in the 2009-14 period and compares these levels with the evolution of carbon prices. The area in yellow represents the carbon prices needed to trigger fuel switching from gas to coal. While in 2010-11 these levels where closer to actual CO_2 prices, in 2013-14 the carbon market prices CO_2 well below levels needed to trigger this switch. These calculations depend on estimations for power plant efficiencies which are estimated in the note next to the graph and are different in each EU market. Nevertheless, they allow showing how the excess in EU carbon allowances has resulted in an adverse market environment for gas generation.

FIGURE III: EU-28 REAL GDP GROWTH RATE (PERCENTAGE CHANGE ON PREVIOUS YEAR)



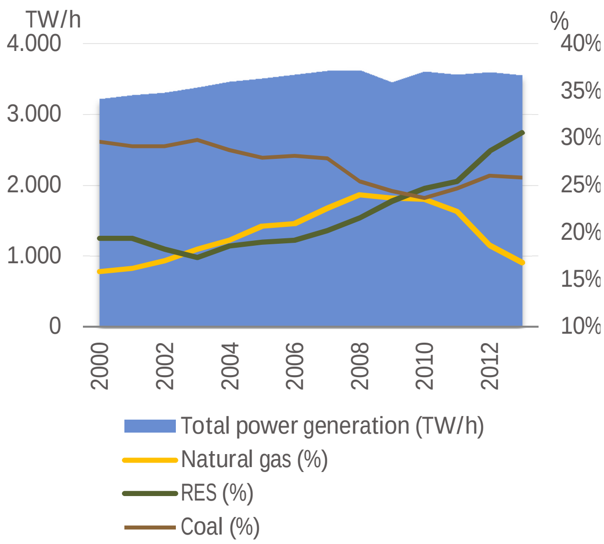
Source: Eurostat [tec00115]

FIGURE IV: HEATING DEGREE DAYS EU-28 AND LINEAR TREND, 1980-2010



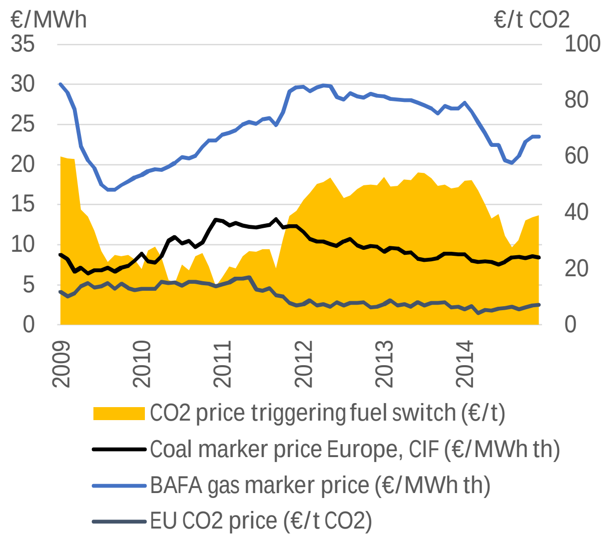
Source: Eurostat: Heating degree-days by NUTS 2 regions - annual data [nrg_esdgr_a]

FIGURE V: POWER GENERATION BY SOURCE IN OECD-EU, 2000-13 (% OF TOTAL GENERATION)



Source: IEA Natural Gas Information

FIGURE VI: EU CARBON PRICE AND SELECTED COAL AND GAS PRICES, 2009-14 (€/T CO_2)



Note: CCGT @ 55% eff. Coal @ 38% eff.

Source: IEA (2014), BAFA (2014), EEX (2014), McCloskey (2014)

In addition to low carbon prices, coal prices have experienced recent decreases due to trends in the global market (e.g. the US-shale gas revolution and general overcapacity in global seaborne coal trading). The recent decrease in oil prices has too brought down coal prices and will create further competition vis-à-vis gas generation. Overall, these trends represented below define the adverse context which explains the decrease in natural gas demand in the last years.

Any recovery for the sector is not projected before mid-2020 or 2030[17]. The retirement of the German nuclear fleet, together with the decommissioning of ageing coal plants are behind these projections.

The contribution to energy security

Decreases in demand generally result in decreases in infrastructure utilisation. These dynamics contribute to increasing energy security as unutilised infrastructure in practice functions as spare capacity.

80 bcm contraction since 2010

A comparison between current EU demand levels and peak recorded in 2010 shows a decrease of more than **80 bcm**. To put this figure in perspective it is equivalent to disconnecting Europe's largest natural gas consumer off the network (Germany) or to closing Europe's largest import corridor (Ukraine). It also exceeds any security measures that could be adopted by disconnecting specific demand segments (generally industry) to guarantee supply to protected customers.

To assess the contribution that these 80bcm pay to security of supply it is important to understand how a decrease in demand is absorbed in the context of the IEM. In a pre-IEM world, all supplies would be reduced more or less proportionally. However in the context of the EIM this decrease in not equally distributed but it is rather concentrated in the most expensive sources. Higher priced supplies go out first. Lower demand therefore has put pressure on the most expensive supplies, which in the case of the EU, and in the 2009-14 period, have been LNG imports. Over this period, pipeline imports have remained constant while LNG imports have recorded a continuing decrease. This is clearly pictured in in Figure IX which shows LNG import levels of 6000-8000 mcm/month in 2011 and levels of 2000-4000 mcm/month for 2014 (in addition Section VIII provides detail of how this has affected regasification rates). As a result the segment of the EU supply network that has been freed to the larger extent are LNG regasification terminals. In 2013 imports amounted to 44bcm while regasification capacity stood at 213 bcm/y. This results of +150 bcm of unutilised import capacity. In comparison, spare capacity in other supply corridors (e.g. Russia and Norway) has not seen similar decreases in the same period. Norway exports to Europe peaked in 2012 (see footnote 22) and Russian imports have been on the rise in 2012 and 2013 (see Figure X).

In addition to LNG, storage facilities have been too affected by Europe's demand decrease. As demand has persevered downwards, pipeline ToP contracts have come to represent a higher

[17] For an analysis of current EU natural gas demand and projections to 2030 A. Honoré (2014) provides a detailed analysis.

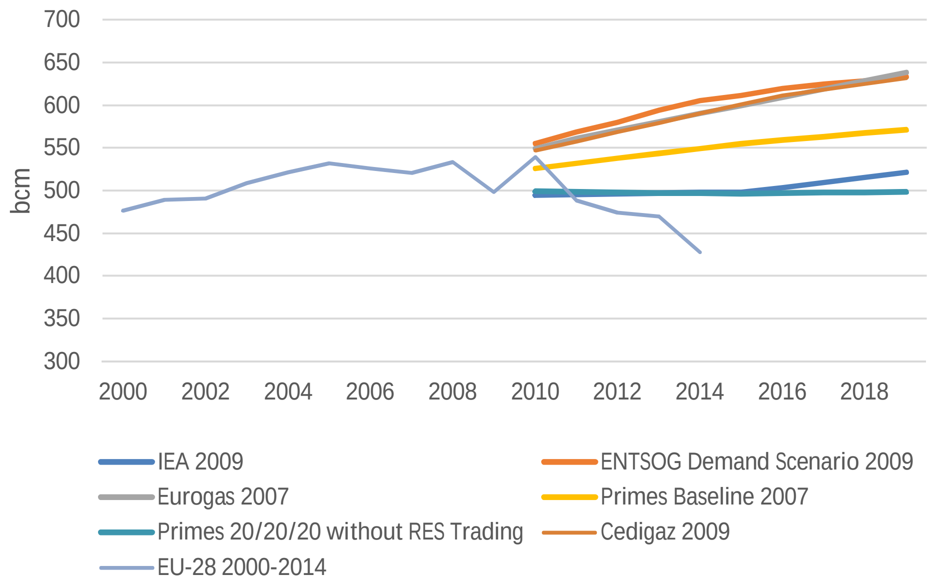
share of supply. These contracts, which have built-in summer/winter flexibility, have contributed to lowering summer/winter spreads. As storage operators rely on these signals, its depression has resulted in a decrease in storage utilisation (see Section VIII for a more detailed analysis).

LNG imports have absorbed the greatest part of Europe's decrease in consumption while storage has been affected too (although in a different way). Both of these sources therefore concentrate the greatest share of unutilised capacity in Europe. Paradoxically, this infrastructure functions as spare capacity available for security of supply purposes. To some degree it is perverse how a negative position for these segments, can be read too in terms of a positive outcome for Europe. The logic is an inversion of positive security of supply mechanisms that should have sustainability as its backbone.

Demand projections off by 100 to 200 bcm

A second look at EU's demand contraction has to do with infrastructure planning. In this regard it is relevant to look back to the 2006-2009 period to examine demand projections upon which current infrastructure is based on (Figure VII below). The result is not an 80 bcm contraction, but rather a decrease between 130 and 230 bcm.

FIGURE VII: EU-28 DEMAND PROJECTIONS 2009-2019 AND CURRENT DEMAND EVOLUTION (BCM/Y)



Source: ENTSOG 2009 TYNDP

Projections have led to implementing infrastructure to cope with volumes much larger than current demand. The EU network in 2014 is prepared to meet demand levels 100 bcm above current levels. At these levels, perhaps Europe would have fewer margin for replacing one of its main import sources such as Ukraine. However, given the overcapacity in place Europe can potentially deal with such a disruption without incurring in the dramatic outcome of 2009.

This unbalance between infrastructure and demand results in additional security of supply, but it results too in an adverse business scenarios for the natural gas sector. Section VIII explores these dynamics in storage, transmission and LNG import facilities to show the difficulties each of these segments are currently undergoing. Although Europe has additional security levels, the sustainability of current capacity is questionable and it opens a debate about how to guarantee and pay for spare capacity in the system.

SECTION II: EUROPEAN NATURAL GAS DEPENDENCY ON UKRAINIAN TRANSIT

To evaluate Europe's dependence both on Russia as a supplier and on Ukraine as a transit corridor, this section looks at two different dimensions of gas trade between EU, Ukraine and Russia:

- **Europe's natural gas imports from Russia and transit through Ukraine**. In 2013 Russian supplies represented 29% of EU-28 natural gas consumption while transit through Ukraine represented 14% of total EU-28 demand. On the short-term Europe's dependence on both of these partners is not cancellable.
- **Russia re-routing capacity to side-line Ukraine.** Russia's export capacity to bypass Ukraine is between 88 and 104 bcm/y. If we consider the Gazprom's abandonment of OPAL's TPA exemption in 2015, this figure rests at 88 bcm/y. This implies that, at current export levels of 163,3 bcm (in 2013), Russia depends on Ukraine to ship 70 bcm/y to Europe (Turkey included). Scenario simulations with the TIGER Model show that a permanent disruption would result in 106 bcm/y of non-delivered gas to Europe, Turkey and Ukraine.

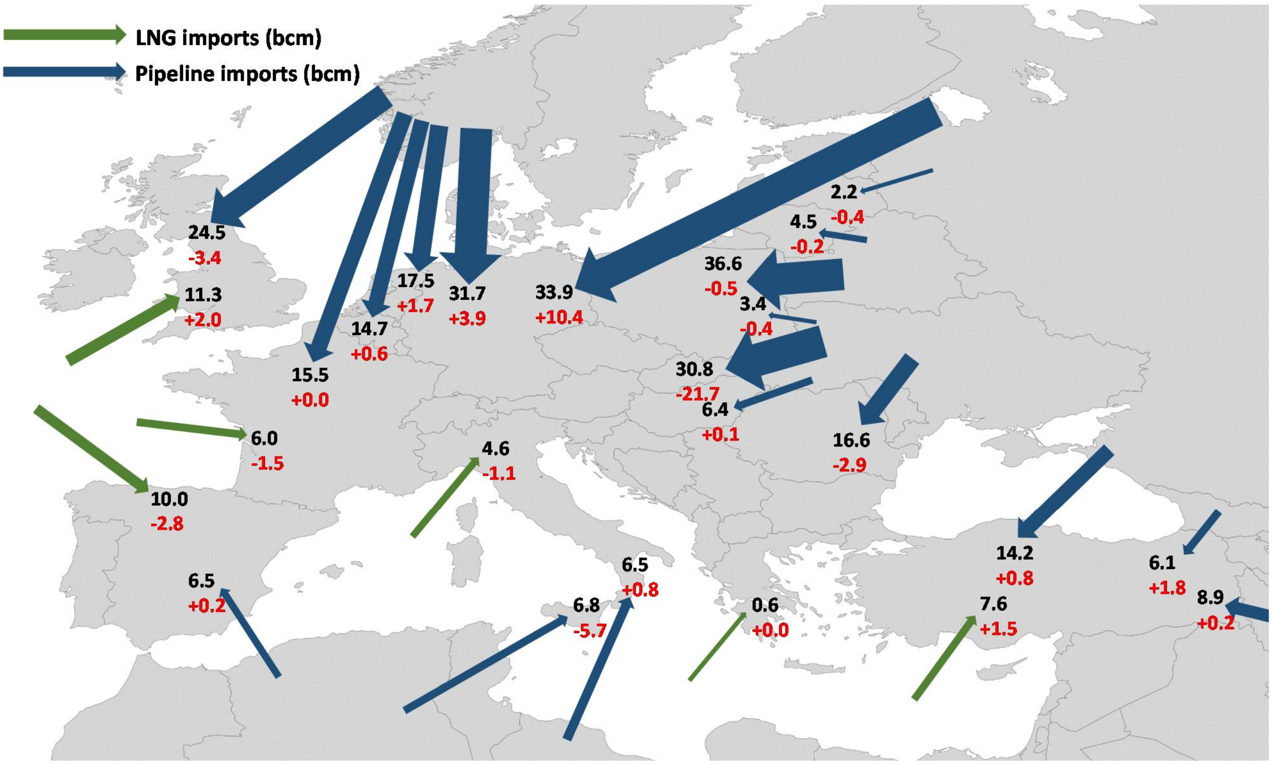
The analysis presented in this section regarding Europe's dependency on Ukraine is expanded in Section III and Section IV that look at alternative emergency supplies and country specific reliance on Ukrainian transit.

Europe natural gas supply: increasing dependency on Russian imports

A contraction in EU demand together with a decrease in EU indigenous production has resulted in greater import dependency. This is particularly the case for Russia. The share of imports from this partner country has increased in the last years to exceptionally high levels of 29%.

Map I below represents gas flows to Europe by supplier and by route during 2014 and represents the variation compared to 2013. To weigh the importance of these figures, the section further looks at the evolution of all EU supplies including its domestic gas production. While low demand has allowed loosening tightness in supply, it has lead too to higher dependency on external suppliers. Other relevant aspects of the evolution of supplies to Europe in the 2013-14 period include the increase of supplies through Nord Stream and the decrease in transit through Ukraine. Both of these changes have important implications for EU gas flows (e.g. reverse flows), transmission utilisation and overall perceptions of security.

MAP I: NATURAL GAS IMPORTS IN 2014 (AND CHANGES TO 2013), EU AND TURKEY (BCM)



Note: Figures in red indicate the change in percentage between 2013-14.

Source: Own illustration based on http://www.iea.org/gtf/index.asp. Data for Romania on the month of November 2014 was provisional at the time of writing. Final data might result in very slight variations for volumes transiting UA - > RO.

Most suppliers decreasing production, except Russia

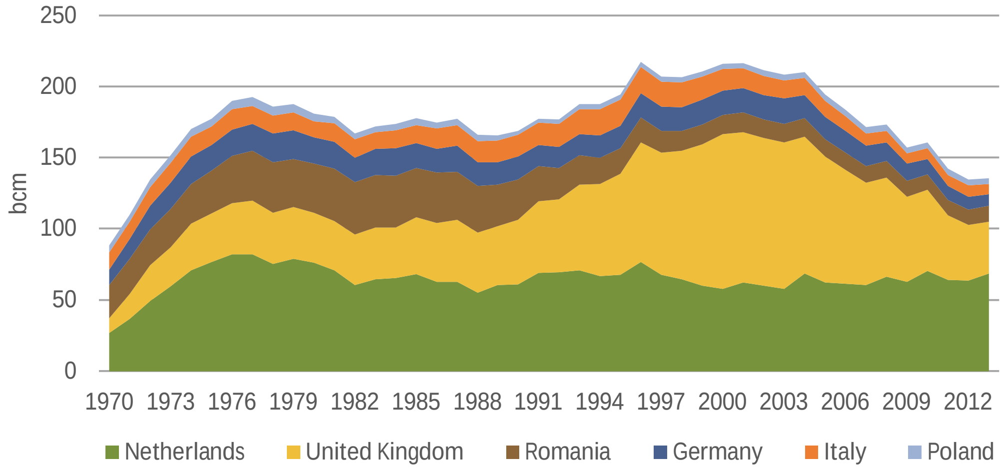
The main suppliers to the EU, with the exception of Russia, have decreased its production and/or its exports to Europe. This applies to domestic EU production, pipeline imports from both Norway and North Africa and LNG imports. In the context of decreasing gas demand in the EU, this has resulted in higher reliance on Russian imports.

Europe's natural gas production has been decreasing since it peaked in 2001. This is mainly due to the evolution of production in the UK and Netherlands, the two main producers that accounted for than 70% of total EU production in 2013[18]. On the side of the UK, natural gas production has been decreasing ever since it peaked in 2000[19]. The case of Netherlands is also a matter of regulation. In 2013 it boosted its production to the third-highest level since 2000 (85 bcm). However, on January 2014 the Dutch government agreed to set a 3 year cap on the Groningen field due trembles in the area. This limitation is estimated to reduce the field's annual output to approximately 33 bcm/y during 2014 and 2015[20] and consequently also Europe's overall

[18] Calculations are based on (IEA 2014b) and BP Statistical Review (n.d.)
[19] For additional information on UK gas production visit: https://www.gov.uk/oil-and-gas-uk-field-data
[20][20] The Groningen field accounted for 62% of Netherland's production in 2012. Detailed information about the country's indigenous gas production can be retrieved at: http://www.nlog.nl/en/oilGas/oilGas.html

production. Figure VIII below represents historical EU indigenous production for the 1970-2012 period. The IEA has further projected a decrease of 25 bcm/y for the 2013-19 when looking at projections for EU domestic production, including Norway[21].

FIGURE VIII: MAIN EUROPEAN NATURAL GAS PRODUCERS (EXCLUDING NORWAY) 1970-2013 (BCM)



Source: BP Statistical Review (n.d.)

The decrease in supply also affects EU foreign supplies. This evolution is represented in Figure IX below. Pipeline imports from Norway have gone too through a moderate decline after production peaked at 114 bcm in 2012[22]. In 2013 Norwegian exports to Europe (103.4 bcm) were 5% below 2012 levels (109.4 bcm) and during the first five months of 2014 a further decrease was recorded. Markets expected this fall after the exceptional production levels reached in 2012. North African exports to Europe in 2013 were 13% below average export volumes of 2010-13 and 2014 levels are below 2013 those of 2013[23].

Regarding LNG imports, volumes have been decreasing since the Fukushima accident and the increased in Japanese LNG imports that followed. The price differential between European and Asian prices resulted in cargoes being re-routed to Asia and South America to take advantage of arbitrage opportunities. Between 2010 and 2013 LNG imports decreased by 52% in the EU[24]. Imports where down by 30% in 2012 and then again down by 30% in 2013 compared to the previous year. This trend continued in the first half of 2014 but reverse in the second half of the year as a result of Asian prices dropping down to $10/mmbtu in Asia and even lower in the EU[25].

Regarding the decrease in output resulting of the field's cap, see: http://uk.reuters.com/article/2015/03/01/uk-netherlands-gas-groningen-idUKKBN0LX1MR20150301

[21] IEA Natural Gas Information (2014a, p.93)

[22] For additional figures on Norwegian natural gas production visit: http://www.ssb.no/en/energi-og-industri/statistikker/ogprodre/kvartal/2014-11-21#content. Fossil fuel export data is available at: https://www.ssb.no/en/statistikkbanken

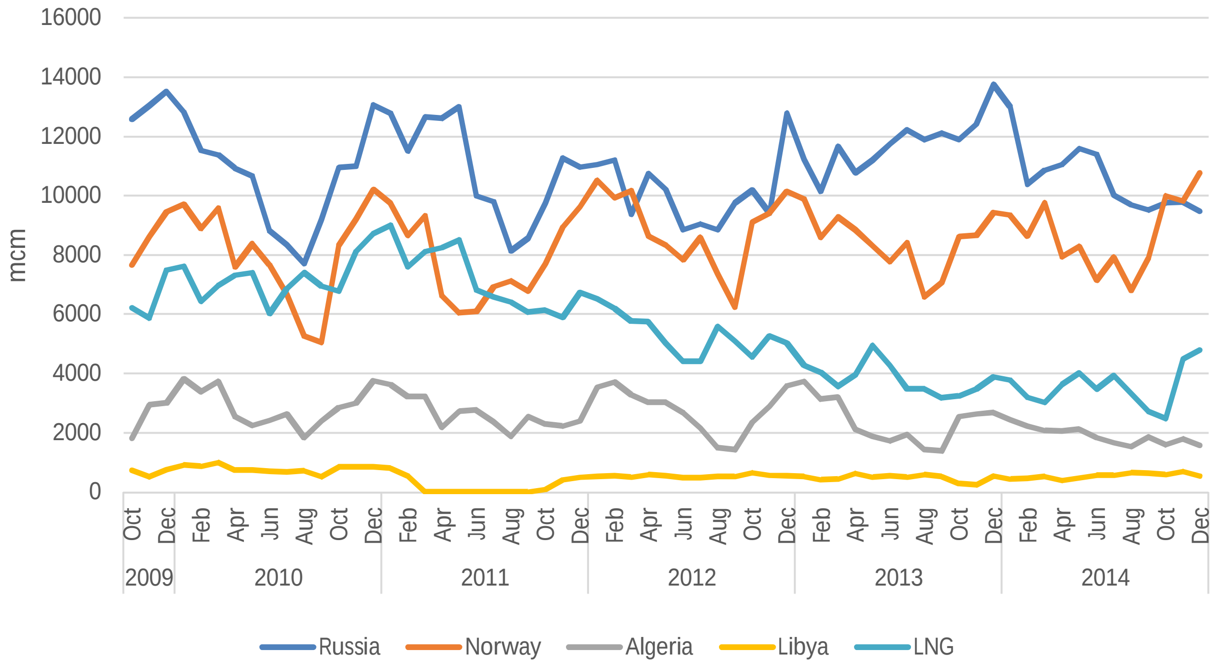
[23] Increasing domestic consumption, low investment and political unrest are behind low production levels in North Africa. Details on these producers can be found in IEA (2014a, p.122). IEA EU Gas Flows Data are used for import calculations.

[24] These calculations are based on IEA EU Gas Trade Flows. EU aggregates are based on figures for regasification terminals in Belgium, France, Greece, Italy, Lithuania, Netherlands, Portugal, Spain and the UK. When adding Turkey imports between 2010-2013 decrease by 52% instead of 49%.

[25] At the time of writing Asian prices have fallen below British levels for the first time since 2010 (4 February 2015 | Ed Cox, ICIS Editor, Global LNG Markets).

At these price levels, arbitrage opportunities favouring cargo diversion to Asia have decreased levelling the ground for competition between these two regions. Figure XVIII in Section III represents the evolution of LNG spot prices by region.

FIGURE IX: PIPELINE IMPORTS TO THE EU BY SUPPLIER, 2009-2014 (MCM/MONTH).



Source: IEA - Gas Trade Flow in Europe.

Decreasing EU natural gas demand has resulted in another particularity of European LNG trade. As pipeline imports have been sufficient to satisfy demand, more expensive LNG has been reloaded at EU terminals to be shipped to higher priced markets. In 2013 LNG re-exports represented about 15% of total LNG imports to Europe (see Figure XLII in Section VIII). This trend is relevant for security of supply as EU re-exports can result in additional supply volumes in the event of shortages from other providers. Section III quantifies these volumes as part of LNG imports available in the event of a disruption.

EU dependence on Russia on the rise

At the same time EU supply sources have decreased, Russia has increased its exports to the continent gaining a larger presence in the continent's gas mix[26]. During 2013, Russian pipeline transit to Europe (excluding Turkey) amounted to **127,4 bcm**, which represents a 17% increase compared to 2012[27]. The upward trend is partially explained by the added capacity of the Nord

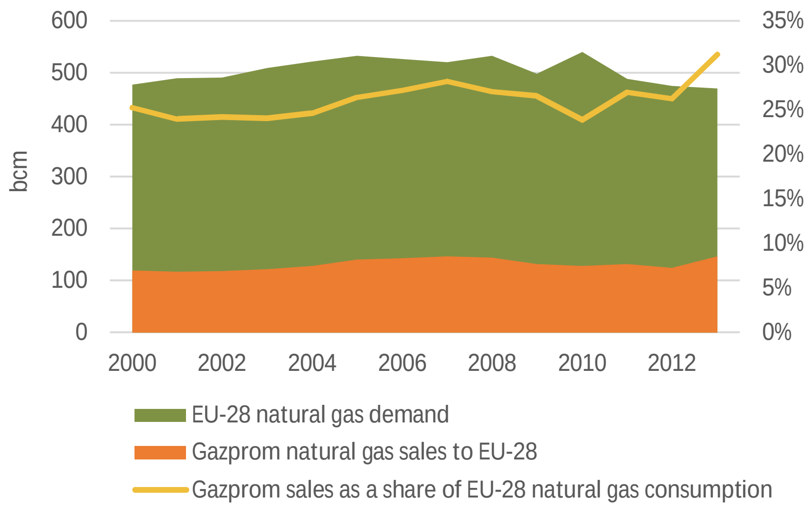
[26] The increase of Russian imports in 2012 and 2013 is partially due to the successful renegotiation of oil-indexed TOP contracts by several big mid-streamers.

[27] These figures refer solely to transit data and are based on IEA EU Gas Trade Flows. For this calculations, transit to Turkey is not considered (this includes both exports via Blue Stream and also transit crossing from Bulgaria to Turkey). Gazprom's sales to EU-28 are larger than

Stream[28] (see the part on reverse flows on Section X). During 2014 imports from Russia continued to increase in the first half of the year but later decreased in the second half.

When looking at aggregated levels, the weight of Russia as a gas supplier to Europe has increased. EU demand has decreased in the 2009-14 period at the same time Russian gas sales have increased. As a resulted, imports from Russia have come to represent a larger share total EU consumption. Figure X represents this evolution. In 2013 the share of Russian gas as part of total EU demand peaked at 29% although changes in the second half to 2014 will bring down this figure. During 2013, **gas-transiting Ukraine represented 14% of EU-28 total gas consumption**[29]

FIGURE X: NATURAL GAS DEMAND EU-28 AND GAZPROM SALES TO EU-28, 2000-2013 (BCM)



Source: EU demand is aggregated as following indications in Figure I. Gazprom sales in Europe are compiled following the company's factbooks (Gazprom 2005; Gazprom 2006; Gazprom 2011; Gazprom 2014). Figures are in Appendix III.

From a security of supply perspectives there are two complementary trends at play. On the one hand Europe has greater security of supply due to larger spare, but on the other, its reliance on a single supplier has also increased.

these transit flows. In 2013 sales amounted to 135,2 –EU bcm- (Gazprom, 2014). The difference (7,8 bcm) can be due to the company's participation in gas trade in the EU together with additional trade flows from storage that do not necessarily have crossed borders to the EU during 2013. Appendix III has a table representing Gazprom sales to Europe in the 2010-13 period.

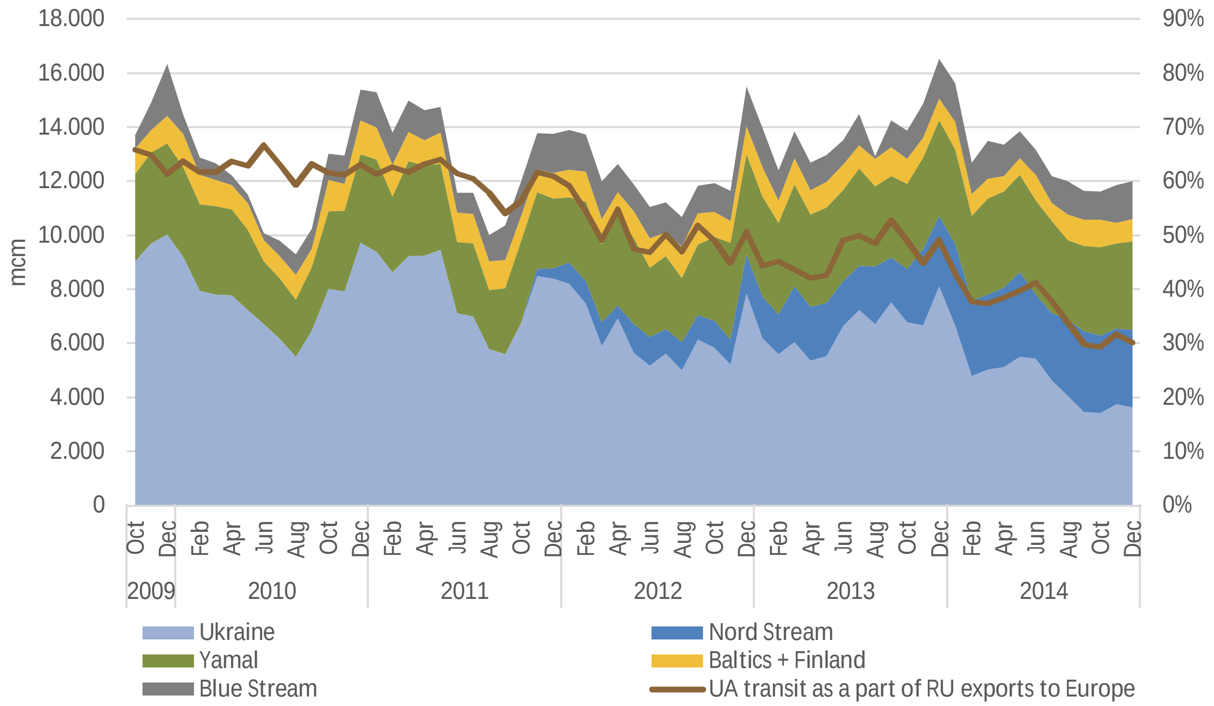
[28] Section XI examines in detail regulatory issues on Nord Stream and OPAL. In 2012 Nord Stream's second line was commissioned such that total capacity amounts to 55 bcm/y.

[29] The 14% figure is the result of comparing total EU-28 natural gas demand for 2013 with imports transiting Ukraine to the EU through Poland, Slovakia, Hungary and Romania. Transit from Bulgaria to Turkey is discounted from Ukrainian flows as these exports transit the EU but later exit to Turkey. Without discounting these volumes, transit through Ukraine to Europe represents 16% of EU-28 consumption.

Re-routing Ukrainian transit:

At the same time Russian exports to Europe have increased, gas transit through Ukraine has decreased at a steady pace to record minimum levels in 2013-14. According to Naftogaz, Ukrainian transit to Europe (Turkey included) peaked in 2005 at **121.5 bcm**[30]. This figure increases to 137 bcm when including transit to CIS countries. According to IEA figures, during 2013 transit through Ukraine to Europe amounted to **65.5 bcm** (**78.4 bcm** if we include volumes later transiting from Bulgaria to Turkey). This represents a **50% decrease compared to 2005** with Gazprom stating plans of continuing this reduction in 2014 to a minimum of 60 bcm[31]. So far, data from IEA suggest this decrease is even greater. Figures from 2014 show that transit through Ukraine to Europe amounted to **44 bcm** (**57 bcm** if we include volumes to Turkey crossing from Bulgaria)[32]. The recently announced Turkish Stream (see Box IV) will serve to re-route the approximately 14 bcm/y that transit to Turkey through Ukraine. Figure XI below represents Russian transit by route and pictures the share Ukrainian transit as part of total imports to Europe and Turkey.

FIGURE XI: RUSSIAN PIPELINE EXPORTS TO EUROPE AND TURKEY BY ROUTE, 2009-2014 (IN MCM/MONTH)



Source: IEA Gas Trade Flows in Europe (http://www.iea.org/gtf/index.asp). Data is aggregated by route. Ukraine includes Hungary (Beregdaróc IP), Romania (Isaccea IP) and Slovakia (Velke Kapusany). Yamal includes delivery at Kondratki, Wysokojei and Drozdowicze).

[30] Figures are published by Naftogaz and can be retrieved at: http://naftogaz-europe.com/article/en/NaturalGasTransitviaUkraine

[31] Gazprom's projections at the beginning of 2014 looked at export figures to the EU 'no lower' than 155 bcm (http://www.interfax.com/newsinf.asp?pg=5&id=475332). Transit through Ukraine was previewed to decrease to 60 bcm during the same year {Pirani:2014vj p.13}

[32] Some figures for 2014 IEA data are temporarly, this is specially the case for Romania in the month of November.

It is relevant in this evolution how an initial share of **60-70%** during 2009-11 decreased to **50-60%** in 2012-13, and has dropped to **25-45%** in 2013-14. **European dependence on Russian imports has increased in the 2012-14 period at the same time that Russian dependence on Ukrainian has bottomed**. In the short and mid-term, neither of these two relationships can be cancelled. Several remarks are pertinent regarding these transit figures through Ukraine.

First of all, transit through Ukraine does not only include Russian gas but also small volumes of gas from Kazakhstan purchased by Gazprom and sent through Ukraine to Europe[33].

Second, the influence of Nord Stream is key for understanding the evolution of transit through Ukraine. The first line of this route was commissioned in in 2011 (27 bcm/y) and a second line was commissioned in 2012 (totalling 55 bcm/y). The pipeline is part of Russia's efforts to side-line CIS transit both through the North (e.g. Nord Stream) and through the South (e.g. South Stream). While Nord Stream has been commissioned, the South Stream project was abandoned in December 2014. The construction of this route would have rendered Ukrainian transit marginal. According to calculations below, a minimum of 44 to 70 bcm/y of Russian gas has to transit Ukraine at current supply conditions. With a total capacity of 64 bcm/y, South Stream would have cancelled Russian dependency on this route (see Box IV).

Finally, Russian transit through Ukraine is based on contracts signed in 2009 for the 2009-19 period[34]. These agreements include addendums, the last one from the gas winter package signed on 31 October 2014 (see Section XII on Ukraine).

Can Russia side-line Ukraine?

Russia's pipeline export capacity to Europe is limited to 229.7 bcm/y according to capacities in entry points in interconnectors to Europe. These volume results of adding up the following routes:

- **55 bcm/y** transiting Nord Stream.
- **33.7 bcm/y** transiting Yamal Europe[35].
- **16 bcm/y** transiting Blue Stream.
- **120 bcm/y** transiting Ukraine (although capacity could decrease to 100 bcm/y for as soon as 2015[36]).
- **5 bcm/y** to Finland and the Baltic region[37].

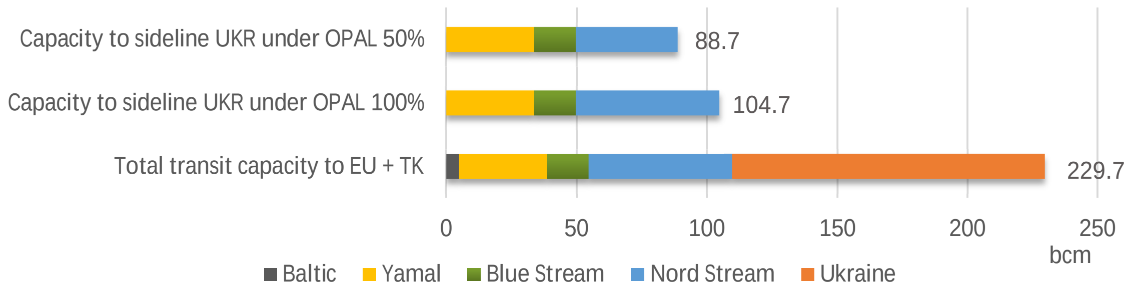
When considering a disruption in Ukrainian transit, pipelines supplying Finland, Estonia, Latvia and Lithuania have to be counted out, as they are not connected to countries supplied through Ukraine. This leaves **224 bcm/y** of Russian pipeline export capacity to the EU. Subtracting

[33] Henderson (2014) provides further analysis of this transit (Chapter 14)
[34] Yafimava (2011) provides an extensive analysis of the legal dymension of natural gas transit through Ukraine
[35] This leaves out the Wysokoje IP with additional 5.3 bcm as the key IP to consider here is Mallnow in the German - Polish border.
[36] Lack of investment could result in the reduction of further transit capacity over the 2010s (Henderson & Pirani 2014, p.80)
[37] This route includes the following IPs: IP Imatra - 249 GW/d (8.2 bcm/y); IP Narva - 5 GW/d (0.1 bcm); IP Värska - 200GW/d (6.5 bcm/y) and IP Kotlovka - 323 GW/d (10,62 bcm/y)

Ukraine's transit capacity, Russia is left with a total pipeline export capacity to Europe of **104 bcm/y** through Nord Stream, Yamal and Blue Stream.

This number has to be further revised according to current EU regulation under which Gazprom is only allowed to access only **50% of OPAL's** interconnection capacity at Brandov IP (in the border between Germany and the Czech Republic). Both OPAL and NEL pipelines receive gas from Nord Stream at its landing point in Germany. The EC was examining a TPA exemption that Gazprom dropped in 2015. The available capacity available to be shipped through Nord Stream comes down by **16 bcm/y** from its plate name capacity (corresponding to the 50% limitation at the Brandov IP). The implications of this regulatory process for security of supply are assessed in Section XI of this study. Altogether, this renders a total of **88 bcm/y** the capacity available for Russia to side-line Ukraine. Figure XII below represents total transit capacity to Europe and selected routes available for re-routing Ukrainian transit.

FIGURE XII: RUSSIAN TRANSIT CAPACITY TO EUROPE, 2014 (BCM/Y)



Source: Authors' own calculations

Given Russia's total transit capacity to side-line Ukraine, non-delivered gas volumes in the event of a full disruption through Ukraine depend on the duration of the interruption and the volumes expected by customers. Basic calculations can be made subtracting 88-104 bcm/y of available re-routing capacity, to expected volumes to EU customers and Turkey (excluding Baltics and Finland). These volumes can be historical or future estimations. The result of this operation renders the quantities Russia is not be able to deliver to the EU and Turkey (Baltics and Finland excluded) given limitations in transit capacity.

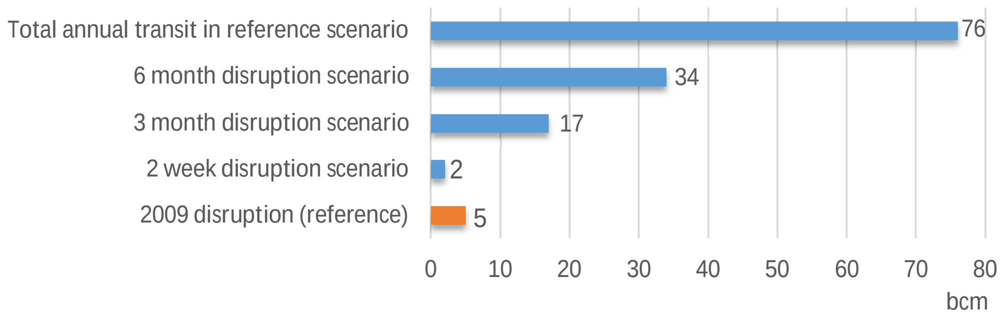
In terms of spare capacity available for re-routing transit, both Blue Stream and transit lines through Belarus are used at full capacity during the winter offering little spare capacity during this part of the year[38]. Nord Stream can accommodate larger volumes although its total capacity at the time of writing is reduced under current TEP regulation.

[38] IEA (2014a, p.141)

Non-delivered gas in modelled scenarios

Results from the gas TIGER model show disruption quantities in the various modelled scenarios and can be seen in Figure XIII below. These figures correspond to transit through Ukraine in several scenarios and refer to quantities that would not cross through this route to Europe. In the reference scenario transit through Ukraine amounts to **76 bcm/y.**

FIGURE XIII: NON-DELIVERED GAS VOLUMES IN TIGER MODEL SCENARIOS (BCM/Y)



Source: Author's elaborations

SECTION III: ALTERNATIVE SUPPLIES

Alternative supplies to the EU in the event of an interruption in Ukrainian transit can come from various sources. This section looks at additional supplies different from Russian pipeline imports, to assess the quantities Europe could have at reach to substitute non-delivered volumes. Although figures are calculated on a year basis (see Figure XIV), a full year interruption is the least probable of all scenarios considered. For shorter periods of time Europe has large volumes of gas in storage in addition to alternative Russian routes that can partially compensate non-delivered gas through Ukraine[39]. Modelling results from a 2-week disruption suggest that missing gas during such a period would vary between 2,4 – 2,9 bcm (see Figure XXVIII), far below from the 5 bcm of non-delivered gas in 2009, and far below then the additional 10 bcm Europe holds in storage compared to any previous peak storage levels in any previous year. As most of the infrastructure in place is prepared to serve much higher demand levels, Europe is in a moderately safe position to guarantee supply. A rather different situation would result if infrastructure was being fully used as it was the case in 2009. Under such a scenario, Europe would still be better off (mainly due to additional import capacity –e.g. Nord Stream– as well as additional cross-border capacity), however alternative supplies would face greater difficulties to substitute missing gas from Ukraine.

Alternative supplies considered refer all to available supplies on the short term. For this, all figures considered look at supply increments based on existing infrastructure[40]. Availability on the short run is determined by both physical capacity and market availability depending on the source examined. When looking at pipeline exports, indigenous production and storage, there are physical limitations based on infrastructure in place (e.g. transmission capacity, production rates and withdrawal rates). This is not the case for the LNG market that is primarily limited by buyers' capacity to pay market prices (e.g. ability to meet premium prices) instead of physical regasification capacity.

In the context of Europe, during a disruption the market is supposed to react first. Storage provides additional gas volumes which are 'physically held' but only served on the basis of an emergency. Finally, LNG cargoes depend on market dynamics although ToP contracts can secure firm supplies. Additional cargoes would require meeting a price tag which corresponds to the cost of SoS. If the cost is born only during a disruption, the impact on consumers is limited as it was in 2009.

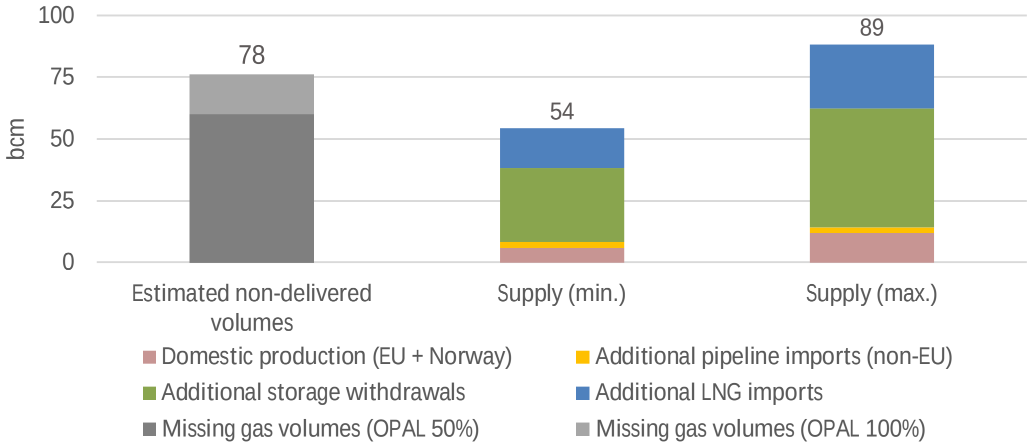
The current section explores both of these dimensions when looking at alternative supplies. According to calculations from Section II, non-delivered volumes to the EU resulting from a

[39] See modelled disruption scenarios in Section V, and modelling results for transit dynamics in selected countries during a 2-week disruption in Section VII.

[40] For a discussion on the long term alternatives to Russian gas supplies see Stern (2014).

complete disruption of Ukrainian transit are estimated between 62 to 78 bcm[41]. Estimations of alternative gas volumes available range between 54 to 89 bcm/y[42]. Figure XIV below represents these volumes.

FIGURE XIV: ESTIMATED NON-DELIVERD VOLUMES IN THE EVENT OF A YEAR LONG DISRUPTION IN UKRAINIAN TRANSIT AND ADDITIONAL NATURAL GAS VOLUMES TO THE EU, BY SOURCE (BCM/Y).



Note: See footnote 41 for calculations for estimated non-delivered gas quantities.

Source: Author's elaborations

Pipeline imports

Despite Europe being surrounded by gas reserves, the capacity to increase pipeline imports and indigenous production on the short run is rather limited[43]. Table I below summarises the estimations discussed in this section for additional gas volumes available on the 2014/15 winter.

TABLE I: ESTIMATED SHORT-TERM PIPELINE ALTERNATIVE SUPPLIES TO THE EU (2014/15 WINTER).

Source	Additional quantities
Domestic production EEA (including Norway)	0.5-1 bcm / month (6-12 bcm/y)
Pipeline (only Azerbaijan can supply additional volumes)	0.2 bcm / month (2.4 bcm/y)

[41] Non-delivered gas quantities are estimated based on Gazprom sales to the EU and Turkey in 2014 (166 bcm, see Appendix IIII). These figures are compared to available transit capacity to sideline Ukraine. The result are 78 bcm that Gazprom would not be able to ship to EU and Turkey during a year long disruption. Additionally a margin of 16 bcm is considered to show how Gazprom's export capacity to Europe would increase in the event of being able to access 100% of Nord Stream's capacity.
This calculation refers to total volumes to Europe and Turkey excluding Baltic countries (see Section II)

[42] Export information contained in this section come from IEA (2014a, p.24,69,122,139-142). It includes data for Algeria, Azerbaijan, Egypt, Iran, Libya and Norway

[43] Information for additional pipeline flexibility is based on data form the IEA (2014a, 2014b) unless otherwise pointed out.

EU indigenous production decreasing

Within Europe, only **Norway** is capable of ramping up its production on a sustained basis to meet additional gas demands. Its pipeline system operates close to full capacity and an increase is limited to **0.5** to **1 bcm** monthly. The **Netherlands** has currently limited its production in the Groningen field hence any increase is not viable in the coming years. As for the rest of Europe, decreasing production is not likely to allow any supply increases. According to the IEA, double-digit reductions have been recorded in the last years in EU indigenous production. Austria and France have seen a reduction of production of a third of its total output; Denmark around one quarter and Hungary and Turkey about one sixth. Altogether, EU production has seen a decrease from levels of 302 bcm (in 2000) to 272 bcm (in 2011) and finally 269 bcm (in 2013). For additional details, see Figure VIII on Section II.

Non-EU supplies

Outside Russia and Norway, North Africa is the closest production centre to Europe with Algeria and Libya connected via pipeline. **Algeria** has three routes together with LNG export capacity reaching Europe. In 2013, natural gas production amounted to 78 bcm. However, out of its pipeline capacity, only the Transmed route to Italy would be helpful in the event of a disruption through Ukraine. The other two routes (11.5 bcm and 8 bcm) reach Spain that is poorly connected to France with interconnection capacity adding up to 5.2 bcm[44]. In addition to limited transit capacity, Algeria has seen a decrease in its mature field (e.g. Hassi R'Mel) and is currently finding trouble attracting investment for new exploration. To this, it adds its difficulty coping with increasing domestic gas consumption. This scenario leaves Algeria in a difficult position to ramp up its exports to Europe in the short term. **Libya** on its side reaches Italy via the Green Stream pipeline which is currently not a reliable route given political unrest in the country (further disruptions could take place in the short term). Finally, **Egypt** is not connected via pipeline to Europe but it does have LNG facilities that in the past have served to supply Europe in times of gas emergency situations. An example is the 2009 crisis where Egypt served additional LNG cargoes to Greece. However, Egypt is currently undergoing political turmoil and a difficult macroeconomic situation. As a result of increasing domestic demand, LNG exports have been diverted for to its domestic market. In January 2014, BG declared force majeure suggesting that no reliance can be awaited from this source for increasing exports to Europe.

Iran is connected to Turkey via pipeline but its exports decrease in the winter in order to cope with domestic demand. Additionally the pipeline is close to its full capacity and pricing disputes with Turkey are currently ongoing.

Finally, **Azerbaijan** could provide additional supplies via the South Caucasus pipeline. Given contractual increases of deliveries to Turkey, spare capacity has been declining over 2013 and it is estimated in 0.2 bcm per month.

[44] Further information regarding the limits of ES – FR border capacity in the event of a disruption in Ukrainian transit can be checked at: http://www.euractiv.com/sections/energy/spanish-midcat-pipeline-replace-10-russian-gas-imports-301205

Natural gas storage

Storage facilities are used for seasonality and balancing purposes although they are too a key instrument in response to supply disruptions. Under an emergency event, the market is expected to respond first, however, in addition to this, storage facilities can supply emergency volumes that are physically located close to demand centres. This turns storage facilities into a quick and reliable tool to respond to supply disruptions.

Additional storage capacity in the EU

Overall EU working gas capacity varies by country. EU facilities hold capacity for up to **95 bcm** with levels of 90 bcm on 1st November 2014. Table II summarises these figures. When adding up storage capacity in Turkey and Ukraine[45] total capacity amounts to **127 bcm**. This evolution is discussed in Section VIII which looks in detail at the evolution of EU natural gas infrastructure.

TABLE II: WORKING GAS CAPACITY AND STORAGE LEVELS AS OF 1ST NOV 2014.

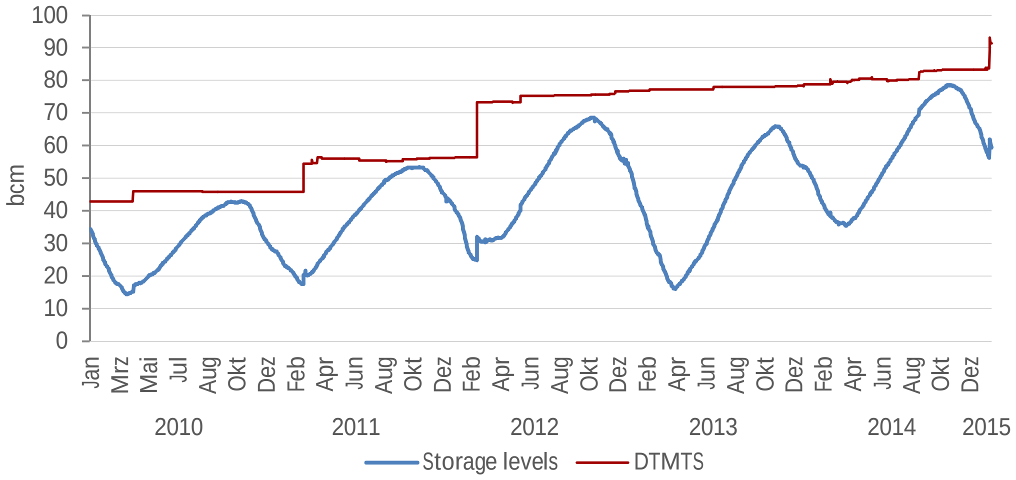
	WGV (mcm)	Levels on Nov 1st (mcm)	% on 1st Nov
Austria	4,760	4,530	95%
Belgium	700	667	95%
Bulgaria	450	395	88%
Croatia	553	515	93%
Czech Republic	3,477	3,477	100%
Denmark	998	936	94%
France	12,898	11,959	93%
Germany	21,730	20,989	97%
Hungary	6,480	4,482	69%
Ireland	230	219	95%
Italy	16,792	16,354	97%
Latvia	2,320	2,320	100%
Netherlands	5,378	5,273	98%
Poland	2,524	2,497	99%
Romania	3,100	2,945	95%
Serbia	450	428	95%
Slovakia	3,135	2,906	93%
Spain	4,103	4,103	100%
UK	4,923	4,886	99%
Total EU-28	95010.4	89887.8	95%
Turkey	1,900	1,805	95%
Ukraine	30,530	15,973	52%
Total	127440.4	107666.1	84%

Source: GSE and EWI database

45 Ukrainian storage facilities are part of the Russian transmission system and hold vast storage capacity to balance seasonal supply to Europe (see Section XII and XIII on Ukraine).

By November 2014 EU storage facilities were 95% full, which represents levels approximately **10 bcm** higher[46] compared to any previous year (based on GSE data). Figure XV below represents the evolution of storage capacity and levels in the 2010-15 period.

FIGURE XV: EU-28 STORAGE WITHDRAWALS AND TOTAL WORKING GAS CAPACITY IN SELECTED GIE FACILITIES, 2010-2015 (BCM)



Note: Levels plotted in this graph do not necessarily represent storage data for the EU (both for working gas capacity and storage levels). This is because changes in the graph depend of data being made available to the GSE transparency platform. A list of listed facilities can be found at the GSE website.

Source: Gas Storage Europe (updated as to 21 January 2015).

Several reasons come to explain this excess in gas storage. First of all, working gas capacity has increased by 27 bcm (+39%) in the 2006-13 period, from 69 bcm to 96 bcm[47]. Second the 2014 injection season (which corresponds to the summer months) already started with high working gas volumes due to a mild temperatures and low withdrawals in the 2013/14 winter (see Figure XV). So far overall mild temperatures in 2014 have contributed to keeping storage levels high (see Figure II representing natural gas demand in 2014). Thirdly, injection rates during the summer increased in response to the escalation of events in the Russo-Ukrainian conflict. Overall, as stated in Section I, this large amount of storage capacity was projected to serve demand levels much higher than current ones. A contraction in demand has greatly increased the share of available storage as part of total EU-28 natural gas consumption.

As a result, Europe had an excess of more than **10 bcm** of stored gas providing a considerable cushion for compensating any eventual shortages taking place. As a reference, the total missing gas quantities in the 2009 crisis amounted to **5 bcm** according the IEA[48]. Simulations on the TIGER Model (see Section VI) suggest a similar interruption of 2 weeks duration would result non

[46] This figure is calculated following data from the GSE transparency platform. It is an approximate figure as explained in the note to Figure XV.

[47] GIE Knowledge Centre (see Section VIII). These figures are not subject to limitations in the GSE transparency platform. For additional details see Figure XXXIX on Section VIII.

[48] IEA (2014a, p.129)

deliveries to Europe between **2,4 bcm** and **2,9 bcm** disruption. Both of these figures are relatively low when considered against the context of Europe's large storage capacities.

In addition to these 10 bcm, storage facilities can provide further emergency supplies depending on the total withdrawals during the winter season. Analysis from seasonal consumption and withdrawal volumes show that available working gas after the winter has fluctuated between 18 and 35 bcm in the 2009-14 period. Assuming the overall higher storage capacity and the mild temperatures for 2014, estimations could be made about additional 19 to 35 bcm of gas available from storage. This renders estimations of total storage volumes available for the 2014/15 winter between **29 to 45 bcm**.

Storage withdrawal constraints

There are two constraints to take into account regarding the availability of withdrawal volumes. The first one is that access to stored gas depends on withdrawal rates[49]. This problem becomes more acute as facilities are emptied because withdrawal rates decrease when storage volumes are lower. The overall pressure of facilities decreases with lower volumes in storage.

Second, storage is used on seasonal basis, which means that gas not consumed on one winter is made available for the coming cold season. An excessive use of storage can eventually ease supply over a winter but this can result in tight supply conditions for the next one if storage is not refilled during the warm season. The injection period running between April and October is designed to allow filling completely storage facilities (from 0% to 100%) to avoid any impact on future cold seasons. However, for this to happen supply needs to be available. During a prolonged disruption additional supplies to refill storage could be short. Part II of this study includes modelling results which represent these dynamics. Simulations take into account both described limitations of storage facilities.

Third, levels which are here analysed refer to storage in the EU. In the event of a disruption in Ukrainian transit it is not likely that storages in the western end of Europe will contribute to alleviating supply tightness in the East. The role of storage is explored by country in modelling results presented in Part II of this study.

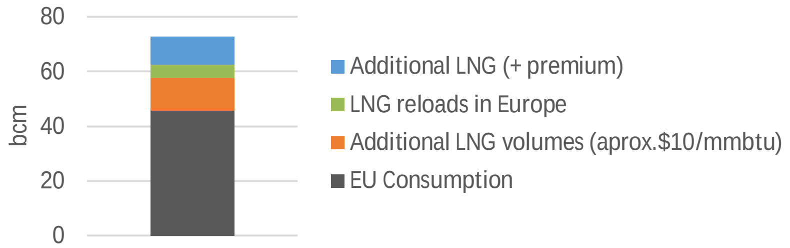
LNG imports

As opposed to supplies discussed so far, constraints on additional LNG quantities to be shipped to Europe rely on cargoes' available on the spot market. The limitation is not determined by production, transit or regasification capacity but rather by supply and demand balances in the world trade. The short term LNG market (the so called spot market) encompasses trades up to

[49] Withdrawal rates depend on storage facilities. There are works reviewing the different types of storage together with the uses different characteristics allow: Le Fevre (2013), Ramboll (2008), Energy Charter Treaty (2010).

four years that in 2013 constituted 27% of the global LNG market[50]. To estimate potentially available quantities, the analysis looks into the evolution of LNG pricing by region. The discussion is summarised in Figure XVI below with estimated additional LNG volumes ranging between **17** and **27 bcm** for the period between November 2014 and November 2015.

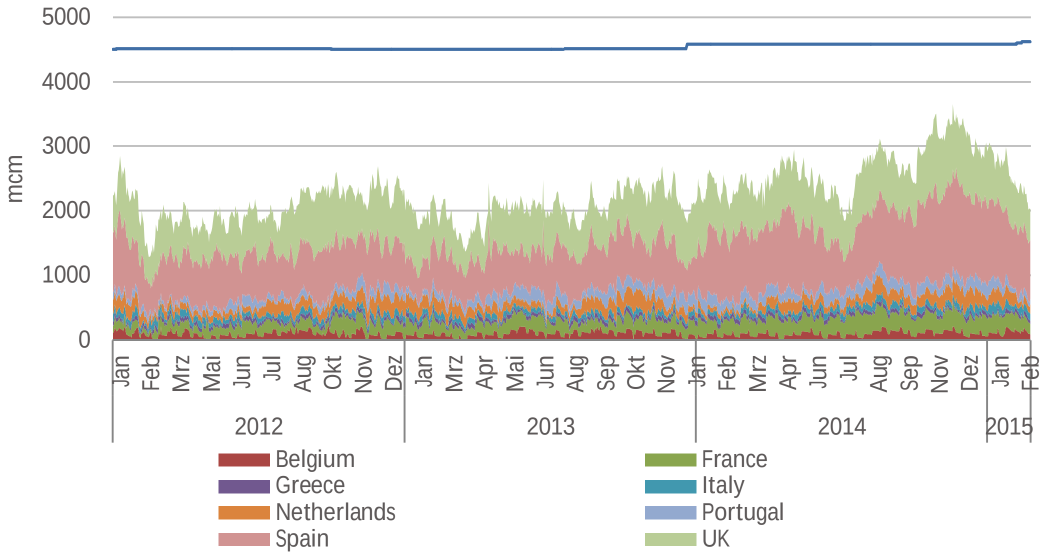
FIGURE XVI: LNG IMPORTS IN 2013 AND ESTIMATED ADDITIONAL QUANTITIES IN THE 2014/15 WINTER (BCM).



Source: 2013 LNG consumption is based on IEA Natural Gas Information 2014; IEA re-export figures are based on IEA (2014a). Additional estimated quantities are authors' calculations.

In addition to volumes available on the market, LNG regasification terminals have storage facilities that allow storing imports. Facilities in EU-28 have storage capacity amounting to 4.5 bcm (8 bcm LNG) with inventories ranging from 1.5 bcm to 3.5 bcm. In the event of a supply disruption these quantities can be immediately brought to the market. Figure XVII represents both storage capacity and inventory levels.

FIGURE XVII: LNG STORAGE CAPACITY AND INVENTORY LEVELS IN EU-28, 2012-15 (MCM)



Note: To maintain homogeneity between units, levels are presented in mcm and not in mcm of LNG as in the original source.

Source: GIE LNG Transparency Platform

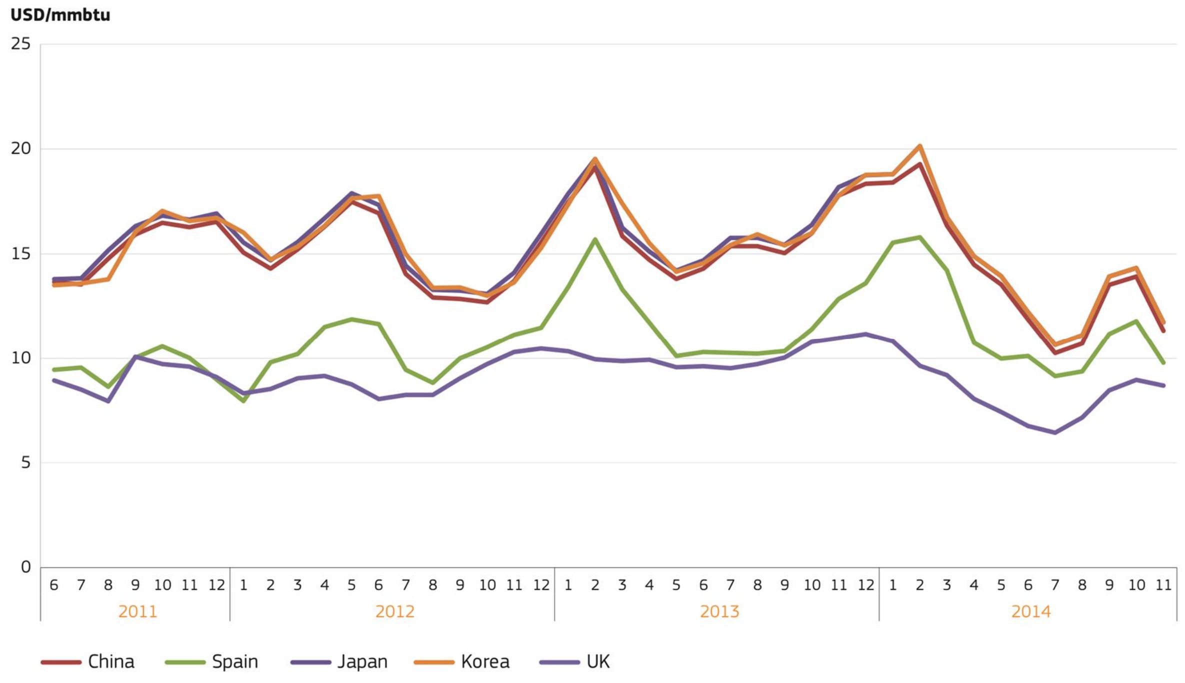
[50] The short term LNG market amounted to 88 bcm in 2013 (GIIGNL 2014, p.5)

The Asian LNG market and oil prices in 2014/15

Analyses looking at the current Ukrainian crisis have repeatedly pointed out the high price levels for emergency LNG quantities. This conclusion was correct in the post-Fukushima context with Asian prices fluctuating between NBP levels above $ 10/mmbtu and JCC levels up to $ 23/mmbtu. Market dynamics in 2014 suggest a different position for spot customers with Asian price levels dropping down to levels pre-Fukushima levels. In the first half of 2014 Asian LNG prices experienced a 50% decline dropping below $ 10/mmbtu. This price decline results from changes in LNG markets which have important implications for EU's security of supply. The following Figure XVIII represents the evolution LNG spot prices by region and pictures the drop in prices in LNG in the second half of 2014.

There are two different dynamics that have pushed LNG prices down. One has to do with LNG the evolution of LNG markets, the other has to do with the decrease in oil prices. Both of these effects are described with some detail in Box I and Box II, and they suggest a shift in the LNG market towards a buyers' market.

FIGURE XVIII: LNG PRICES BY REGION (EUR/MWH).



Source: EU Market Observatory (Thomson-Reuters Waterborne)

Box I: LNG prices moving downwards in 2014/15

Spot dynamics in LNG markets have shifted in 2014 bringing prices to pre-2011 levels. The trend has important implication for EU natural gas supply generally allowing greater flexibility. As LNG is a tool for security of supply this turn is likely to increase the availability of LNG cargoes at overall lower price levels. As opposed to the 2011-14 period, this makes LNG an important source for alternative supplies, both in the event of a disruption and later to refill storage levels during the summer months.

Spot LNG prices are represented in Figure XVIII. After the Fukushima accident Japan increased by more than 20 bcm its LNG imports pushing up Asian prices that have ever since remained between $12-20/mmbtu. During the end of 2014 and 2015 Asian spot prices have come down to $9-10/MMBtu and EU levels have seen an average between $3 and $4/MMBtu lower the levels one **year back.** The decrease is the result of overall stabilising consumption in China and Japan and Korea being served on the basis of long-term contracts. No additions in supply capacity have been added in the year with the exception of the New Guinea LNG.

These levels might be sustained in the short and medium term. Japan's gradual nuclear restart is likely to displace spot cargoes at the same time new LNG upstream capacity is coming online from the US and Australia starting on 2015. By 2017 Australia could ramp up its production by 85 bcm/y[51] while the US 40 bcm/y have achieved FID with 23 bcm/y under construction[52]. In addition, Russia has a substantial deal with China on pipeline deliveries of 68 bcm/y from the end of the decade which can add further pressure on LNG.

Implications for security of supply

Low LNG prices are expected to reduce market tightness creating greater flexibility for importers. European buyers, who previously had access to less LNG quantities, will have access to larger LNG volumes and at lower prices. After Fukushima, arbitrage opportunities made the Asian market more lucrative for sellers. With the drop in Asian prices this situation is likely to even out competition between regions. This results in larger volumes available for Europe on the basis price convergence.

Additional LNG quantities are difficult to determine as this depends on the evolution of the market. Under current conditions close to $10/mmbtu consulted analyst have suggested a twofold trench for additional supplies consisting of a +10 bcm at close to market prices and a second +10 bcm at a variable premium. Beyond these levels additional LNG quantities would require overbidding other customers. Finally, not only available volumes will be larger, but also

[51] For a discussion on the future of Australian LNG natural gas exports see IEA (2014a) and Ledesma (2014)

[52] Data as for September 2014. Additional information can be found at: http://www.timera-energy.com/uk-gas/this-is-no-ordinary-fall-in-global-gas-prices/

prices will be lower for these quantities. In this regards, security of supply by LNG is likely to cost less to EU customers in the near future and also in the event of a disruption.

When quantifying these quantities it is also important to take into account volumes that were previously being re-exported out of Europe. In 2013 this practice represented 15% of EU imports amounting to 5 bcm (see Figure XLII). These volumes could be available to Europe if needed.

Box II: Oil prices and the spill over effect to LNG markets

During the second half of the 2014 oil prices moved to a downward trend that has continued on to 2015 without great expectation of recovery in the short term. This shift will affect the world economy and has immediate effects on Europe's gas supply.

Between 2010 and mid-2014 oil prices had been stable at levels above $110/bbl. The decrease that started in July 2014 has sent prices below $50/bbl for the first time since May 2009. In November 27th OPEC failed to reach an agreement on production caps sending the price further downwards. Besides this inability to limit production there is some consensus regarding the reasons behind this drop. Basic supply and demand equilibriums point at an excess of supply mainly driven by the increase in US domestic production taking place simultaneously with a decrease in its domestic demand (partly due to increases in efficiency). Crude previously being sent to the US (e.g. Saudi, Nigerian and Algerian oil) is now competing in Asian markets creating a downward pressure. This trend is further accelerated with additional supply being added in the last years (e.g. Canada, Iraq and Russia).

The shift has different implications for both producers and consumers and will spill over to other commodities such as steel, coal and also natural gas. Regarding the latter case the transmission is takes place by means oil-linked contracts. Dynamics are different for both Asia and Europe[53]. In the case of Asia, the majority of LNG contracts are long-term and are indexed to oil. There are two delays for oil prices to reach LNG First, the JCC index (Japan custom-cleared), to which Asian LNG is often linked, follows oil prices with a 4 to 6 week delay. In addition, LNG contracts follow this market typically with a 3 month delay. As a result, levels of $50/Bbl will result in typical long term Asian LNG prices between $8 and $8.50/MMBtu in May 2015. This levels are half the average during the 2012-14 period.

In the case of Europe this effect is marginal as LNG indexation is lower than in the Asian market. LNG prices are decoupled from oil as a result of contracts netbacked from hub prices (NBP and the Netherlands TTF). For these contracts indexed to oil, there is generally a delay from 6 to 9 months that will result in lower price levels in Europe in the second half of 2015.

[53] Andy Flower provides an anaylysis of the challenges ahead for the LNG industry in 2015 and covers these issues: http://lnghub.biz/2015-will-be-a-year-of-change-for-the-lng-business/

Infrastructure constraints

Several constraints must be taken into account when relying on LNG for security of supply. First, despite the excess of regasification capacity, these terminals are not located close to countries being served through Ukraine. In the event of a disruption, countries in East and South East Europe would not be able to fully substitute non-delivered gas with LNG imports. Greece is the sole country supplied by LNG that additionally consumes large volumes of gas that transit through Ukraine. A major part of Europe’s regasification capacity is located in the Atlantic coast (e.g. Italy, Belgium, France, Netherlands, Spain and the UK) and bottlenecks in the EU network prevent full send-out capacity being transmitted eastwards[54].

Second, supplies in times of severe weather conditions are not fully guaranteed. During cold spells, when dependency on additional gas supplies is greater, LNG cargoes can face difficulties for unloading gas at terminals. Such was the case of the 2012 cold spell when bad weather conditions prevented cargoes from docking in Italian LNG terminals[55].

Third, there is a time lag to consider before cargoes can arrive once they have been called. A ship departing from Qatar takes 13 days to arrive to Spain and 15 to the UK. Often there is floating storage and diverted cargoes that can shorten up this time, but availability depends on market rigidity. These limitations are considered in the TIGER Model for all proposed scenarios.

[54] See CEER’s (2015) presentation for the 2015 Madrid Forum For Gas on ‘The role of LNG in the security of supply context’.
[55] See GLE (2012) for a review on the contribution of LNG to SoS conditions during a cold spell.

SECTION IV: COUNTRY DEPENDENCE ON UKRAINIAN TRANSIT

So far Section I, Section II and Section III have analysed dependence on Ukrainian transit and additional available supplies for the whole of Europe. However, reliance on this route is not uniform throughout Europe. The following section distinguishes the different degrees of exposure MSs have within Europe. By doing so it presents the particularities of this dependence to unveil its regional dimension. Only EU countries with some proximity to Ukraine would be directly affected by interruptions in the route.

According to analyses in this section, MSs with the greatest exposure to supply shortages the event of a disruption in Ukrainian transit are few, and only **Bulgaria** is both heavily dependent and unable to substitute imports transiting Ukraine. Out of the six largest EU gas markets, only Italy has large share of gas being supplied through Ukraine as part of its supply mix. **Greece** and **Slovenia** do not fulfil the N-1 standard but it is not in regards to gas transiting Ukraine. Other countries such as **Hungary**, **Czech Republic** and **Slovakia** are largely supplied through Ukraine but have alternative capacity to substitute these imports. In addition to EU-28, during the 2009 Ukrainian crisis, the emergency was more acute amongst Balkan countries. **Serbia**, **Macedonia** and **Bosnia Herzegovina** remain to be greatly exposed to Ukrainian transit[56] although they are not represented in neither the N-1 nor the SCI analysis in this section.

To assess country specific dependency on Ukrainian transit several security of supply indicators are used. Later on, Section VII will come back to these analyses to present modelling results from the TIGER Model for countries more exposed to shortage risks. These include transit dynamics, supply alternatives and shortages during a 2-week disruption.

Ukrainian transit by country of destination

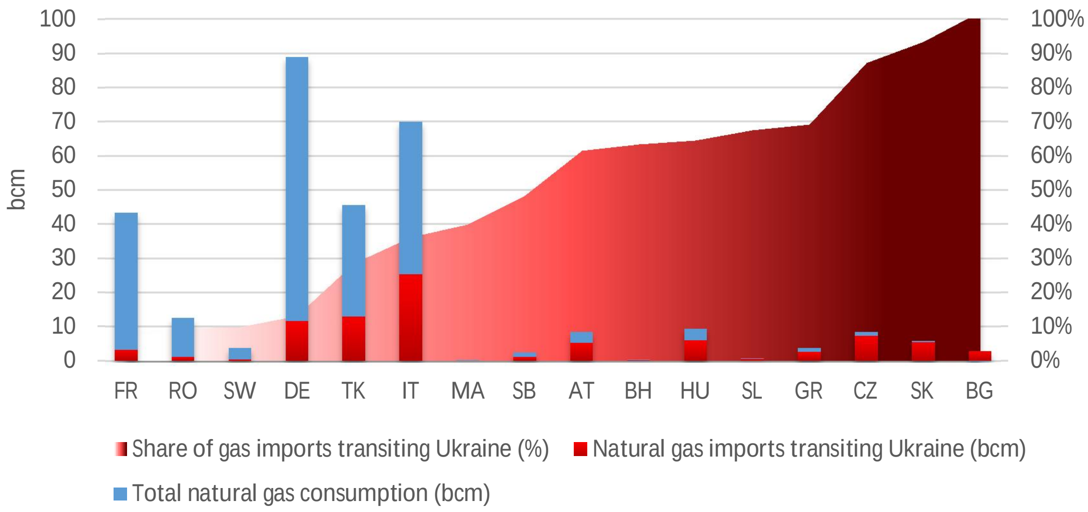
An analysis looking at the final destination of Ukrainian transit allows identifying countries importing this gas. Figure XIX below represents Ukrainian imports by country and compares these figures with total gas consumption. Countries aligned closer to the right axis have a larger share of natural gas transiting Ukraine in the supply mix.

The ratio between gas imports transiting Ukraine and total gas consumption is similar to the SCI index that is used in Figure XX. Countries can be grouped in three different categories depending on the share gas transiting Ukraine represents as part of their supply mix:

[56] See Section VI for additional information on the 2009 disruption.

- **Below 30%** (France, Romania, Sweden, Germany, Turkey and Italy).
- **Between 30%-60%** (Macedonia, Serbia, Austria, Bosnia Herzegovina, Hungary, Slovenia and Greece);
- **Above 90%** (Czech Republic, Bulgaria and Slovakia).

FIGURE XIX: UKRAINIAN TRANSIT BY COUNTRY OF DESTINATION AND SHARE OF TOTAL NATURAL GAS CONSUMPTION 2013 (BCM)



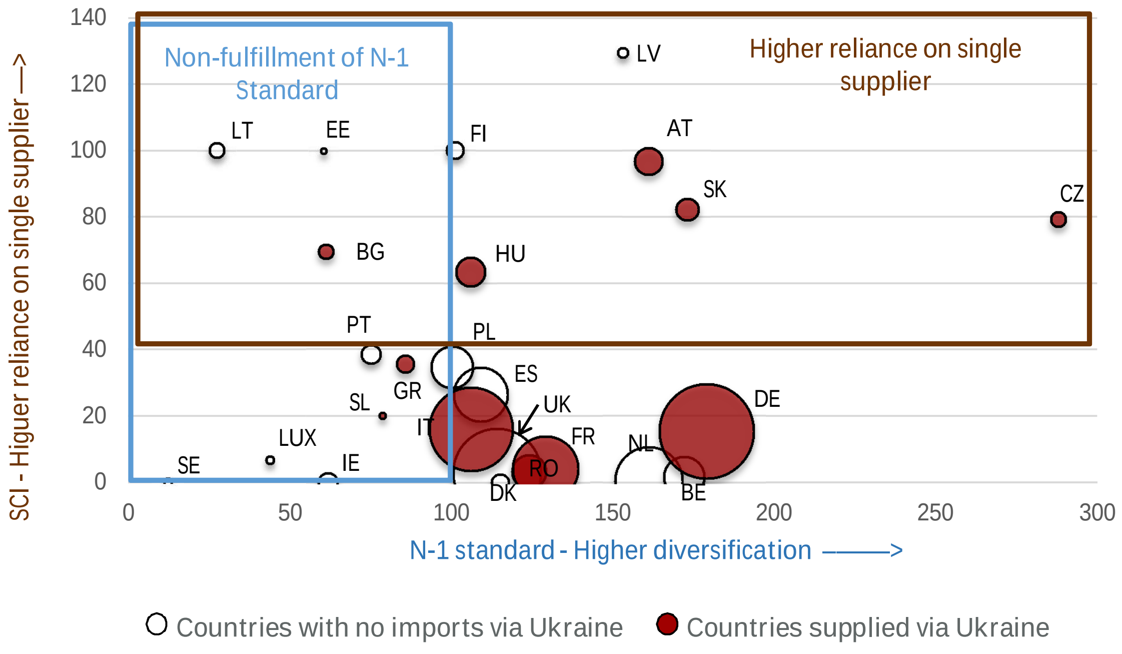
Source: Data for Ukrainian imports by destination is based on calculations by Pirani et al. (2014, p.8). For OECD-EU demand figures IEA Natural Gas Information are used. Eurostat data [nrg_124a] is used for non-OECD-EU

Import dependency and diversification indicators

Countries identified as importers of gas transiting Ukraine are further analysed in terms of dependence from this route. For this the Country-Specific Supplier Concentration Index (SCI) and the N-1 standard provide a complementary measure of dependence[57].

[57] Additional information on the SCI and the N-1 standard can be found on European Commission(European Commission & European Commission n.d.), Bolado (2012), Kopustinskas (2012)

FIGURE XX: EU-28 DEPENDENCE ON NATURAL GAS IMPORTS TRANSITING UKRAINE, 2013



Note: Bubbles are proportionate to markets' size in 2013 following data in Figure I.

Source: SCI Index and N-1 Standard data come from the European Commission (2014b). Data for country bubbles is compiled following aggregated data as noted in Figure I.

Values from the SCI index[58] allow identifying countries with a high reliance on a single supplier. In order to assess the implications for security of supply these values have, these figures have to be crossed with a measure of diversification. Often countries can import a great share of their gas from a single route showing high SCI values. Such is the case for Slovakia and the Czech Republic. However these imports should not be counted as a high level of dependency as they can often be substituted. To differentiate between countries able and not able to diversify imports from one particular route, the N-1 standard measures the capacity of a network to substitute supplies[59].

The N-1 standard has been adopted under EU Regulation to assess MSs' exposure to gas shortages as part of the EC's efforts to increase security of supply (see Section VI on Regulation 994). Countries outside the EU-28 group and part of the Energy Community Treaty have also conducted analysis to assess the adoption of the standard as part of their energy security

[58] The SCI allows quantifying the diversity of suppliers in a given network. The indicator is based on a Herfindahl-Hirschmann index (HHI) and is computed as the sum of squares of the quotient of net positive imports from a partner to an importing country (numerator) and the gross inland consumption of that fuel in the importing country (denominator). The index varies between 0 (indicating no imports) and 100 (indicating that all gas consumption comes from a single supplier). In selected countries this source is Russia, and given their position in the EU networks, the index most likely computes imports transiting Ukraine. Smaller values indicate greater diversification, hence lower exposure to gas shortages in the event of a disruption through this supply source. Values beyond 100 indicate large gas flows not necessarily linked to demand supply (e.g. transit or storage flows in the cases of Austria, Czech Republic and Latvia).

[59] The N-1 infrastructure standard measures a networks capacity to cope with the technical disruption of the largest infrastructure. This does not imply that additional volumes will be available at alternative supply points. An LNG regasification facility can compute as a supply source to substitute gas volumes from the main network infrastructure. However, this does not mean that LNG imports will be available in the event of a disruption.

strategies[60]. Section VII of this study looks with additional detail regulation concerning the adoption of this indicators as part of EU sectorial standards. This standard measures the degree to which a MS (or a regional network) can stand the interruption of its largest network infrastructure. It therefore quantifies diversification capacity by measuring available infrastructure to substitute supplies from a selected route or supplier. Failure to meet the standard implies excessive dependence or/and insufficient diversification, although fulfilment does not imply that gas will be available to be supplied through infrastructure in place. An inquiry conducted be the EC in 2013[61] revealed 16 MSs complying with the N-1 standard in 2012 and Bulgaria, Greece, Lithuania, Estonia, Poland, Slovenia, Sweden, Ireland, Luxembourg, and Portugal not doing so. Out of this group, the only country with insufficient capacity to substitute imports transiting Ukraine is **Bulgaria**. In the case of **Greece** the N-1 standard applies to its LNG facilities

While the SCI indicator measures the degree of dependence on a single supplier, the N-1 standard measures the capacity to substitute these volumes. Both indicators complement each other quantifying both the reliance on a source and the capacity to substitute it. They are represented in Figure XX. The graph plots both the SCI (y-axis) and the N-1 standard (x-axis) and represents countries in proportion to the size of their domestic gas market. Countries represented in red are those importing gas through Ukraine, with the rest importing no gas or negligible quantities through this route. Four conclusions are worth pointing out in regards to transit through Ukraine:

First of all, **among Europe's largest consumers only Italy is reliant to a large extent on Ukrainian transit**. As shown in Figure XIX, Italy is the largest importer of Ukrainian gas (25 bcm in 2013 amounting to 36% of its natural gas consumption[62]) however it counts with sufficient supply diversification to fulfil the N-1 standard. It is the only market out of Europe's largest natural gas consumers that relies on Ukrainian gas for more than 30% of its gas supply. The rest (e.g. Germany, UK, Italy, Netherlands, France and Spain) are well below these levels and only Germany imported more than 5 bcm in 2013 (11% of its total gas consumption). The UK[63], Netherlands, France and Spain import none or close to no gas transiting Ukraine. EU's largest gas markets either import little quantities through Ukraine or none.

Second, countries a large share of gas imported via Ukraine as part of their total are all **small gas markets with annual consumption below 10 bcm/y**. They are represented in the top half of the chart (indicating higher SCI values): **Bulgaria, Hungary, Austria, Slovakia and Czech Republic**. Other countries with high SCI values are Lithuania, Latvia, Estonia and Finland, but these are not supplied through Ukraine. In addition Poland is largely supplied by Russia although only marginally through the Ukrainian corridor. Added up, the total gas consumption in

[60] The study is financed by the Energy Community (Energy Institute Hrvoje Pozar,Energy Community 2013).
[61] European Commission (2014b)
[62] Regarding Italy's position in the SCI axis (Figure XX), note that it's lower then it should be according to its 36% dependence on Ukrainian transit. This is because Russian imports increased by 10 bcm between 2012 and 2013. SCI figures represented in the graph are from 2012, hence they do not take into account this increase.
[63] Gazprom has natural gas sales to the UK amounting to 16.5 bcm in 2013 (Gazpromjob 2014), (12.5 according to other sources - (Henderson & Pirani 2014, p.51)) however, analyst suggest it is very unlikely that this represents gas volumes being exported from Russia to the UK (Stern et al. 2014).

countries with high SCI values because of gas supply from Ukraine had a total aggregated capacity of 42 bcm in 2013. This does not mean Ukraine fully satisfied this demand, but it gives an idea of the proportion of the EU gas sector showing greater exposure to Ukrainian transit. This segment is similar to Europe's fifth natural gas market (e.g. France). The SCI methodology has been also used by the OIES to measure non-EU countries being supplied through Ukraine[64]. Results for 2013 indicate the total dependence on this route is high for **Bosnia & Herzegovina** (SCI: 100) and **FYROM** (SCI: 100) and also for **Serbia** (SCI: 56.47) and to a lesser extent, **Turkey** (SCI: 38.36).

Third, out of EU-28 countries importing a large share of gas through Ukraine, **only Bulgaria is has insufficient capacity to substitute these volumes** according to the N-1 standard. Although several countries have high SCI values (e.g. high dependency on a single supplier), not all are equally exposed in the event of a disruption. Some of these countries have large diversification capacity and are able to substitute imports transiting Ukraine. This is the case of **Austria,** the **Czech Republic**, **Hungary** and **Slovakia** which fulfil the N-1 standard.

Finally, looking at all identified countries showing greater exposure, it is important to point out that the risk of supply disruptions resulting from interruption in Ukrainian transit is **regionally concentrated**. Dependence on this route is a **regional phenomenon** not affecting the whole of the EU. This is important for at least two reasons. First of all, LNG terminals are too a regional phenomenon in Europe with most of regasification capacity built in the West end of Europe (e.g. Belgium, France, Italy, Netherlands, UK and Spain). Because of this, the complementarity between both LNG and Ukrainian imports is rather limited. Second, public expenditure is dedicated to increasing energy security in Europe (this is reviewed in Section IX on regulation). When looking at these budgets, often aiming at increasing diversification vis-à-vis Ukraine, it is important to bear in mind the limited exposure EU has as a whole to Ukrainian transit.

[64] Stern (2014)

CONCLUSIONS

Ukraine is Europe's largest natural gas supply corridor with approximately 120 bcm/y of transit capacity. While volumes have been on constant decrease they are by no means neglectable nor cancellable on the short-term. In 2013 transit crossing to the EU amounted to 78.4 bcm (12,9 bcm later exited to Turkey) and in 2014 these figures dropped 27% to 57 bcm (1.7 bcm later exited to Turkey). Overall Europe is capable of substituting these volumes on the short-term while on the long-term they result on shortages as simulations in Part II of this study show.

Europe has four supply sources that can potentially contribute to substituting non-delivered gas volumes in the event of a disruption through Ukraine: indigenous production, pipeline imports, storage and LNG imports. Indigenous production is on decline since it peaked in 2002, but the remaining three sources can potentially substitute missing deliveries through Ukraine in the event of a total shutdown.

Regarding pipeline transit, additional exports to Europe are limited to Russia and Norway, and only the former is capable of substantially ramping up its deliveries to Europe. This can be done mainly through the Nord Stream pipeline that was commissioned in 2012. Storage and LNG can serve additional volumes in the event of an emergency. Regarding the former, Europe has large working gas capacity, however current levels are not sustainable and will decrease as storage facilities are facing adverse market conditions. On the other hand, LNG imports can currently provide additional gas volumes as markets are oversupplied. However, this was not the case for the last three years. This leaves Russia as the most reliable option to provide additional gas volumes in the event of a disruption in Ukrainian transit. Paradoxically, when Russia cut gas to Ukraine in 2014, Europe became Ukraine's supplier of last resort. This comes to show the complex relations between these three actors.

Overall, Europe's increased security position is guaranteed by additional import infrastructure with Russia (e.g. Nord Stream), favourable LNG market conditions and large storage capacity. These conditions have partially been determined by a decrease in demand that was not widely expected previous to 2009. This results in large underutilised capacity which comes to play the part of spare capacity to deal with any supply disruption. It must be noted that as opposed to spare capacity, unutilised capacity is not paid for, hence it is not sustainable on the long-term. This is an important point to take into account when looking at Europe's security of supply in the medium to long-term.

In regard to countries showing a greater exposition to shortages, three groups can be distinguished. First, countries in the Balkan region that experienced an emergency situation in the 2009 Ukrainian crisis remain to be exposed to shortages. Second, amongst EU-28 only Bulgaria continues to have difficulties substituting imports transiting Ukraine. Third, for EU-28 MSs serving as transit countries for Ukrainian gas (Austria, Czech Republic, Slovakia and Hungary), the situation has improved since 2009. This is the result of additional border capacity implemented in the recent years that allows reverse flow to provide alternative gas volumes.

Part II: Gas market simulations

SECTION V: DISRUPTION SCENARIOS 2014/15

In order to quantify the resilience of countries against a disruption in Ukrainian gas transit with a higher level of detail, this section comprises a numerical analysis regarding a halt of Russian gas exports to and through Ukraine. Such a disruption has two immediate consequences:

- First, Ukraine itself would not be supplied with Russian gas.
- Second, major parts of usual gas transit to Europe via Ukraine is not served.

In order to quantify the effects of such a disruption on the EU gas market (including Ukraine and Turkey), we use simulation model TIGER, developed by the Institute of Energy Economics at the University of Cologne.

The TIGER model (see more details in Appendix I) is a tool to simulate gas flows in Europe accounting for over 900 pipeline segments, the European LNG import terminals and the entirety of the underground gas storages in Europe. The model aims at satisfying gas demand in 58 demand regions and optimises gas flows, LNG imports and storage operations for that purpose. TIGER simulates the interactions of supply, demand and gas infrastructure on a daily basis.

In this study, we simulate different scenarios with respect to a Ukrainian transit disruption. The following ones are discussed in this section

TABLE III: MODELLED SCENARIOS

Scenario	Duration of Disruption	Weather conditions
Reference	No disruption	Normal weather
2 weeks	Feb 01 – Feb 15	Normal weather
3 months	Nov 01 – Jan 31	Normal weather
6 months	Nov 01 – Apr 30	Normal weather
2 weeks cold spell	Feb 01 – Feb 15	Cold spell in February
6 months cold spell	Nov 01 – Apr 30	Cold spell in February
1 year limited LNG	Permanent	Normal weather
1 year unlimited LNG	Permanent	Normal weather

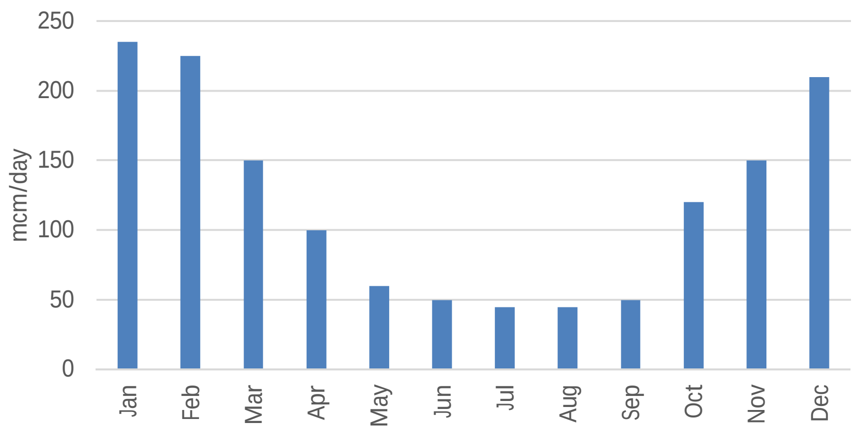
Concerning the assumptions of the simulation-based analysis, we mainly stick to the analysis of Hecking et al. (2014)[65], i.e., concerning gas demand, gas production capacities, gas infrastructure capacities and LNG volumes available to the European market. Concerning storages fill-up levels we use the historical storage levels as of November 1st 2014 as published in GIE (2014)[66] (see Table II). Concerning Ukraine we assume the following seasonal demand

[65] http://www.ewi.uni-koeln.de/fileadmin/user_upload/Publikationen/Studien/Politik_und_Gesellschaft/2014/2014-09__An_Embargo_of_Russian_Gas_and_Security_of_Supply_in_Europe_0610.pdf

[66] Gas Infrastructure Europe. (2014-11-04). GIE Transparency Platform. Retrieved from https://transparency.gie.eu/

profile and an annual production capacity of 18.3 bcm (see Figure XXI). Furthermore, we assume reverse flow capacities from the EU to Ukraine to be about 6 bcm/y from Slovakia[67] and about 1.5 bcm/y from Poland. We assume reverse flow capacities from Hungary to the Ukraine to be zero to reflect the announcement of September 2014 to stop any reverse flows through this IP.[68] The demand pattern in the cold spell is derived from the 14-days average scenario by the Ten-Year Network Development Plan 2013-22.

FIGURE XXI: UKRAINE SEASONAL DEMAND PROFILE USED FOR SCENARIO SIMULATIONS



Compensation of a Ukrainian transit disruption

Russia's decision to interrupt flows to Ukraine would result in non-deliveries both to Ukraine and European countries that would have to be compensated in order to guarantee normal demand. **In case of a 6 months transit disruption between November 2014 and April 2015, Russian exports to Ukraine and Europe would decrease by 51.4 bcm in total**. The European gas market would compensate missing volumes as illustrated in Figure XXII:

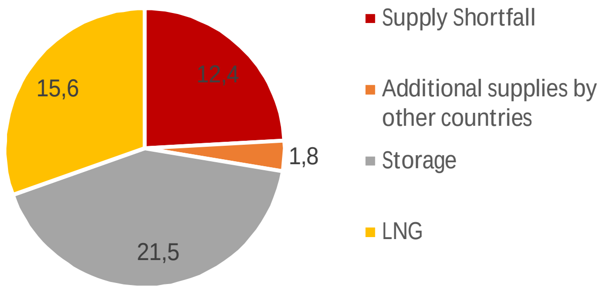
The major part of volumes would be compensated by extensive storage withdrawals, i.e., 21.5 bcm in total. Additionally, LNG imports would increase by 15.6 bcm between November and April.[69] Although European gas production would increase by 1.8 bcm, **a total gas demand of 12.4 bcm could not be compensated**.

[67] At the finishing phase of the report, the capacity is even 24 mcm/day and an increase to 40 mcm/day is likely soon. This would improve the supply situation of the Ukraine.

[68] See for example http://www.ft.com/intl/cms/s/0/7c5d2bf0-4552-11e4-ab86-00144feabdc0.html#axzz3LZZ23K3i

[69] LNG imports do not compensate for more gas because of (temporary) bottlenecks in the pipeline system. Hence, even more LNG imports would not reduce the supply shortfalls. The additional LNG imports will be triggered by higher LNG import prices. The price reaction would however require an additional analysis.

FIGURE XXII: COMPENSATION FOR NON-DELIVERED GAS VOLUMES (51.4 BCM) DURING THE 6-MONTH MODELLED DISRUPTION (BCM).



Supply shortfalls

Box III: How to interpret a supply shortfall?

A supply shortfall of gas can be interpreted as normal gas demand, which cannot be satisfied during the disruption. A supply shortfall can have two explanations:

- As prices increase during a disruption, very price-elastic gas consumers reduce their consumption.
- Gas needs to be curtailed for certain consumers.

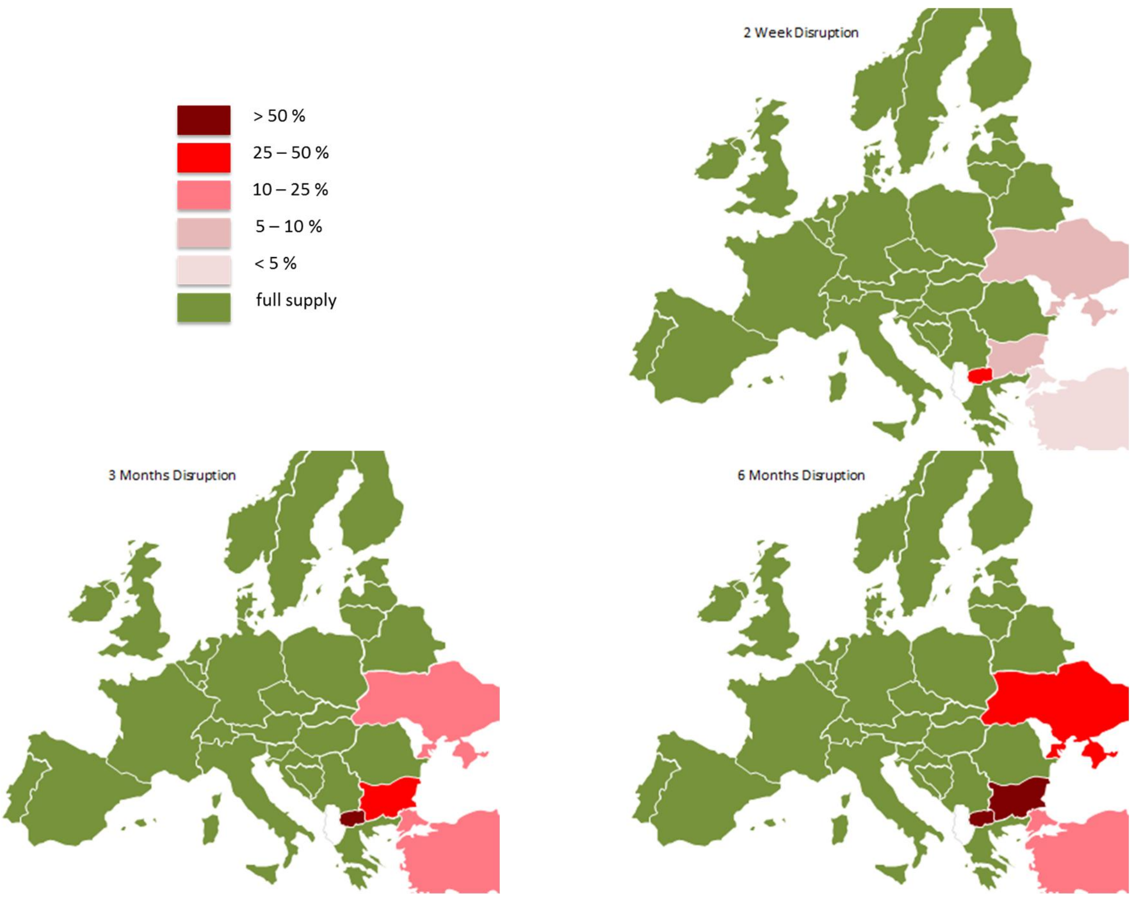
If gas needs to be curtailed, it is usually curtailed first from industry clients and power producers, before gas for heat plants and heating gas of private households is cut.

In the case of a **2-week disruption** at the beginning of February, the only countries where demand could not be satisfied entirely are **Ukraine**, **Turkey**, **Bulgaria** and **Macedonia**. In Ukraine, up to 9% of daily demand could not be served during a disruption. Daily gas shortages would also occur in Turkey (2.5%), Macedonia (26%) and Bulgaria (10%). Other European countries could be supplied to full extent.

In a **3-month disruption** of Russian gas flows through Ukraine between November and January, it is again in **Ukraine**, **Turkey**, **Macedonia** and **Bulgaria**, where supply shortages could occur. The supply situation would be critical in particular during the month of January, where 15% of monthly demand in the Ukraine could not be served, as well as 12% in Turkey, 35% in Bulgaria and over 90% in Macedonia. All other European countries fully manage to secure gas supply.

Even in a **6-month disruption** (November to April), the only countries that would suffer from missing Russian gas volumes would be **Ukraine**, **Turkey**, **Macedonia** and **Bulgaria**. In Ukraine, total supply shortages would amount to 9.5 bcm, with the most critical supply situation occurring in December and January, where 41% and 37% of monthly demand could not be served. December and January would be the most critical months also for Bulgaria (71% and 49% of unserved demand), Turkey (17% and 12%) and Macedonia (over 90%).

MAP II: MAXIMAL DAILY SUPPLY SHORTFALL IN 2-WEEK, 3-MONTH AND 6-MONTH SCENARIOS. (% OF DAILY DEMAND)



In the scenarios discussed before, we assumed a winter with normal temperatures. If, additionally, a cold spell would last for two weeks would occur during a disruption of Russian gas flows to Ukraine, the situation would be more critical[70]:

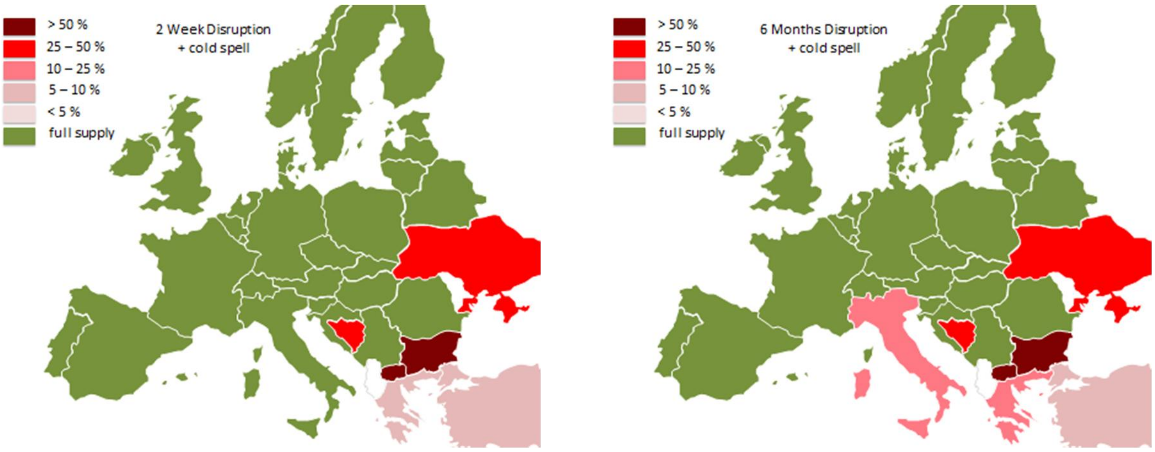
In a **2-week disruption with a cold spell** in Europe, besides **Ukraine**, **Turkey**, **Bulgaria** and **Macedonia**, also **Bosnia/Herzegovina** and **Greece** could not secure full supplies. In Ukraine, up to 27% of daily demand could not be served. Shortages would also be significant in Turkey (6%), Bulgaria (62%), Macedonia (>90%), Bosnia/Herzegovina (27%) and Greece (9%).

If, under a **6-month disruption**, a **cold spell** would hit Europe in the first two weeks of February, **Ukraine** would suffer severe shortfalls of up to 49% of daily demand. The same holds for **Turkey** (6%), **Bulgaria** (74%), **Macedonia** (>90%), **Bosnia/Herzegovina** (27%) and **Greece** (18%). But even in **Italy**, up to 19% of the daily demand could not be served during 5 days of the cold spell

[70] We assume the demand level of the 14-days average scenario of the Ten-Year Network Development Plan 2013-22 (ENTSO-G, 2013).

since the other supply options (for Northern Italy), i.e. storages and LNG imports could not provide sufficient peak supplies. Other Central European countries such as Austria, Slovakia, Czech Republic or Hungary would benefit from reverse gas flows and their (compared to the annual demand) large storage capacities.

MAP III: MAXIMAL DAILY SUPPLY SHORTFALL IN 2-WEEK AND 6-MONTH SCENARIOS WITH COLD SPELL (% OF DAILY DEMAND)



Note: Cold spell takes place during the first two weeks of February. Percentages indicate maximal daily supply shortfall as a percent of daily demand in the reference scenario.

LNG imports

One crucial supply source for a compensation of missing Russian gas volumes during a Ukrainian disruption would be LNG. Figure XXIII shows the monthly LNG volumes that are additionally imported to Europe in the disruption scenarios. We observe that LNG imports compensate **2.5 bcm per month during a 3-month disruption** and **3.5 bcm per month during a 6-month disruption**. Additionally, we observe, that **also in the aftermath of a crisis, LNG imports are on a higher level**. This is because the extensive storage withdrawals have to be compensated. This effect becomes most obvious in **November and December 2015**, where storages are on a lower-than-normal level at the beginning of the winter 2015/16.

FIGURE XXIII: ADDITIONAL LNG REGASIFICATION BY EUROPE PER MONTH IN DIFFERENT DISRUPTION SCENARIOS

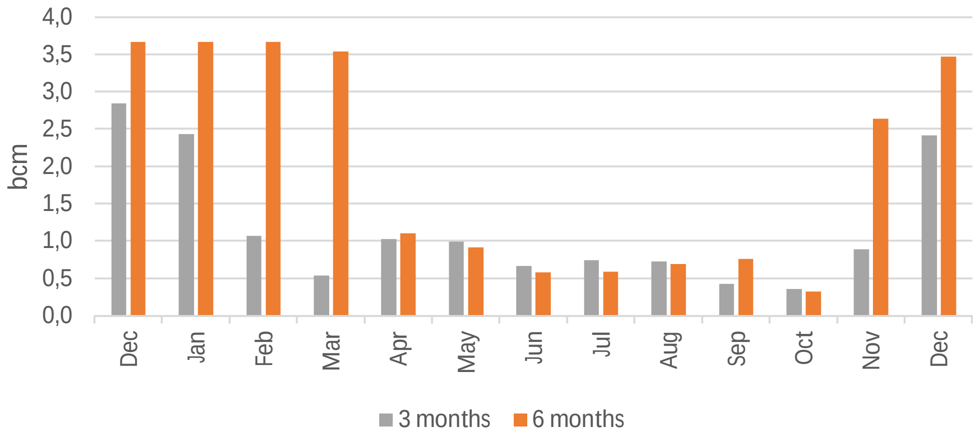
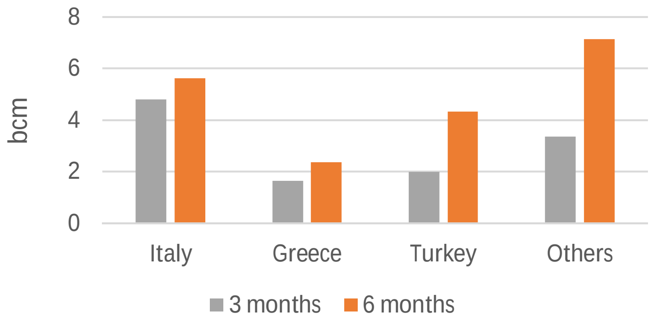


Figure XXIV illustrates to what extent LNG imports by country increase during the different disruption scenarios. We see that the LNG importing countries in South-East Europe, i.e., Italy, Turkey and Greece compensate a major part of the missing Ukrainian transit gas. This finding can be explained by the geographic location, since the respective LNG terminals are closest to the regions where Ukrainian gas transits are missing. However, import capacities at LNG terminals in addition to pipeline capacities distributing the LNG towards South-East Europe limit potential compensation. LNG imports also increase in other LNG importing countries, foremost Belgium, the UK and the Netherlands. This LNG landing in Western Europe impacts pipeline flows and storage operations such that it indirectly helps in compensating missing Russian gas volumes.

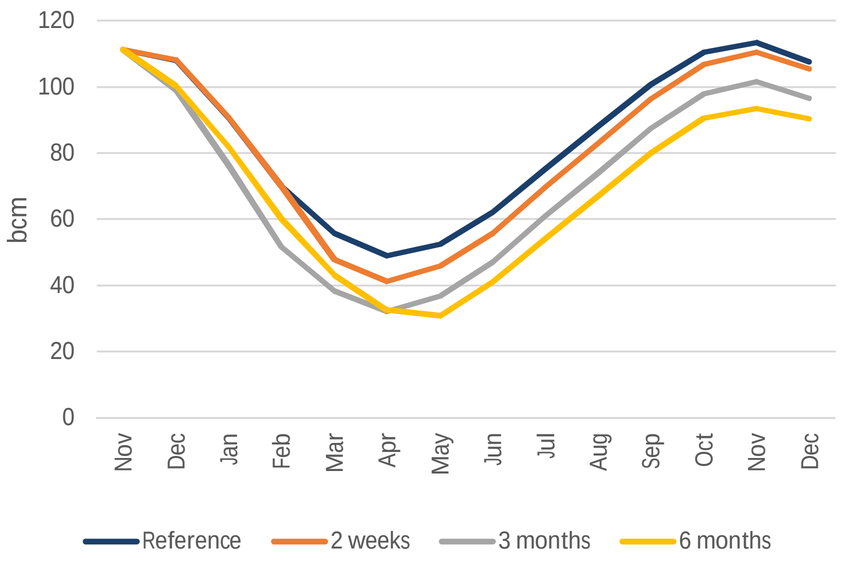
FIGURE XXIV: ADDITIONAL LNG REGASIFICATION (NOV 14-NOV 15) BY COUNTRY IN DIFFERENT DISRUPTION SCENARIOS



Storage

Besides LNG, gas storages would provide significant volumes of natural gas during a disruption of Russian gas flows to the Ukraine. Figure XXV illustrates EU storage filling level (incl. those in Ukraine) in the reference case and in selected modelled scenarios.

FIGURE XXV: FILLING LEVEL OF EUROPEAN GAS STORAGES IN DIFFERENT SCENARIOS



We observe that, once the disruption begins (1st of November in the 3- and 6-month case and 1st of February in the 2-week scenario) storage withdrawal intensify compared to the reference scenario. Not only will storages be emptied to a lower level until the end of the heating season, their refilling is also affected by the duration of the disruption: as such the refilling level in November 2015 is 20 bcm lower in the 6-month scenario than in the reference case.

Since Figure XXV represents aggregated European gas storages (incl. Ukrainian storages), it is important to note that **storages are not emptied entirely** even during a 6-month disruption for two reasons. First, storage withdrawal capacities decrease with the storage level becoming lower and pressure declines. Second, the need of intensified gas withdrawals is higher, the closer the storages are located to those countries where gas is missing (e.g. Spanish gas storages will probably not help as much as Austrian storages during a Ukrainian gas crisis).

FIGURE XXVI: STORAGE LEVELS IN REFERENCE SCENARIO AND IN 6-MONTH SCENARIO IN SELECTED COUNTRIES (BCM)

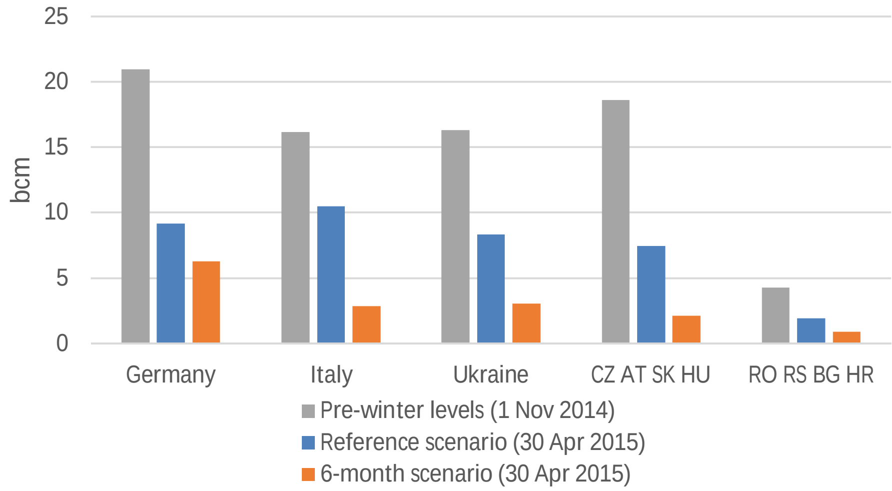


Figure XXVI depicts in which countries storage facilities provide additional supplies during a disruption of Russian gas flows through the Ukraine in a 6-month disruption scenario. Most of the additional volumes are supplied by storages in Italy, Ukraine, as well as Czech Republic, Slovakia, Hungary and Austria. But as the supply situation is critical during a 6-month disruption, those storages in countries further apart such as in Germany would supply additional gas, too.

The effects of a permanent disruption of Ukrainian transit

So far, the analysis has revealed that storages play a major role in compensating for non-delivered gas during a temporary transit disruption. The question still to be answered refers to a **permanent interruption of Ukrainian gas transit.** What would happen if a disruption lasted one year or longer? Although it can be argued that this setting is rather unrealistic, it provides valuable insights about countries most dependent on the Ukrainian transit.

We simulate two scenarios for our analysis. In the first one, we assume that European importers[71] can purchase an annual 95 bcm of natural gas from the global LNG market[72]. In the second one, LNG purchases are unlimited. In both scenarios, a normal temperature pattern is assumed, that is, no cold spell is assumed. Additionally, as opposed to temporary disruptions, gas storage can´t provide any additional net-supply.

Map IV shows the supply shortfalls for the "limited LNG scenario" if Russia-Ukraine gas flows are stopped permanently. In many countries, like Ukraine, Bulgaria, Macedonia, Bosnia Herzegovina, Serbia, Slovenia and Hungary, more than 50% of annual demand could not be

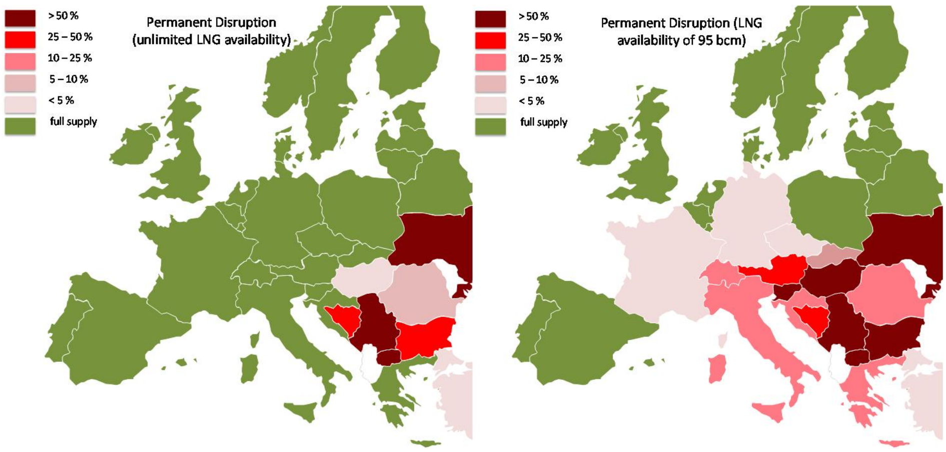
[71] Here and in the following, European LNG imports comprise those of Turkey.
[72] In the scenario with limited LNG imports, this translates into a monthly cap of 8,7 bcm/month.

supplied. But also Austria (36%) and Italy (18%) would suffer from significant shortages. Germany and France could not satisfy their usual gas demand especially in winter times.

Assuming unlimited LNG supplies (see Map IV), the picture changes substantially for many countries such as Germany, France, Italy, Austria, Czech Republic or Slovakia, which could be fully supplied as a consequence of available LNG import and reverse flow capacities as well as storages during winter. For Ukraine, Bulgaria, Macedonia, Bosnia Herzegovina or Serbia, higher European LNG imports would not substantially improve gas supply, implying a poor interconnection with LNG terminals via the pipeline grid.

The total annual LNG imports would amount to **124.6** bcm annually, with **14.1** bcm in the peak month. Note that the overall annual peak of European LNG Imports (incl. Turkey) was 86,8 bcm in 2010 and the monthly peak was 9 bcm in January 2011[73]. Thus, replacing the Ukraine transit route by LNG would have a major impact on the global LNG supply/demand balance.

MAP IV: SUPPLY SHORTFALLS FOR PERMANENT DISRUPTION OF RUSSIA-UKRAINIAN FLOWS (PERCENT OF ANNUAL DEMAND)



Note: LNG availability is different in each map. Left: Unlimited LNG availability. Right: availability of 95 bcm year (8,7 bcm/month cap).

Both scenarios underline that the Ukrainian transit route is not replaceable currently for many European countries. However, we also see that given a high LNG availability many countries could be well supplied. However it is important to stress the point that we talk about normal weather patterns. Given a cold spell, the capacity from the Ukraine route would probably be missing a lot more in many Central European countries, if daily demand was peaking at the same time around the region.

[73] IEA Natural Gas Information 2013).

Implications of the simulation results

The simulation of a **permanent disruption** of Russian gas flows through the Ukraine reveals that this neuralgic transit route is not currently replaceable, i.e., without further infrastructure expansions. Supply shortages would occur in **Ukraine, Bulgaria, Romania, Macedonia, Serbia and Bosnia/Herzegovina** even when assuming very high additional LNG supply (indicating infrastructure constraints) and additionally in many Central European countries (e.g. Italy, Austria, Germany) when assuming historic peak LNG availability on the global market. But a permanent transit disruption would not leave **Russia** untouched either as **exports to Europe, Turkey and Ukraine would decrease by 106 bcm** compared to the reference scenario which does not include any disruptions. These results underline the **mutual dependency** of Russia and Ukraine as well as many European countries.

However, simulation results indicate too the **high resilience** of many European countries against **temporary** disruptions of Russian gas transiting Ukraine. The duration of a disruption, together with temperature levels, are crucial for the magnitude of supply shortfalls in the countries which would be affected most: **Ukraine, Bulgaria, Macedonia and Turkey**. The high resilience of many European countries comes from extensive **storage withdrawals** as well as from **increased LNG imports** and **reverse flows** from Western to Eastern Europe. However, besides infrastructure, two other effects improve security of supply in the simulated situation. A rather low assumed **gas demand** (e.g. compared to the year 2010) and **higher-than usual storage level** at the beginning of the winter.

Yet, all of the factors mentioned, i.e. large infrastructure capacity, low demand and high storage levels at the beginning of the winter, cannot be taken as granted when it comes to security of supply in the future. High storage levels, for example, are all but certain in the future: Given an ongoing low demand, it is conceivable that flexibility would be achieved by flexible usage of long-term contracts and pipelines instead of using storages.

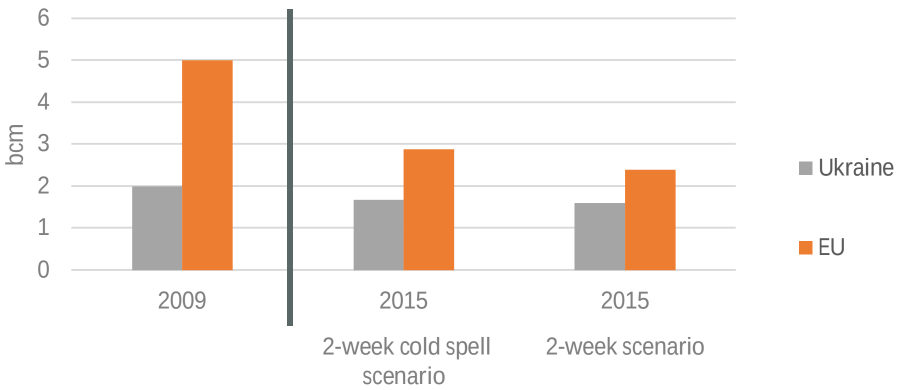
Also, the current situation of large infrastructure capacities and low demand, is not likely to be a sustainable on the long-term. In case of a continuing low gas demand (or even worse, a low annual gas demand with high demand peaks) a question arises about how investment in new infrastructure or re-investment in existing infrastructure will be rendered economical. Security of supply implies to some extent overcapacity and redundant infrastructure, and this additions have to be paid for even if not used. In the context of current geopolitical tensions, security of supply needs to be increased as markets not only need to be prepared for seasonal variations, but also for political uncertainty. Overcapacity is a form of insurance against supply outages, but paying for it is easier under a sector performing as expected. The low demand context in Europe makes it difficult to guarantee these margins. If the consumer is willing to pay a risk premium for security of supply (and the market design makes him pay for that) overcapacity can be financed. Otherwise, infrastructure operators might have little incentive to spend money in order to provide spare infrastructure and the network can come to face a higher exposure to supply risks in the future.

SECTION VI: 2009 AND 2014 COMPARED

After presenting modelling results for disruptions taking place in the 2014/15 period, this section proceeds to establish a comparison with the events of 2009. The disruption that took place at the time has shaped Europe's current perceptions about the reliability of Russian supplies to Europe and transit through Ukraine. It has shaped too the approach taken in this study. Despite obvious differences between the two compared events (notably one is a real life situation while the other one is a simulation), the results provide some insights about Europe's different security of supply position in 20014/15 compared to 2009.

Within this comparison several figures are interesting to look at. Differences in affected countries in 2009 and in 2014/15 modelling results, compensation volumes by source, and shortages all provide a good idea of Europe's better off position. However the single figure better representing this change is the comparison between non-delivered volumes as a result of interruptions both in 2009 and the simulated disruption in 2014/15. These quantities are represented in Figure XXVII below.

FIGURE XXVII: TOTAL NON-DELIVERED RUSSIAN SUPPLIES IN 2009 AND 2-WEEKS MODELLED DISRUPTIONS IN 2015 (BCM)



Source: IEA (2014a) and TIGER Model

What is relevant about this figure is the difference between non-delivered volumes to Europe in 2009 and modelled scenarios in 2015. According to the IEA the 2009 disruption resulted in 5 bcm not delivered to Europe (in addition to 2 bcm missing to Ukraine). On the other side, modelling results vary depending on the scenario. In the case of normal 2-week disruption with regular winter temperatures, non-delivered gas amounts to 2,4 bcm. For a 2-week disruption modelled with a cold spell, levels raise to 2,9 bcm[74]. **The decrease in non-delivered volumes from 5 bcm to 2,4 - 2,9 bcm** is important as it represent the decreasing dependency Europe holds on

[74] Weathern during 2009 was colder than in the regular 2-week simulation not colder than the temperatures used for the modelled cold spell. Simulations therefore provide a reasonable margin to evaluate the differences 2009 and the effects of a similar disruption at the present

Ukrainian transit. This is mainly the result of changes in EU demand and together with the diversification options made possible with the commissioning of Nord Stream (in addition to reverse flows in Central Europe). Regarding Ukraine, reliance continues to be similar in 2009 and 2014/15. The small decrease in non-delivered volumes during compared disruptions is mainly a result of assumed demand reductions in the country and the possibility of reverse flows from the EU.

The 2009 crisis

7 bcm disruption compensated with storage

Starting on 1 January 2009, some 110 mcm per day of Ukrainian supply was interrupted[75]. On 5 January, supplies were further reduced, and all transit through the Ukrainian network was halted on 7 January. From that day some 300-350 mcm per day of transit gas were interrupted. When flows were restored on 20 January, 5 bcm of transit gas supplies to Europe had not been delivered over a two-week period, in addition to approximately 2 bcm to Ukrainian[76].

TABLE IV: NON-DELIVERED GAS VOLUMES TO UKRAINE AND EUROPE DURING THE 2009 UKRAINIAN CRISIS.

	Duration of the interruption	Interrupted transit	Non-delivered gas volumes
Ukraine Supply	1 - 20 January 2009	110 mcm/d	2 bcm
Transit to Europe	7 - 20 January 2009	300 – 350 mcm/d	5 bcm

Source: IEA(2010)

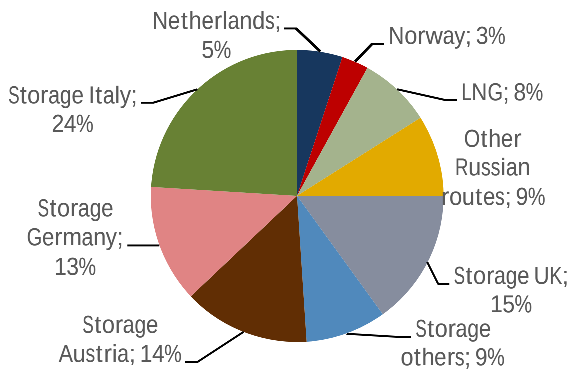
Alternative supplies to substitute missing gas included a variety of instruments including demand side measures and fuel substitution together with additional gas supplies. The IEA[77] has provided an analysis of compensation volumes that were used during the crisis. The figures are summarized in Figure XXVIII below. **Up to 75% of the non-delivered 5 bcm where replaced with storage**.

Additional supplies included Russian imports through transiting outside Ukraine and LNG. Both Germany and Italy recorded the largest missing volumes. Route flexibility through Belarus could substantially mitigate the initial gas disruption for Poland. Other affected countries (Hungary, Slovakia, Bulgaria, Romania, Greece, Slovenia and Austria) couldn't make use of this instrument and therefore responded differently to Russian shortages according to their possibilities. Mostly

[75] Several studies describe in detail the distortion in transit and supply produced by the interruption. The following provide a relevant review: Bettzüge et al. (2009), European Commission (2014), IEA (2010, 2014a), Kovacevic (2009), Pirani et al. (2009) and Vanhoorn (2009).
[76] IEA (2010)
[77] IEA (2014a)

by the combination of storage withdrawals, increase in production, alternative gas or LNG imports from other suppliers, fuel switching and last but not least demand reduction.

FIGURE XXVIII: COMPENSATION SUPPLIES TO EU DURING THE 2009 UKRAINIAN DISRUPTION (AS PERCENTAGE OF NON-DELIVERED GAS, 5 BCM)



Source: IEA (2014a)

Emergency measures varied between countries

Gas transit and shortages resulting from the interruption have been descripted in various studies. For the purpose of this paper we use Vanhoorn's[78] division in three groups of the countries most affected during the 2009 crisis. This allows assessing how countries responded to supply shortages.

For a first group of countries, a combination of first phase measures was sufficient to offset non-deliveries (e.g., storage and increases in domestic production). Germany, Austria, Italy, Poland, Czech Republic, Slovenia and France are in this group and were the least affected EU-countries out of the 12 affected ones. A second group including Greece, Romania, Hungary, could only manage the emergency with a combination of LNG imports and alternative gas supplies from other sources (e.g. Turkey supplying Greece). Substitution volumes could be arranged in a short period of time.

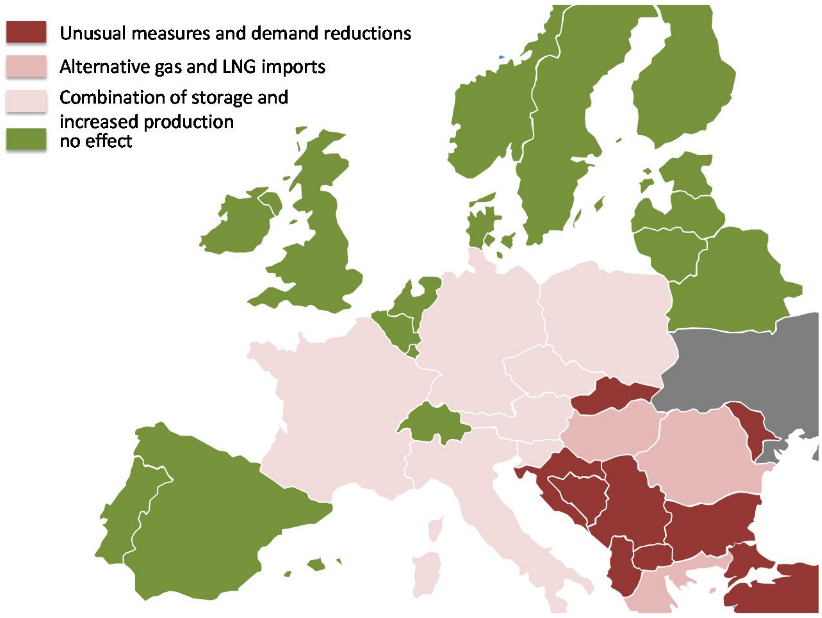
The third group including the Slovak Republic, Bulgaria, Turkey, Macedonia, Serbia, Bosnia and Herzegovina, Croatia had more difficulties offsetting non-delivered quantities. They took "unusual" measures, which needed more time to be implemented. Certain countries were also forced to reduce consumption to business, as well as residential sectors. Countries in the Balkan region experienced a humanitarian emergency while the situation in Hungary and Slovakia was severe but not an emergency[79].

The biggest barrier for alternative gas to be transported to the markets were infrastructure constraints (capacities, unusual routes, insufficient interconnections, reverse flow capabilities).

[78] Vanhoorn's (2009)
[79] Pirani (2009)

Hence our assessment in comparing 2009 crisis with today situation focuses on evaluating the infrastructure resilience and country specific alternatives in the following sections.

MAP V: THE 2009 UKRAINIAN DISRUPTION, DIFFERENT MEASURES TO COPE WITH NON-DELIVERED GAS VOLUMES.



Source: Vanhoorn's (2009) and authors' elaborations.

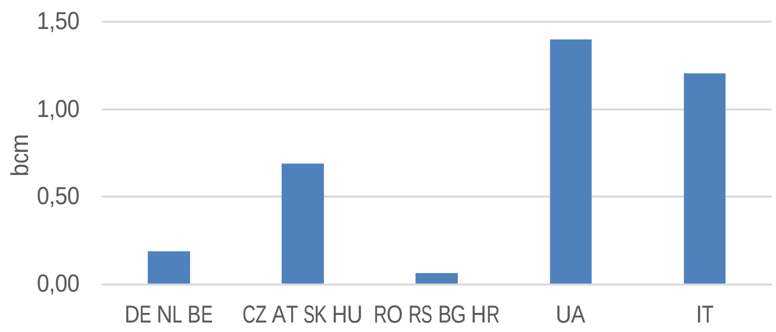
2-week disruption simulation in 2015

In order to evaluate the progress in EU's security of supply since the 2009 crisis we simulate a 2-week disruption between 1st and 14th of February 2015, i.e., an interruption of gas deliveries to both Ukraine and Europe. It is not enough to stress the point, that an average February temperature level is assumed. In the case of colder weather, demand would be higher and the supply situation could aggravate. Non-deliveries during a 2-week cold spell are represented in Figure XXVII and further details regarding this scenario are in Section V.

2 bcm disruption compensated with storage

The modelled disruption shows 4.1 bcm of missing Russian gas volumes, 2.4 bcm of which are deliveries to European consumers. These volumes are compensated mainly by increased storage withdrawals as shown in Figure XXIX. This illustrates the extent to which storage withdrawals are higher in the 2-weeks disruption scenario compared to the Reference scenario in the time range between 1st and 14th of February 2015. During the 2 weeks crisis, it is mainly increased storage withdrawals from Ukraine and Italy that compensate non-delivered Russian gas.

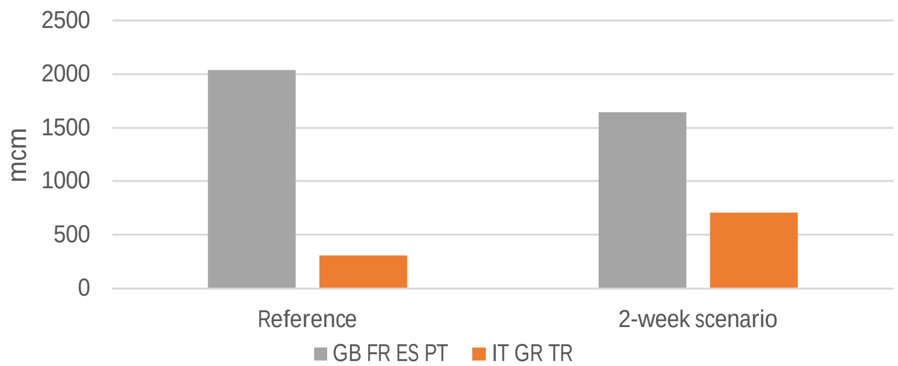
FIGURE XXIX: COMPENSATION OF MISSING RUSSIAN DELIVERED BY MEANS OF GAS STORAGE DURING A 2-WEEKS DISRUPTION (BCM)



LNG

Concerning the compensation contribution of LNG it is important to stress the following aspect: Due to the assumption that increased LNG imports from the global market are only available 2 weeks after the beginning of the crisis (to account for ships to be rerouted). However, some LNG is available immediately since the model accounts for LNG storages in the regasification terminals. Additionally, we assume, that to limited extent, LNG can be rerouted within Europe on shorter notice (e.g. ships in the Mediterranean Sea destined to Spain can be rerouted to Turkey or Greece). However such short-term switching of LNG flows within Europe is rather speculative and would require the appropriate price signals as happened in 2009. The effect of regional redistribution of LNG within Europe is illustrated in Figure XXX. Although numbers are to some extent speculative, they illustrate South East Europe's need for emergency LNG quantities during a disruption such as the one here modelled. In the case of rigidity in LNG supply preventing these levels to be served, South East European networks would have to face supply shortages.

FIGURE XXX: REGIONAL LNG IMPORTS DURING A 2-WEEKS DISRUPTION (MCM)



SECTION VII: COUNTRY-SPECIFIC INFRASTRUCTURE RESILIENCE ASSESSMENT

In line with the evolution of the EU gas transit network pictured in Part III of this study, this section provides modelling results that allow assessing this transformation. It looks several EU countries to represent transit and supply dynamics during a 2 weeks disruption with normal weather conditions from 1st to 14th February. The section complements Section IV, which pointed out countries with a greater exposure to shortages in the event of a disruption through Ukraine. It provides simulation results derived by the TIGER model showing how new transit capacity behaves during such an event.

The criteria used for this selection corresponds to indicators used in Section IV, to measure countries' exposure to shortages in the event of an interruption of Ukrainian transit. These criteria are:

- Non-fulfilment with the N-1 standard in connection with Ukrainian supplies (Bulgaria)
- High dependency from Ukrainian transit (Bulgaria, Slovakia, Czech Republic, Greece, Hungary and Austria)

Some of the countries examined experience shortages during a modelled 2-week disruption. Graphs represent the variations in import points in selected countries including transit, storage, indigenous production and LNG imports when available. The positive **x-axis** shows imports while outward transit is represented in the **y-axis**. This allows representing how supply varies during the interruption of Ukrainian transit. Finally, details about cross border interconnections can be found on Map VI and in Appendix II[80].

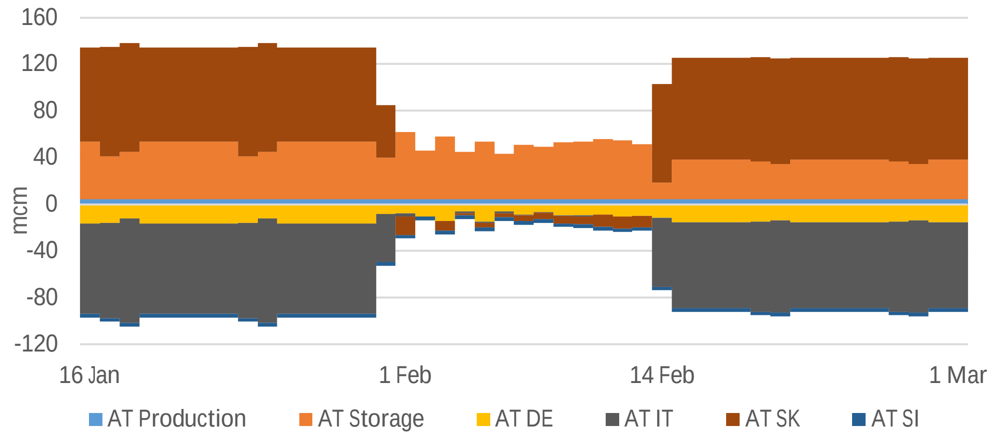
Austria

Austria's main supply entry point is Baumgarten that provides gas transiting Ukraine and arriving through Slovakia (AT SK). During the modelled disruption Austria ceases imports through this interconnector that, in turn, starts working in reverse flow to supply gas to Slovakia.

Alternative routes in the event of a disruption in Ukraine are the German (AT DE) and Italian (AT IP) corridors. Under normal circumstances Austria serves as a transit route for gas to move westwards towards Italy (AT IP), Slovenia (AT SI) and Germany (AT DE). However, in the modelled scenario, reductions in these volumes serves as a major compensation for missing imports. Transit to Italy decreases from 70 to 5 mcm/d and transit to Germany decreases from 17 to 7 mcm/d. Slovenia continues to receive stable supplies during this period.

[80] Additional infromation can be checked at ENTSOG's transparency platorm and in its EU network capacity map.

FIGURE XXXI: SUPPLY COMPENSATION IN THE 2-WEEK DISRUPTION SCENARIO, AUSTRIA (MCM/DAY)

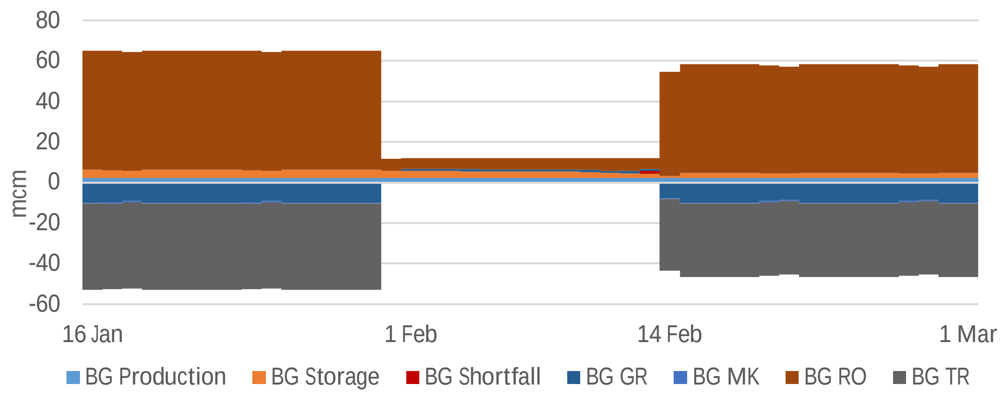


Regarding storage, Austria partly compensates missing gas quantities with increasing gas withdrawals. Scenario results show how reverse flow exports to Slovakia are further synchronous with increasing withdrawals in Austria. This shows the link between withdrawals and reverse flow in these two countries.

Bulgaria

Bulgaria is fully dependent on Russian gas transiting Ukraine imported through Romania. The inability to fulfil the N-1 standard in 2013 shows the high dependence on this route.

FIGURE XXXII: SUPPLY COMPENSATION IN THE 2-WEEK DISRUPTION SCENARIO, BULGARIA (MCM/DAY)



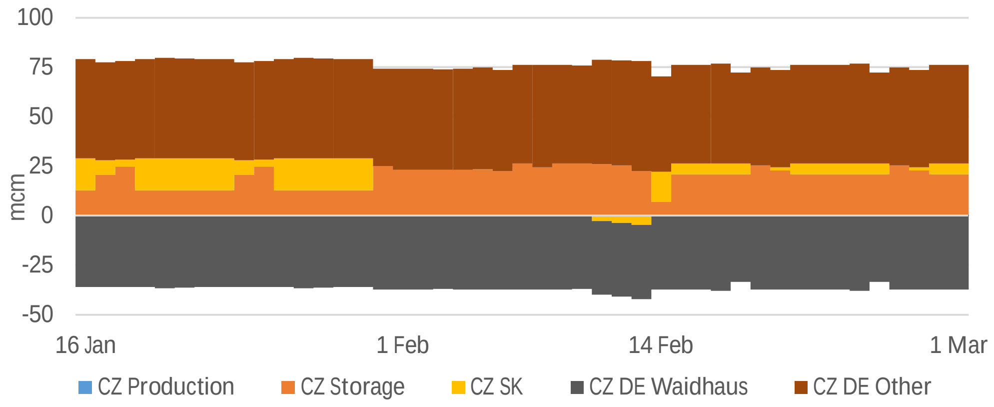
Under normal transit circumstances Ukrainian imports through Romania (BG RO) cease completely and so does transit towards both Turkey (BG TR) and Greece (BG GR). The only outwards transit that continues to flow is the minor one to Macedonia (BG MK) that decreases by around 15% during the disruption period.

Alternative volumes are provided through imports from Greece's LNG terminal. Unlike Greece, Bulgaria has storage facilities that can compensate missing gas volumes during the initial days of a disruption. However, by the end of the 2-week disruption shortfalls take place. This could be linked to the low storage levels and the decreasing withdrawal rates in storage facilities.

Czech Republic

Half of the gas transiting from Ukraine to Slovakia has traditionally transited further to the Czech Republic (with the rest going into Austria). This has classically been the main import route for the Czech Republic and is represented in yellow in Figure XXXIII.

FIGURE XXXIII: SUPPLY COMPENSATION IN THE 2-WEEK DISRUPTION SCENARIO, CZECH REPUBLIC (MCM/DAY)



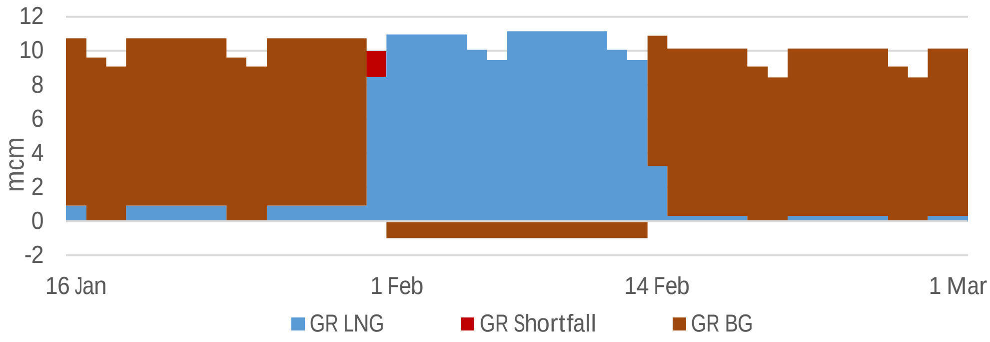
During the modelled disruption compensation volumes come almost entirely from storage which double during the interruption. This is one of the highest withdrawal ratios observed for countries considered.

In addition, the Czech Republic can import gas transiting through Germany though the Brandov IP and the Gazelle pipeline. During the disruption a minor increase in these volumes at the end of the disruption takes place simultaneously with gas flowing in reverse flow to Slovakia. This suggests that transit to Slovakia is made possible by an increase in OPAL import volumes. During the two weeks gas continuously flows from the Czech Republic to Germany through the Waidhaus IP. These volumes correspond to OPAL's imports to the Czech Republic.

Greece

Greece's main supplier is Russia and the country can be alternatively served through its LNG regasification facility in the South (Revythoussa)

FIGURE XXXIV: SUPPLY COMPENSATION IN THE 2-WEEK DISRUPTION SCENARIO, GREECE (MCM/DAY)



Modelling results show that Greece replaces gas imports transiting Ukraine solely with LNG imports and especially for the first days with gas stored at Revithoussa's facilities. Depending on the delay for cargoes to arrive, shortages can take place. In the modelled scenario this happens during the first days of the interruption. Additionally, results show that, similar to 2009, Greece exports a part of its LNG imports to Bulgaria

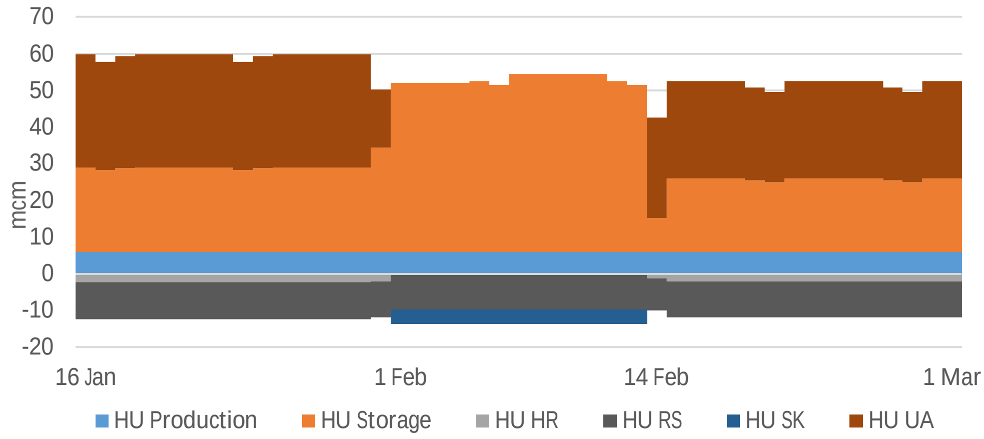
Hungary

Hungary is supplied trough Ukraine and in 2013 this presented up to 98% of its consumption. Alternative to this route, the country can be supplied through Austria and Croatia (HU HR). During the modelled disruption imports from Ukraine (HU UA) are interrupted together with gas flows coming from Croatia (HU HR). Regarding outflows, modelling dynamics show how transit is interrupted to Croatia (HU-HR) at the same time they begin towards Slovakia. This implies a shift in the direction of outwards transit to a reverse flow direction. Croatia further substitutes missing deliveries from Hungary with storage. Regarding outflows, modelling dynamics show how transit is interrupted to Croatia (HU-HR) at the same time they begin towards Slovakia. This implies a shift in the direction of outwards transit to a reverse flow direction. Croatia further substitutes missing deliveries from Hungary with storage. Figure XXXV represents these changes.

Although Austria is Hungary's main alternative route, it is not used during the disruption. This is because storage is sufficient to substitute non-delivered gas during a 2-week disruption. During the 6-month disruption Austria becomes key for supplying additional gas volumes as storage is not sufficient to cover non-delivered gas.

Regarding outflows, modelling dynamics show how transit is interrupted to Croatia (HU-HR) at the same time they begin towards Slovakia[81]. This implies a shift in the direction of outwards transit to a reverse flow direction. Croatia further substitutes missing deliveries from Hungary with storage.

FIGURE XXXV: SUPPLY COMPENSATION IN THE 2-WEEK DISRUPTION SCENARIO, HUNGARY (MCM/DAY)



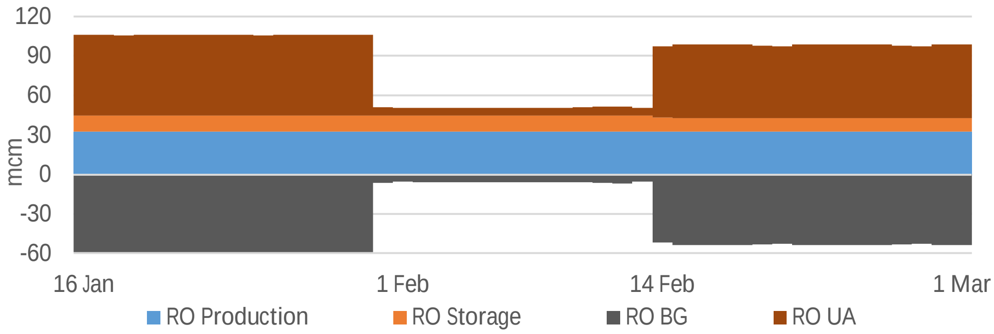
At the same time, transit to Slovakia activates providing the country with a steady gas flow during the disruption (HU SK). In the model the HU – RS interconnector is assumed to be working and results show stable outwards transit throughout the two weeks.

Romania

Romania is directly supplied by Ukraine through two routes, one of which previously transits Moldova. A large share of this volumes transit farther South towards Bulgaria, Greece and Turkey (RO BG). In addition to this, Bulgaria has large natural gas domestic production which covers for a large share of the country's demand. As opposed to other MSs in the region, Romania's share of natural gas transiting Ukraine is rather low (11.3% in 2013).

[81] Modelled scenarios assume a full operation of the interconnector. Both TSO re-scheduled the opening of commercial flows from January to February 2015 because of technical problems on Hungarian side. http://www.eustream.sk/en_media/en_news

FIGURE XXXVI: SUPPLY COMPENSATION IN THE 2-WEEK DISRUPTION SCENARIO, ROMANIA (MCM/DAY)

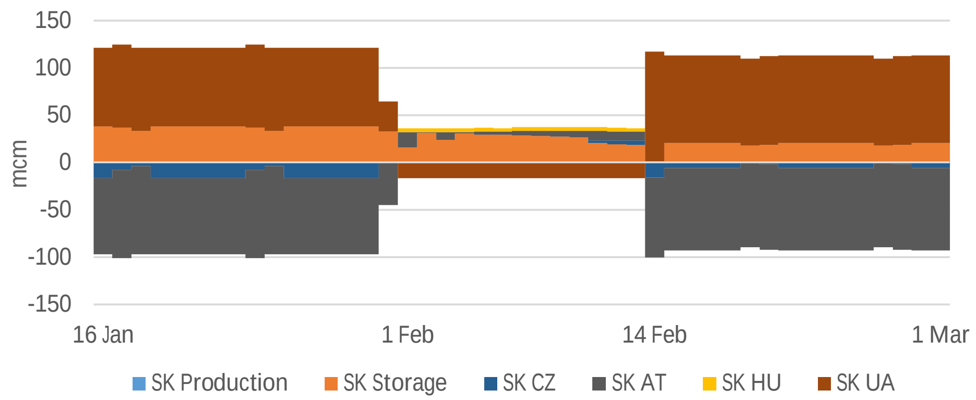


During the disruption imports from Ukraine to Romania (RO UA) are partially halted, and so is transit from Romania to Bulgaria (RO BG). This is because in the modelled scenario this interconnector is left open for transit South of Ukraine. In case of closing this transit point, shortages would be more severe for countries South of Romania as part of this gas coming from Ukraine is exported in this direction. For Romania, alternative supplies come from domestic gas production (RO Production) and storage (RO Storage).

Slovakia

Slovakia, with its massive border transit system is traditionally at the centre of redistribution of Ukrainian gas flows westwards towards the rest of the EU. After successful implementation of reverse flow capacities from the Czech Republic and Austria, Slovakia is secured with alternative gas from German markets. The country also recently implemented export capacity to Ukraine and a southward connection to Hungary that entered into a testing phase in September 2014 (official full firm capacity is expected to be offered in January 2015).

FIGURE XXXVII: SUPPLY COMPENSATION IN THE 2-WEEK DISRUPTION SCENARIO, SLOVAKIA (MCM/DAY)



During the modelled two-week disruption imports through Ukraine cease completely and so does the transit to both Austria and the Czech Republic.

Alternative supplies come mainly from reverse flow transit from Austria (SK AT) and Hungary (AT HU). By the end of the disruption, additional supply flows from the Czech Republic (SK CZ).

Storage rather decreases when compared to normal withdrawal levels. This is simultaneous to an increase in reverse flow pipeline imports.

Inversely to the interruption of gas flowing westwards, reverse flow transit to Slovakia takes place during the interruption. This is made possible by imports from Hungary (SK HU) and Austria (SK HU), together with storage withdrawals.

CONCLUSIONS

The scenarios modelling different interruptions of Russian gas flows transiting Ukraine show that this traditional route is currently not entirely replaceable. A full-year disruption of Russian flows would lead to substantial supply shortfalls in many countries, some of which would need unseen levels of LNG imports to circumvent the problem. Simulations of a shorter duration (e.g. 2 weeks, 3 months and 6 months) show a high resilience against temporary disruptions as supply shortages can be avoided in most countries. Exceptions to this are Ukraine, Bulgaria, Romania, Macedonia, Serbia and Bosnia/Herzegovina where supply shortages occur even when assuming very high additional LNG supply. For the EU as a whole, the security situation has however substantially improved compared to 2009. Extensive storage withdrawals as well as increased LNG imports and reverse flows from Western to Eastern Europe would secure gas supply in many countries. Besides infrastructure, two other effects improve security of supply in the simulated scenarios: a rather low assumed gas demand (e.g. compared to the year 2010) and higher-than usual storage level at the beginning of the winter.

To better analyse these improvements in European gas network, we compared the 2009 Crisis with a 2-week modelled scenario. Results point to a less dramatic situation than that of in 2009. It can be argued that several factors and mainly the anticipation created by an existing precedent make the 2014/15 less of a crisis than that of 2009. But this doesn't rule out the fact that intense preparation for an event of such a nature has taken place at all levels in the EU network. This study argues that these efforts, combined with factors aligning in favour of Europe's security of supply have resulted in better odds to face of a potential disruption.

Yet, all of the mentioned factors (i.e. large infrastructure capacities, low demand and high storage levels at the beginning of the winter) cannot be taken for granted when it comes to security of supply in future. Nevertheless, not only modelled results, but also flow dynamics in 2014 have come to show Europe's relative success at coping with the need of diversifying away from overreliance on single supply sources (in this case Ukrainian transit). The combination of increased pipeline imports (e.g. Nord Stream) with greater interconnection capacity, supported by consistent legislation and regulation has served to increase Europe's security of supply.

Part III further explores the conclusions from modelled simulations. It presents the evolution of European network in the post 2009 period including the evolution of infrastructure (e.g. storage, LNG and transmission) and regulation. The purpose of this assessment is to analyse the improvements that have served to increase Europe's security and to assess the sustainability of these gains.

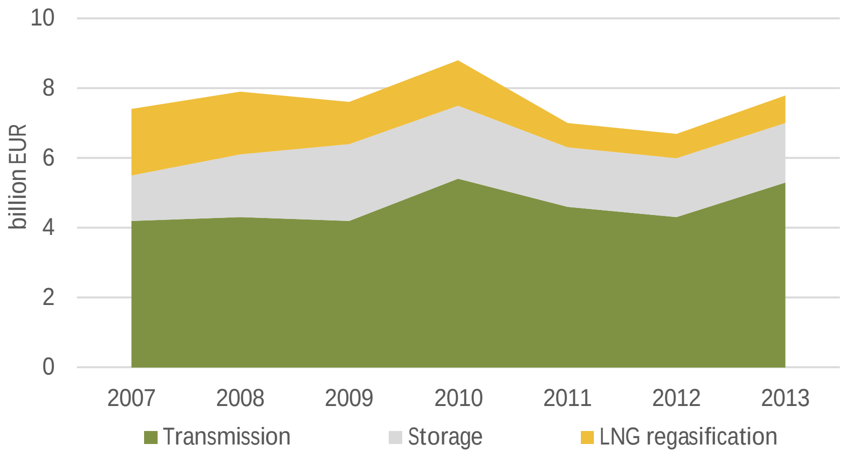
Part III: The evolution of the EU natural gas network 2009/14

SECTION VIII: INFRASTRUCTURE

Energy security partly relies on spare capacity that can be called upon emergencies. The sustainability of such back up infrastructure is based on the ability to price a service that under normal circumstances might not be used at all. The current evolution of the EU natural gas sector has led to large amounts of idle infrastructure. This has resulted a challenging economic situation for many players in the sector, although in practice, it has resulted too in additional security margins for Europe. This position has greatly contributed to lowering Europe's dependency position vis-à-vis Ukraine but as it is based on a non-sustainable logic, these gains could be partly reversed on the medium term.

The following section explores the additions in storage, LNG and transmission in the EU network between 2009 and 2014. These improvements have played a key part in Europe's current security position. They include greater storage capacity, greater regasification capacity and a larger transmission network (including greater import and cross border capacity). Figure XXXVIII below summarises these investment in the 2007-13 period according to GIE calculations:

FIGURE XXXVIII: ANNUAL INVESTMENT IN NATURAL GAS INFRASTRUCTURE BY GIE MEMBERS IN EU-28 2007-13 (€ BN)



Source: GIE Knowledge Centre (Information available at GIE website)

In order to assess the sustainability of current infrastructure additions, this section explores how each segment of the sector has absorbed the contraction in EU demand. While storage has facilities being decommissioned, additional LNG regasification terminals are currently being build or planned. In regards to transmission, infrastructure faces shifts in supply routes.

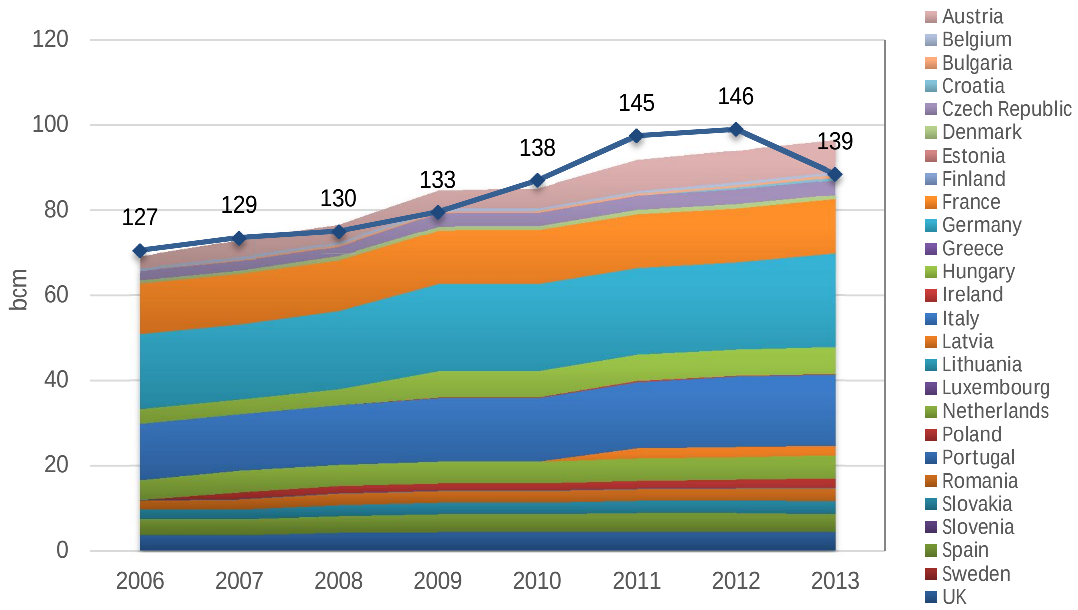
Overall, the section aims at exploring the changes in the EU network during the 2009-14 period. This transformation has added great capabilities to the network (e.g. Nord Stream and the subsequent increase in reverse flows, large storage capacity), but this has to be carefully revised in order to weigh their contribution toward sustainable levels of security.

Storage facilities

Storage is the first security of supply alternative for many EU countries as it provides alternative gas volumes already in place and close to demand centres. Because working gas capacity has greatly increased in the last years, storage can supply large amounts of gas to substitute non-delivered quantities in the event of disruption. While these levels result in a large amount of spare capacity, such margins can result unsustainable on the long term. In the last years the response from storage operators to current market conditions has been the reduction in the number of facilities (e.g. mothballing and decommissions), and the development of new storage products to adapt to new market demands for storage.

Investment figures for storage facilities gathered by GIE for the 2007-2013 period add up to €12,5 bn. This represents the second largest investment amount on a segment of the natural gas sector that totals €53,2 bn for the same period. Figure XXXVIII represents this evolution that has sustained its levels despite demand falling below projections.

FIGURE XXXIX: EVOLUTION OF EU-28 STORAGE CAPACITY AND NUMBER OF FACILITIES, 2006-2013 (BCM)



Note: The blue line represents storage facilities in operation.

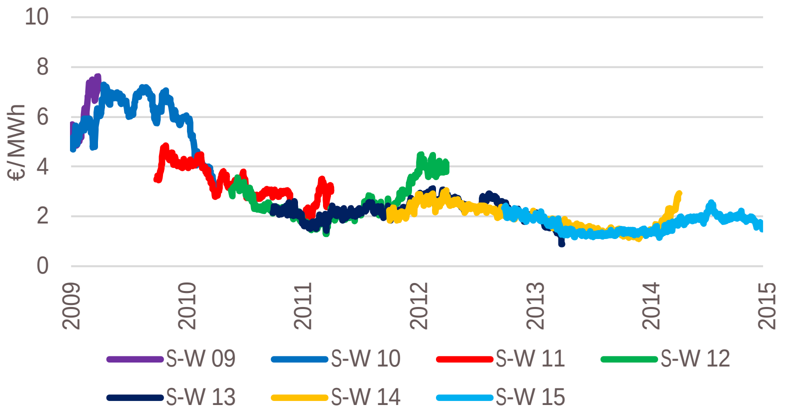
Source: GIE Knowledge Centre (Information available at GIE website)

Additional investment has translated into a steady increase in working gas capacity from 69 bcm in 2006 to 96 in 2013 (+39%). The evolution is represented in Figure XXXIX which distinguishes additions by country for the period. Countries in Central Europe recording large increases include Austria (+164%), Germany (+24%), and Czech Republic (+55%). In addition Italy, which is the EU destination for the largest quantity of gas transiting Ukraine has recorded to a large increase (+25%). Overall, increases in working gas capacity follow demand projections that have not been realized (see Figure VII on Section I).

The increase in capacity is problematic for storage operators given the current evolution of the market. Traditionally storage operators have relied on seasonal spread to recover investment and operation costs. However, price differentials between summer/winter seasons have decreased pushing storage operators out of business.

Seasonal spreads generally depend on supply flexibility. When supply tightness increases greatly in the winter as compared to the summer months, so do spreads. However, under current market conditions supply is more flexible during both winter and summer months. As a result, seasonal spreads on which storage operators rely, have also decreased. The factors explaining this decrease are not solely linked to demand although this decrease in consumption plays an important role. Low demand levels render supply more abundant. In addition to this, other factors not necessarily linked to the evolution of demand have contributed to decreasing seasonal spreads. These include greater integration under the IEM and higher interconnection and cross-border capacity. To weight these changes Figure XL below represents the evolution of seasonal spreads in the 2009-15 period. The marker fluctuates between levels of €4-8/MWh in 2010 to levels of €1-3/MWh in the 2010-14 period. Calculations by RWE Gas Storage for Central and North Europe estimate storage operation costs between 2,5 and €9,3/MWh[82]. Approximately half of the facilities considered in this estimation are above €4/MWh, which means that under current market conditions, seasonal balancing does not cover operation costs.

FIGURE XL: SEASONAL SPREADS IN EU GAS MARKETS, THE 2009-14 (€/MWH)



Note: 'S-W' marks represent summer-winter spreads.

Source: RWE Gas Storage presentation at the London Gas Storage conference, 2014

[82] RWE Gas Storage presentation at the London Gas Storage conference, 2014

As a result of these dynamics, storage utilization has decreased in the last years. Storage withdrawals have been low on successive winters 2010/11, 2011/12, 2013/14, 2014/15 with only two exceptions recording high storage withdrawals and injections. The first one is the 2012/13 winter, with in large withdrawals as a result of exceptionally cold temperatures. The second one is 2014, where large injections where recorded. In this case, increased storage utilisation has not been the result of normal operations but rather of the ongoing crisis in Ukraine and of cheap gas prices that allowed stocking gas in advanced of an interruption. This evolution is represented in Figure XV on Section I.

Storage decommissions and new flexible services

The response to the adverse situation storage currently faces is at least twofold. On the one hand, a challenging economic environment has led to facilities being mothballed and decommissioned. This can be appreciated in Figure XXXIX. Although working gas capacity has increased in the 2006-13 period, the overall number of working facilities decreased in 2013. Given high maintenance costs for storage facilities, decommissioning is more economical than mothballing[83] (the latter often results in continued losses). As a result working gas capacity is likely to decrease in the upcoming years. Given required time to plan infrastructure the current evolution will result in a decrease of current storage margins for security. So far this adverse context has lead storage operators to question the market valuation of security of supply.

On the other hand, storage operators are also changing their traditional working strategies to adapt to a different market environment. While storage has traditionally relied on seasonal spreads current adaptations shift towards offering more flexible products for short-term balancing. Facilities are often not designed for these purposes, however this unnatural adaptation is one of the responses the sector is developing to low demand levels. It is still to be seen whether market’s willingness to pay these services (and its extra costs) will be there.

Overall, it is important to point out how this adverse scenario has resulted in a positive outcome for Europe’s security of supply vis-à-vis Ukraine. Current underperformance of the sector paradoxically results in security of supply gains for Europe. In the coming years, the evolution of storage levels will raise question about where sustainable energy security levels stand.

LNG regasification terminals

The position of EU regasification terminals is different to that of storage as they are part of the LNG value chain rather than the EU midstream segment. This result in a different response to low EU demand levels. While LNG terminals have decreased its utilisation rates by larger margins than storage operators, their resilience to these shocks is greater. Responses to the

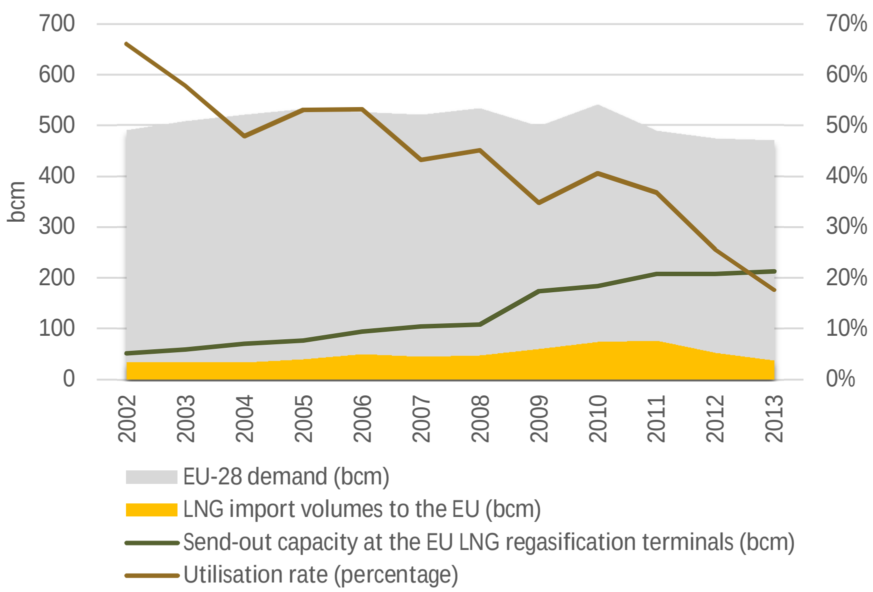
[83] Another reason for operators to close down is the need of reinvestment. This contributes to rendering facilities uneconomical under current market circumstances

current crisis include the reverse of operations to use facilities as re-export terminals. However, as opposed to the decommissioning of storage facilities, new LNG terminals are in construction or planned (e.g. Poland, Croatia, Lithuania and Bulgaria).

Within the LNG value chain, regasification terminals are part of portfolios that include upstream facilities (e.g. liquefaction plants). Concentrating the greatest share of investment, this segment of the value chain requires permanent utilization rates as opposed to regasification facilities that can be run at lower rates. Because regasification terminals are part of these different portfolios, they have been more resilient to decreases in utilisation rates. This particularity of the LNG business model is exemplified by the fact that world regasification capacity largely exceed liquefaction capacity.

Within Europe, investment on LNG terminals in the 2007-13 period amounts to €8.4 bn according to GIE (see Figure XXXVIII). Regasification capacity has increased from 104 bcm/y in 2007 to 213 bcm/y 2013. Figure XLI below shows the evolution of regasification capacity in the 2002-2013 period and compares it with total send-out volumes and EU demand during the period. It can be observed that while regasification capacity increases at a high pace during the 2009-13 period, send-out volumes start to decrease on 2012. As reviewed on Section I, the rise in regasification capacity is based on EU demand projections for the 2008-14 period that predicted levels above current consumption of about 100 to 200 bcm (see demand projections on Figure VII in Section I). On the other hand, the decrease on send-out volumes responds to high LNG prices after the Fukushima accident (see Figure XVIII) because of the high Japanese LNG demand. When demand in Europe started its current decrease, flexible LNG volumes where the first to be pushed out the supply mix due to their price being above other EU supplies.

FIGURE XLI: EU-28 EVOLUTION OF LNG REGASIFICATION CAPACITY, SEND-OUT VOLUMES AND DEMAND, 2002-13 (BCM/Y)



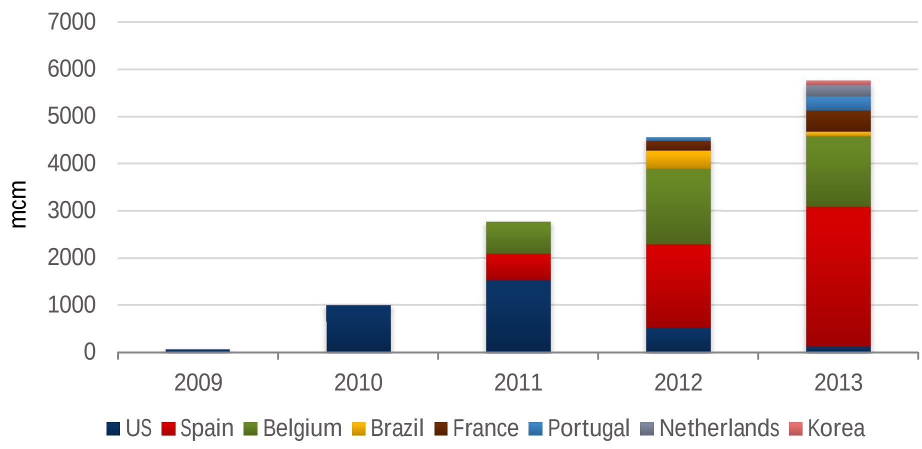
Source: GIE Knowledge Centre (Information available at GIE website). Demand figures are aggregated following Figure I in Section I.

The outlook for LNG started to turn in 2014 after three years of high prices in the global LNG market (see Box I and Box II). This has resulted in an immediate increase in LNG imports and a large margin as a source for alternative supplies in the event of a disruption. LNG imports can work as an immediate source of supply and also as a supply for refilling storage volumes after any disruptions in the winter.

LNG re-exports and further planned terminals

As a result of lower EU demand levels regasification capacity has decreased in EU terminals. However, given that this was caused by higher prices in other world regions, regasification terminals have been able to adapt its infrastructure to re-export volumes. This practice consists in the unloading of liquefied gas and its later reload and is a result of contract clauses often forcing importers to unload the cargo. For suppliers, these contracts allow controlling price differentials between world regions. The operation is only economical when these differences in prices exists and allow covering for costs of re-loading. LNG re-exports amounted to 4 bcm in 2012 and 5 bcm in 2013[84] and represented up to 15% of total European LNG imports. Although an expensive alternative, they are an example of the response in EU terminals to low send-out levels. The phenomenon is however expected to decrease in the current context with Asian prices levelled to the EU[85]. Figure XLII represents re-loads by country of destination

FIGURE XLII: LNG RE-EXPORTS BY COUNTRY, 2009-13 (MCM)



Source: IEA (2014a, p.137)

A second particularity of EU's LNG segment to low demand is the increase in planned infrastructure. While storage facilities are being decommissioned, there are planned LNG regasification facilities in Europe. Traditionally LNG has served to reach the West end of Europe, which was not supplied by Russia. However, in the current context several terminals are under

[84] IEA (2014a, p.129)
[85] At the time of writing in 2015 LNG re-exports where still a practice in Europe.

construction or planned. These include Croatia, Lithuania, Poland and Bulgaria. Additionally, Greece's LNG regasification terminal is expanding its storage capacity to be able to unload full cargoes in shorter time.

Import and transmission infrastructure

The role of transmission infrastructure is different to the two previous segments analysed. As opposed to storage and LNG terminals, transmission is a regulated business which means that its exposition to demand variations is to some degree lower. This last part of Section VIII examines changes in the network between 2009 and 2014 and refers both to additional import and to transmission capacity implemented during this period (including cross-border interconnections). While cross-border capacity increases the diversification potential of a network, it heavily relies on gas supplied for this purposes which often comes from additional import projects.

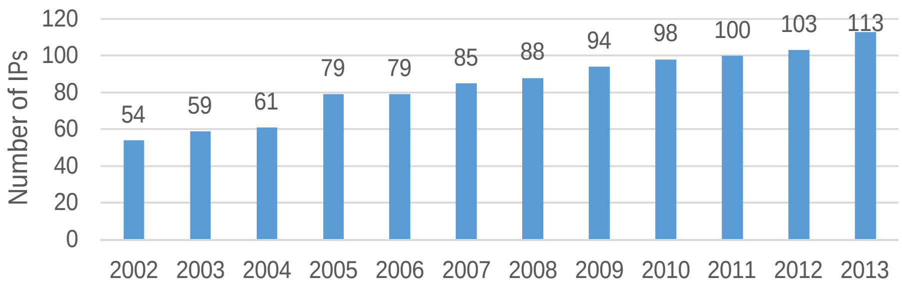
The most notable import project during the examined period is the Nord Stream pipeline, which was fully commissioned in 2012 and added 55 bcm/y of import capacity to Europe. In regards to Interconnection capacity, infrastructure additions have expanded bidirectional capabilities in cross-border interconnections to 40% of Europe's IPs. This represents an increase of 25 percentage points in the 2009-14 period from previous levels of 15%.

The section is complemented by Section X which looks at the evolution of reverse flow in the recent years. As opposed to both LNG and storage, which have seen utilisation rates decreasing as a result of low demand, transmission infrastructure has not necessarily seen such a decrease. Specific routes have recorded lower flows whilst other have increased its utilisation rates. Changes in demand have resulted in variations in supply routes within Europe and consequently in changes in transmission patterns. Additionally, Section IX looks at regulatory aspects of security of supply which complements too the views here presented on transmission.

Capacity additions in North, East and South-East Europe

Despite decreasing demand, transmission capacity has continued to increase in the EU network during the 2009/14 period. Investment in this segment surpassed both additions in LNG and storage capacity amounting to €32,3 bn (60% of investment recorded by GIE; see Figure XXXVIII). This translates into an increase in cross-border and imports points from 94 to 113 during the period (see Figure XLIII below). As shown in the Section X on OPAL, the potential of both import infrastructure and cross-border capacity is mutually dependent. The capacity to re-route supplies is only unlocked with the adequate transmission infrastructure in place. Inversely, transmission infrastructure only allows re-routing flows when supplies are available at entry points in the EU network. The unlocking of this potential is shown in the case of Nord Stream, which is supported by large cross-border capacity in Central and East EU to distribute additional gas volumes in.

FIGURE XLIII: NUMBER OF CROSS-BORDER AND IMPORT POINTS IN THE EU, 2002-13



Source: GIE Knowledge Centre (Information available at GIE website)

A representation of additional import and transmission capacity in Europe in the 2009-14 period is included in Map VI below. What is notable in it are the different results in Central and South-East Europe. While in the former case import and transmission capacity have both increased, in the latter the few transmission projects have not been accompanied by large additions in import capacity. The various planned projects are not yet in place or have been cancelled (e.g. South Stream and Nabucco).

Regarding **Central Europe**, the key project is Nord Stream that in 2012 commissioned a second line such that the total capacity amounts to 55 bcm/y now. At its receiving end in Greifswald two further segments, NEL and OPAL, divert its gas into Germany (and later towards France, the Netherlands, Belgium and the Czech Republic). Figure XI and Figure XLIV show the displacement in volumes from Ukrainian transit to the Nord Stream route. As transit through Ukraine has decreased, additional Russian export volumes have been shipped through the Nord Stream in the 2012-14 period.

The Czech Republic and Southern Germany respectively are served with Gazelle pipeline of total capacity of 32 bcm. Both ends of Gazelle at Hora Sv. Kateriny (North West of the Czech rep.) and at Waidhaus (Southern Germany) together with Germany-Austria interconnectors at Sudal and Oberkappel are able to bring alternative quantities. Additional reverse flow capacity include additions allowing flows from the Czech Republic and Slovakia (70 mcm/d) and from Austria to Slovakia (22 mcm/d). This allows gas to flow as far as the East of Slovakia where it can be transported to Ukraine. Border capacity from Slovakia to Ukraine consists of 17 mcm/d to be increased to 27 mcm/d (Budince IP).

Altogether these alternative routes have established a remarkable West to East reverse flow corridor that has even eclipsed in terms of capacity conventional East to West gas flows (reference). This gas reaches the Czech Republic, Austria, Slovakia and Hungary. Bottlenecks to ship further quantities South towards Romania, Serbia and Bulgaria, are observed.

MAP VI: ADDITIONAL IMPORT AND TRANSMISSION INFRASTRUCTURE 2009/14 (BCM/YEAR)

Note: PL and HU border points with UA offer only interruptible capacities of 4 mcm/d (1.4 bcm/y) and 17 mcm/d (6.2bcm/y) respectively. At the time of writing there was no technical firm capacity established. In addition, transmission through this border points has been repeatedly interrupted during 2014.

Source: GIE presentation. Madrid Forum XXV, 6 May 2014. Network upgrades from ENTSOG TYNDP 2013-2022. Technical firm capacities in bcm/y (estimated).

As opposed to Central Europe, **South and East Europe's** efforts to increase interconnection capacity have not been accompanied by additional import capacity. Countries in the region, together with West Balkans relied on projects such as the South Stream or the Southern Gas Corridor. Bulgaria, Serbia, and Hungary had invested substantial financial and political capital in the Gazprom-led project, which was cancelled in December 2014 (see Box IV).

After the meeting with energy ministers from eight of the EU countries involved in the South Stream project (Bulgaria, Slovenia, Austria, Croatia, Italy, Greece and Romania) the European Commission issued a statement suggests alternative infrastructure that notably include LNG regasification terminals[86] (e.g. Croatia and Bulgaria).

Box IV: South Stream and Russia's eastwards expansion

In 2014 Russia announced a turn in its natural gas export strategy based on an agreement with China for the construction of two pipelines and the cancellation of the South Stream project for a pipeline to Turkey. The shift notably turns Russia's expansion towards the East and it will have important consequences for both EU and Asian natural gas markets.

The expansion to China includes two projects, one of which is already agreed[87]. The $400 billion deal for the Power of Siberia pipeline was reached in May 2014 for a total export capacity of 38 bcm. In addition, in November 2014 Gazprom and CNPC signed a memorandum of understanding for a second pipeline via the Russian republic of Altai. While export capacity is agreed around 30 bcm, negotiations about pricing are still ongoing. Overall the deals could result in China importing up to 68 bcm as soon as 2019 and poses serial competition to upcoming LNG projects which look at China as the fastest growing natural gas market.

In parallel to these decision which had been in discussion since the 1990s, Russia announced in December the cancellation of the South Stream project. The pipeline was the largest gas infrastructure project in Europe and was planned for a total capacity of 63 bcm and $40 billion. It was expected to cross the Black Sea arriving at Bulgaria allowing Russia to fully by-pass Ukraine.

Gazprom's cancellation was followed by the announcement of the 'Turkish Stream' for a similar export capacity of 63 bcm/y. Out of this capacity 14 bcm/y are planned to replace Turkish imports from Ukraine (transiting Romania and Bulgaria) with the remaining volumes to be shipped to the Turkish-Greek border. From here it is still to see how previous South Stream customers will be supplied[88]. The finalisation date still depends on the route chosen to cross the Black Sea. One of the possibilities being discussed is the Turkish town of Kiyiköy.

Networks in South-East EU that were isolated in 2009 continue to be isolated in 2014[89]. Their interconnection has so far dependent on large pipeline projects which so far have not been

[86] European Commission (2014c)
[87] Further details can be found in Herderson (2014).
[88] For a review of this changes see Stern et al., (2015)
[89] For an analysis of the state of the natural gas network during the 2009 Ukrainian dispute see Kovacevic (2009).

realised (e.g. South Stream) leaving the region with continuing diversification difficulties. These disconnected networks are represented in the three different circles in Map VI above.

- **Romania**, **Bulgaria**, **Greece** and **Macedonia** were supplied though Ukraine and they continue to be supplied mainly through this corridor. An interconnection has been built to connect this section with Hungary and further interconnections have been built between these countries.
- **Serbia** and **Bosnia Herzegovina** continues to be supplied from Ukraine via Hungary.
- **Croatia** continues to be supplied via Austria and Slovenia, although transit capacity from Hungary has been added together with a planned LNG terminal.

Cross-border interconnectors

Looking specifically at interconnection capacity, cross-border capacity has also increased during the period. The share of IPs capable of permanent bi-directional cross-border flows has increased from 24% in 2009 to 40% in 2014[90] (EU-28). This figure illustrates that almost one out of every two interconnectors implements bi-directional capability. Compared to 2009 there are four additional borders implementing bi-directional transit, all of which are relevant for countries relying in Ukrainian transit: Germany-Denmark; Italy-Austria, Greece-Bulgaria and Romania-Hungary. The table below summarises implemented projects during the 2009-14 period.

TABLE: THE EVOLUTION OF INTERCONNECTION CAPACITY 2009-2014.

	2009	2014
Number of cross-border interconnection points in the EU	49	53
Number of bi-directional interconnection points	12	21
Number of unidirectional interconnection points	37	32

Source: European Commission (2014d)

The EC's review of the implementation of Regulation 994 points out additional segments key for increasing security of supply Europe which include:

- France / Germany (Obergailbach IP)
- UK / Netherlands (BBL pipeline).
- Germany / the Czech Republic (Waidhaus IP).

Both interconnectors in the German borders are relevant for dependence on Ukrainian transit, but the Waidhaus IP is especially important as it allows further flows to arrive to Central and Eastern Europe. This evolution is represented in Map IX in Appendix II.

[90] European Commission (2014d)

Flow dynamics, network congestion and investment cycles

The effects of low EU demand on the transmission network have been different than those on the LNG and storage segments. The main reason for this is that transmission is a regulated business. Its exposure to losses resulting from low utilisation is therefore lower.

In addition to this, it is also important to remark how decreases in demand have not necessarily resulted in decreases in transmission utilisation. This is especially true when focusing on specific routes. What can be observed (and this is something developed in Section X on reverse flow) is that after 2009, and especially after the commissioning of Nord Stream, flow dynamics have greatly changed. Despite demand continuing to decrease, some routes have recorded greater transmission levels. The effect is different from the responses of both LNG and storage to low demand. Instead of a decrease in utilisation rates for transmission utilisation, there is an observed changed in supply routes.

Part of the change in transmission utilisation is linked to the changes in supply patterns to Europe. At the same time demand has decreased, indigenous production has decreased too. This has resulted in a greater reliance on imports to Europe, particularly on pipeline imports. Gas to Europe travels farther as it arrives from farther away destinations. Russia and Norway have recorded the largest increases as suppliers to the EU.

SECTION IX: EU SECURITY REGULATION

The EU natural gas network has not only changed because of improvement in infrastructure but also because of changes in regulation. The EC has approved new legislation, security of supply regulation and infrastructure projects in the 2009-14 period, which have been key to provide a common framework to increase security of supply. The previous section has already emphasised the relevance of network codes and regulation in regards to both storage and transmission. The current section explores in detail the actions taken by the EC to promote energy security in the EU.

During the 2009-14 period the TEP entered into force allowing to create various regulatory bodies to coordinate network plans, transparency platforms and network codes (e.g. ENTSOG and ACER). The EC's role has been key for adopting common security of supply standards (e.g. the N-1 standard), and obligations for implementing bidirectional capabilities in cross-border IPs. During the analysed period several finance instruments have been used to promote infrastructure projects aiming at increasing security of supply. A total budget of €6 bn has been allocated for natural gas projects in the 2008-20 period (€1 bn under the EEPR program and close to €2 bn under the TEN-E/CER facility)

The EC's competences on energy

The EC and other EU regulatory and legislative bodies have had a changing mandate in the transformation of the EU energy sector. Notably, this participation has gradually increased with energy security becoming a more active policy in the latter stage of the process. Both, the added EC competences in the Lisbon Treaty and the 2009 crisis have contributed to increasing the priority of energy security as part of EU policies.

The initial steps taken by the Community were not seconded by competences on neither the EEC Treaty (1957) nor the Maastricht Treaty (1992). The first proposal for and European Internal Energy Market by the EC dates back to 1988[91] and several gas directives were approved by the Community to 2003. These are the Gas Transit Directive (1991), the First Gas Directive (1998), Gas Regulation 1775 (2005), and the Second Gas directive (2003). For this legislation, the Community ruling on energy were based on competences for the development of the Single European Market (SEM), which came to justify the application of EU competition law, together with competences from environment[92].

[91] European Commission (1988)
[92] Yafimava (2011, 2013)

These Directives proved to be insufficient for implementing competition in the IEM as showed by the Energy Sector Inquire launched by DG COMP in 2005. In response to this deficiencies the EC proposed a third legislative package that resulted in the adoption of the Third Gas Directive and Regulation 715 (known as the Third Energy Package). The legislation encompasses the unbundling of gas transmission capacity under three different proposed options, an entry-exit access system to the gas network, the development of European cross-border codes, and the creating of two new agencies: the Agency for Cooperation of Energy Regulators (ACER) and the European Network of TSOs for Gas (ENTSOG).

In addition to this evolution, the Lisbon Treaty has strengthened the role of the EC in energy security. MSs signed it on 13 December 2007, and the Treaty entered into force on 1 December 2009. It guarantees specific legal basis in the field of energy with the creation of art. 194 of the Treaty on the Functioning of the EU[93]. It allows the EC to take action to ensure the functioning of the energy market, and to promote energy security, energy efficiency and the interconnection of energy networks. As opposed to the initial steps taken by the EC in the area of energy, the Lisbon Treaty provides shared competences between the EU and MSs in this domain according to the principle of subsidiarity. The EU can therefore act when its capable of acting more efficiently then MSs, although it does not have competences to rule over MSs choices in relation to their energy mix.

Security of supply regulation

The later stages of this process has allowed for actions at a EU level aiming at energy security. The first security directive dates back to 2004 together with the EC's Energy Security and Solidarity Strategy from 2007 and 2008[94]. In the aftermath of the 2009 Ukrainian dispute the revision of security of supply regulation was proposed.

In Oct 2010 the European Commission adopted the security of gas supply Regulation (EU) 994/2010 [95]('Security regulation') repealing the older Directive 2004/67/EC. On 2 December 2010 it entered into force defining a common framework for enhancing and coordinating gas security of supply for the whole European Union. Overall the Directive defines market-based mechanism to guarantee supply, and coordination measures at a EU level in case these policies fail to deliver gas in the event of a crisis. The instruments defined in the Directive are:

- A definition of **protected customers** including small and medium-sized enterprises, essential social services and/or district heating installations.
- Common **security of supply standards** for protected customers under extreme circumstances[96].

[93] For the Consolidated Versions of the Treaty of the European Union and the Treaty on the Functioning of the European Union (2010/C 83/01) containing article art. 194 see: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C:2010:083:FULL&from=EN (Official Journal of the European Union)

[94] EC (2008)

[95] Regulation (EU) No 994/2010 of the European Parliament and of the Council of 20 October 2010 concerning measures to safeguard security of gas supply and repealing Council Directive 2004/67/EC. Official Journal of the European Union, 12.11.2010, L295/1.

[96] Extreme circumstances include: a) seven day temperature peak, b) at least 30 days of high demand, c) an infrastructure disruption under normal winter conditions. The latter case applies to a disruption in Ukrainian transit to Europe.

- The N-1 standard aiming at implementing **a common security of supply benchmark for infrastructure**. This index measures the capacity of gas networks to secure diversification; MSs must ensure it by 3 December 2014. The Directive does not provide any standards on neither supply nor storage for MSs to guarantee these supply conditions. Competent authorities are responsible for supervising how this undertaking is carried by companies by means of non-discriminatory measures.
- The obligation on transmission operators to implement **permanent bi-directional flow capacity on all interconnectors** by 3 December 2014. The responsibility of this actions relies on Competent Authorities which can grant exemptions on specific IPs where bi-directional capacity would not contribute significantly to security of supply of any MS or region or when investment costs outweigh the benefits of increasing energy security
- MSs' obligation to define a **regulatory or government authority** responsible for making full risk assessments on gas security of supply. These include establishing a Preventive Action Plan (PAP) and an Emergency Plan (EP). The former should contain risk assessments (RA), emergency and preventive measures to address described risks. The latter aims at defining roles and responsibilities and identifying the contribution of different measures.

To facilitate the funding of security standards, Regulation 994 was accompanied by regulation on infrastructure defining the category of Projects of Common Interests eligible for EC funding. This adds to previous EC financial instruments in the field of energy that are reviewed in the next section.

Overall, common EU regulation has contributed to increasing Europe's security of supply[97]. Notably, obligations for developing bi-directional interconnectors have contributed to enhancing reverse flow capabilities as shown later in this section.

EC infrastructure projects

The EC's participation in the financing of infrastructure projects increased over time, notable in the aftermath of the 2009 Ukrainian dispute and as a result of revised mandate in the Lisbon Treaty. This section looks at three different funding instruments used by the EC since 2007 and planned to 2020. The contexts of these tools are different and do not all refer explicitly to security threads. They are a response to particular events (e.g. the 2009 Ukrainian crisis), but they are also part of efforts designed for boosting economic recovery (e.g. after the 2008 financial crisis).

During the mentioned period the EC's efforts have aimed at increasing interconnection capacity as means of achieving higher security of supply and liquidity in EU hubs. As results, MSs in the EU, especially in Central and South East Europe, have larger interconnection capacity between

[97] The European Commission (2014d) has carried out an assessment regarding the implementation of Regulation 994.

them (see Map VI and Map IX in Appendix II). This developments has been relevant in reducing exposure to gas shortages in the event of a disruption in Ukrainian transit lines notably by allowing gas to transit between MS, particularly in reverse direction (from North to South and from West to East).

The majority of interconnections developed during the 2009/14 period are financial projects justified on the basis of market demand according to the TEP supported by regulation (NRA). However, additional EU funding has been granted to projects for which market interest was not high enough and where security of supply could be improved. This is the aim of the TEN-E (old and new framework linked to the Connecting Europe Facility – CEF) and the European Energy Program for Recovery (EEPR). EU funds cover up to 50% of the costs of a project with a typical value of 10%. With this participation the EC is able to increase investment recovery. The role of the EC has been important in projects such as the German-Poland IP (Yamal pipeline), the Romania-Hungary IT, and the Greece-Bulgaria IP[98].

Although these programs include budgets dedicated to promoting infrastructure often beyond the energy sector, they specifically target gas. The EEPR has dedicated €1 bn and the TEN-E program under the CEF has dedicated one third of its €5.85 bn budget (approximately €200 mm/y).

Trans-European Energy Networks: 2007-2013

Several guidelines have been proposed for Trans-European Energy Network (TEN-E) projects. The first were adopted in 1996 and subsequent revisions have taken place in 2003 and 2006. The last of which referred to the 2007–13 financing period[99] and allocated €155 million to infrastructure initiatives.

These guidelines included 42 projects of European interests which were presented in line with the "Priority Interconnection Plan"[100] (COM(2006) 846). They consisted mainly of feasibility studies aiming at evaluating interconnection projects, monitoring the internal energy market, coordinating TSO's activities, and encouraging EU banks (EIB and EBRD) to fund priority interconnections.

European Energy Program for Recovery: 2008

The European Energy Plan for Recovery (EEPR)[101] was set up by the EC in the late 2008 as a response to the double energy and financial crisis in the context of an 'Economic Recovery Plan'[102]. The instrument has been used simultaneously to the TEN-E program and encompasses

[98] The Greece-Bulgaria IP is not in operation at the time of writing (2014d, p10).
[99] Further details can be fount at the EC's website: http://ec.europa.eu/energy/en/topics/energy-strategy/2020-energy-strategy
[100] European Commission (2007).
[101] Further details are available at the EC's website for EEPR: http://ec.europa.eu/energy/eepr/
Information on budget allocation in 2014 can be retrieved at: http://ec.europa.eu/energy/eepr/doc/2014_cswd_council_final.pdf
[102] Details are available at the EC website:
http://europa.eu/legislation_summaries/economic_and_monetary_affairs/stability_and_growth_pact/ec0004_en.htm

a total budget of €3.85 billion dedicated to energy projects. Out of this, €2.2 bn have been dedicated to gas and electricity infrastructure. By April 2014 €0.89 had already been disbursed (40% of the committed budget).

The EEPR funded projects in three main areas of the energy sector: gas and electricity infrastructures, offshore wind energy and carbon capture and storage in addition to energy efficiency and RES in line with the 20/20/20 targets. Proposals eligible for funding are selected on the basis of technical, financial, environmental and socioeconomic criteria and with several gas infrastructure projects were accepted including pipeline interconnectors, the adaptation of existing projects to function in reverse flow mode, gas storage facilities and an LNG import terminal. Countries with a high reliance on gas imports through Ukraine are considered to be a priority under the EEPR category to contribute to diversifying gas supply routes in Central, East and South East Europe.

The EEPR instrument facilitates the recovery of investment costs for projects contributing to energy security. This is especially important for projects falling out of a commercial logic but still being paying a relevant contribution to energy security.

Projects of Common Interest: 2014-2020

In order to facilitate common security of supply standards, set in Regulation 994/2010, the EC approved Regulation (EU) 347/2013)[103] laying down the guidelines for the implementation of infrastructure projects in identified corridors. The regulation was adopted on 21 March 2013 and entered into force on 1 June 2013 defining criteria for Projects of Common Interest (PCI) to be eligible to funding under the Connecting Europe Facility (CEF). The PCI selection process is part of the new framework for TEN-E. The CEF is the financial instrument under the new TEN-E.

The CEF covers the 2014-2020 financial period and it is designed to finance EU infrastructure projects in Transport, Energy and Telecommunications. It encompasses a budget of €33,2 billion of which €5.85 billion are allocated to energy infrastructure. The guidelines for PCI projects were laid on Regulation 347/2013[104]. The directive identified 12 priority corridors covering the areas of electricity, gas and oil, and defined the category of Projects of Common Interest (PCI) which would benefit from a faster and more efficient permitting procedures and improved regulatory treatment. These projects comply with criteria including the mandatory contribution to the implementation of one out of four identified energy corridors, and being in the interest of at least two MSs. Some of these projects had been made eligible to funding under the EEPR criteria. The starting date is 2014, and projects are updated every two years.

[103] Regulation (EU) No 347/2013 of the European Parliament and of the Council of 17 April 2013 on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC and amending Regulations (EC) No 713/2009, (EC) No 714/2009 and (EC) No 715/2009. Official Journal of the European Union, 25.4.2013, L115/39.

[104] As laid on art. 4 of Regulation 347/2013, PCI criteria for infrastructure projects include: (a) Contributing to security of supply in at least one of the energy infrastructure priority corridors and areas identified; (b) involving at least two MS or being located in one MS projects should benefit cross border transit with a neighbouring MSs or EEA countries. Additionally, gas infrastructure projects should contribute to one of following categories: market integration, security of supply, competition and sustainability.

The first list of PCI projects were adopted on 29 October 2013 and proposed a list of 106 gas infrastructure projects[105] amounting to €1.37 billion. After this first stage, a second round is due in 2015. Although PCI regulation states that the greater share of the energy budget should be dedicated to electricity, this first round dedicated €255 million to electricity projects, and €392 million to gas initiatives[106] (16 grants dedicated to gas projects and 18 to electricity). Projects relevant to dependency from Ukrainian transit are listed in Table V below.

TABLE V: PCI PROJECTS IN THE SOUTHERN GAS PRIORITY CORRIDOR AGREED ON 2014

Corridor	Country	Description
North-South gas interconnection in Central Eastern and South Eastern Europe Priority Corridor	Poland-Czech Republic	Interconnection
	Poland - Slovakia	Interconnection
	Hungary - Slovenia	PCI Interconnection
	Austrian - Czech Republic	PCI Bidirectional interconnection
	Croatia	LNG regasification vessel.
	Greece	Offshore LNG terminal (FSRU)

Source: EC's website. See footnote 105

[105] The list of PCI projects under CEF funding is available at the EC's website: http://ec.europa.eu/energy/infrastructure/pci/doc/20141121_cef_energy_lists.pdf
[106] European Commission (2014b)

SECTION X: REVERSE FLOW

While reverse flows have been a common practice in North and Central Europe they have not been a common part of transmission dynamics in East Europe. Capacity additions in the 2009-14 period in storage and transmission, together with regulation have changed this. The year 2014 has come to exemplify the potential of reverse flow as a tool for security of supply as some border points (e.g. Lanzhot in CZ – SK) have recorded reverse flow volumes surpassing traditional East to West flows. This section summarises changes in flow dynamics in the 2009-14 period where new transmission capabilities resulting of new infrastructure additions have been realised (the evolution of storage, LNG and transmission infrastructure is reviewed on the previous Section VIII).

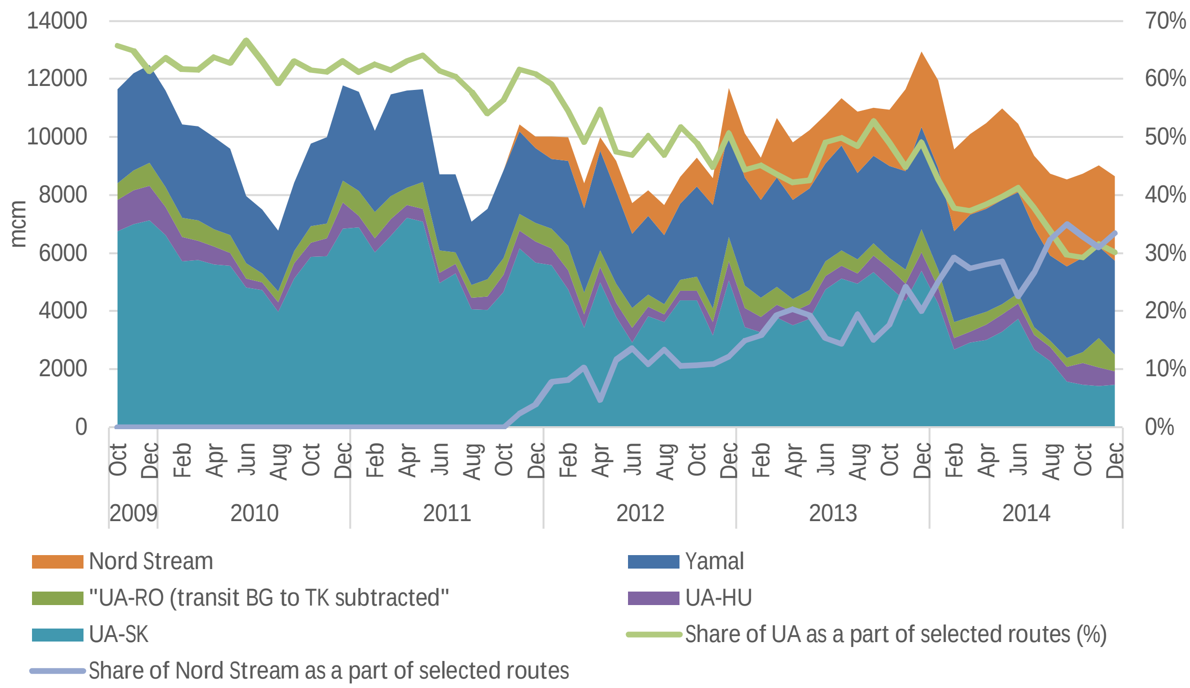
The use of reverse flow in this region and its contribution to energy security was first pointed out in the aftermath of the 2009 Ukrainian crisis when unusual transit was used as a response to the 2-week disruption. It was a tool frequently used in North and Central Europe but not in East Europe. The main energy security documents prior to 2009 do not mention at all reverse flow as a security instrument for Central, East and South-East Europe. The term was incorporated in the energy lexicon in the aftermath of the dispute[107]. Since then, the EU has embarked in the promotion of bidirectional transit to allow the inversion of traditional supply routes.

The EC's 2014 Energy Security Strategy[108] and the later Stress Tests[109] have emphasized the importance of reverse flows. During this year several factors have allowed transit in these directions to increase. Since 2012, Nord Stream allows diverting gas from Germany towards the Czech Republic and further eastwards. In addition to this increase in imports via Germany, newly implemented cross-border capacity has allowed distributing these additional volumes. In 2014 several factors aligned allowing an increase in reverse flow volumes. Besides the urgency in Ukraine as a result of the Russian interruption in 2014, Europe's low demand and high storage levels allowed gas to be shipped cost effectively in reverse direction.

The traditional route for Russian supplies to Europe has been Ukraine. In 1997 Yamal was started flowing gas in a parallel corridor and only in 2012 Nord Stream was fully commissioned. While the first to corridors have flown gas from East to West, Nord Stream has opened the possibility of gas arriving to Europe through Germany and further flowing East and Southwards against the traditional import route for Russian gas. Figure XLIV represents these flows in the 2009-14 period, and plots the shares transiting through Nord Stream and Ukraine. There is an obvious shift towards flows through Nord Stream by 2014. The shift of balance towards Nord Stream has made it possible to reverse flows to take place in other EU border points. It is Russia's export strategy that allows the transit to flow against its traditional export routes.

[107] It is in the aftermath of the 2009 crisis that GTE (2009) underwent a study assessing the role of reverse flow as a security instrument.
[108] European Commission (2014b)
[109] European Commission (2014a)

FIGURE XLIV: RUSSIAN EXPORTS TO CENTRAL EUROPE AND SHARE TRANSITING NORD STREAM AND UKRAINE, 2009-14 (MCM/MONTH)



Note: Percentages represent the share of transit through Nord Stream and through Ukraine as part of total selected routes. These routes include Russian exports to Europe excluding the Baltics and Finland, South Stream and exports exiting Bulgaria towards Turkey.

Source: IEA Gas Trade Flows Europe.

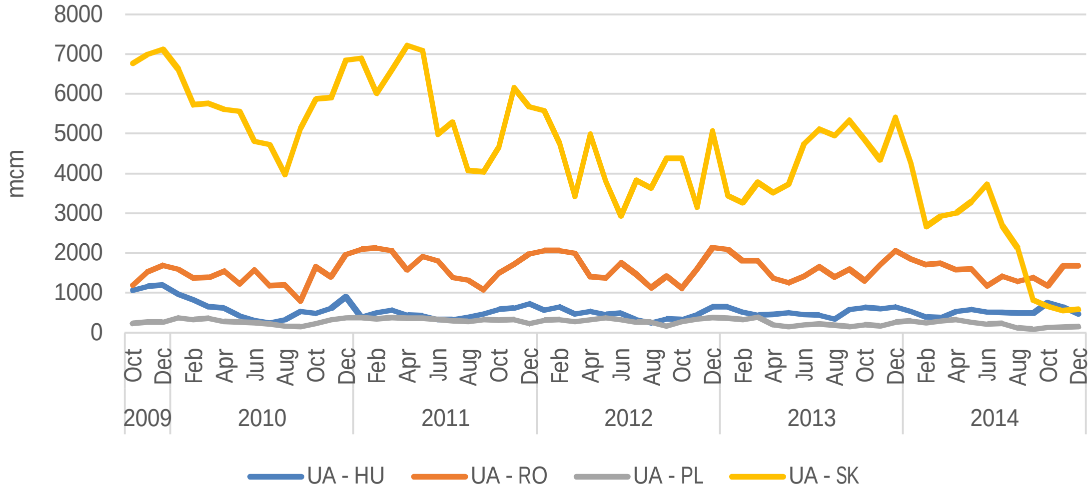
As a result of this evolution a shift towards reverse flow has spread to other segments of the EU network, particularly the Ukrainian border and Central Europe. Regarding the former, reverse flows to Ukraine have increased in 2014 as a result of decreasing Russian exports to Europe through that route, supply interruptions to Ukraine, additional interconnection capacity from EU to Ukraine and high EU storage levels. Slovakia, Poland and Hungary all have capacity to ship gas to Ukraine. This evolution is pictured in Figure XLV below which represents net flows in the Ukrainian border with selected neighbouring countries. Out of the three borders represented, Romania has no reverse flow capacity so the net flow decrease is not due to increasing reverse flow transit.

Reverse flow from Slovakia to Ukraine started in September 2014 at the Budince IP. The Slovak TSO Eustream announced firm capacity amounting to 17 mcm/day to be increased on March 2015 to 27 mcm/day[110]. Flows from Hungary to Ukraine had 7.9 mcm/day of interruptible capacity. However gas flows were halted on 26 September 2014 after Alexeï Miller's visit to the country and in advanced of one of the trilateral meeting between Europe, Russia and Ukraine.

[110] Firm capacity together with interuptable capacity at Budince IP ammount to 41 mcm/d since January 2015. See: https://tis.eustream.sk/TIS/#/?nav=bd.cap
Check also: http://ec.europa.eu/commission/2014-2019/sefcovic/announcements/enhancing-energy-security-between-eu-and-ukraine_en

The Hungarian operator FGSZ has argued this halt was due to increasing gas flows entering the country that rendered reverse flows to Ukraine technically not feasible. Finally, Poland has a technical capacity to Ukraine of 4.4 mcm/day.

FIGURE XLV: NET FLOWS IN UKRAINIAN – EU IPS, 2009-2014 (MCM/MONTH)

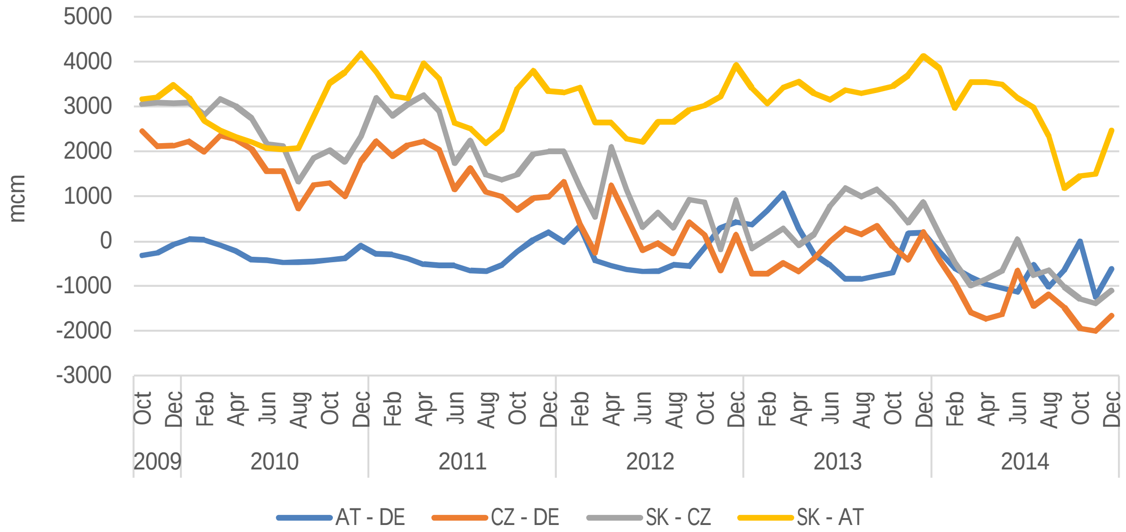


Source: IEA Gas Trade Flows Europe. UA – HU includes Beregdaróc, UA – RO Isaccea, UA - PL Hermanowice and Drozdowicze

Within Europe a similar evolution can be observed in some of the main border points traditionally serving for Ukrainian gas to transit westwards into Europe. In these cases net imports have shifted towards higher reverse flows, especially during the 2013-14 period. Figure XLVI represents border transit between Germany – Czech Republic, Germany – Austria and Czech Republic – Slovakia.

According to transit dynamics previous to 2012, gas entering Europe through Ukraine would mainly do so through Slovakia. These flows would later divide with half of these quantities going to the Czech Republic (Lanzhot IP) and with the other half going into Austria (Baumgarten IP). As a result of increasing gas quantities being shipped through OPAL and arriving at the Czech Republic through Brandov IT and the Gazelle pipeline, flows in Lanzhot have recorded greater gas volumes transiting in reverse flow towards Slovakia. This evolution is represented in Figure XLVI under the 'DE-CZ' and 'CZ – SK' markers. As transit from Germany to the Czech Republic has increased, the net transit at the Czech – Slovakian border have shifted towards reverse flow. In regards to gas flowing from Slovakia to Austria, commercial reverse flow at Baumgarten started in mid-August 2014. The change in border flows is represented as a steep decrease at the end of 2014.

FIGURE XLVI: CROSS-BORDER TRANSIT IN SELECTED INTERCONNECTION POINTS, 2009-2014 (MCM/MONTH)



Source: IEA Gas Trade Flows Europe; SK – AT includes Baumgarten; CZ – DE Hora Svate Kateriny, Brandov, Waidhaus and Olbernhau; CZ – SK Lanzhot; AT – DE Kiefersfelden, Oberkappel, and Uberackern II

SECTION XI: OPAL'S TPA EXEMPTION MODELLING RESULTS

This section explores the implications that a TPA exemption for the OPAL interconnection point at Brandov has for gas transmission in the EU. It presents modelling results from the TIGER Model with variation in supply from LNG, storage and pipeline transit on two different scenarios. It aims at assessing the implications of TPA regulation for **security of supply**. The case study used it that of the OPAL pipeline.

During 2014 the crisis between Russia and Ukraine raised concerns about a potential interruption of supplies to Europe. Under such scenario the current TPA limitation on OPAL's transit could come to limit supply from Germany to the Czech Republic (Brandov IP). These limitations were seen with concern given the restraint they created on transit flowing from Germany towards South East Europe. The region faced a severe emergency situation in 2009 and a limitation in OPAL's capacity could result in worsening supply conditions in the event of a disruption.

Section II has already presented how a change in OPAL's regulation alters the total volumes Russia can divert to bypass Ukraine. These quantities vary between 88 bcm/y and 104 bcm/y depending on Gazprom's access to Brandov IP. In the event of a disruption, this difference results in changes in the supply mix used to compensate non-delivered volumes. Under a scenario with limited IP access to Brandov, alternative volumes amounting to 16 bcm are supplied by LNG imports and storage rather than through Nord Stream.

This example comes to show how European regulation on gas transit has the potential to affect Europe's supply mix. Since the inception of the Internal Energy Market, the liberalisation of the gas sector has aimed both at increasing competition and security of supply. Simulations show how different regulatory decisions on OPAL 's TPA regime alter Europe's gas supply structure. At last, the argument tries to prove how the EU Internal Market can affect Europe's foreign policy when it comes to energy.

OPAL and TPA regulation

The OPAL pipeline was commissioned in 2011 linking Nord Stream in Germany (Greifswald) with the Czech Republic (IP Brandov). It has a co-ownership structure between the German based Wintershall-Gazprom subsidiary WIGA Transport Beteiligungs-GmbH & Co. KG (WIGA) (80%) and Lubmin Brandov Gastransport GmbH (E.ON Group) (20%). Its transit capacity from Nord Stream Land Fall in Greifswald to the Czech Republic is 32 bcm and corresponds to the interconnection capacity at the Czech Republic (31 bcm/y). Nord Stream has a total capacity of 55 bcm/y which splits into NEL (23 bcm/y) and OPAL (32 bcm/y).

Wintershall BASF.DE, BASF's and E.ON applied for exemptions on both of the lines at the receiving point of Nord Stream, OPAL and NEL to free investors from both TPA and tariff checks based on both pipelines' transit. However, the German regulator only accepted the case for OPAL as it considered that the NEL pipeline was to be used on purely national basis. Instead of transiting to another country (as OPAL does shipping Nord Stream's gas to the Czech Republic), NEL's destination is the German market (it arrives at Rehden in North Germany).

An agreement was signed between Gazprom and BNetzA on November 2013 for a TPA exemption for the pipeline. The deal, which remained under confidential terms, was sent for approval to the EC the same month[111]. However, a response has been repeatedly delayed on technical basis[112] with the issue eventually becoming part of the trilateral negotiations between the EC, Ukraine and Russia during 2014.

According to the EC, a TPA exemption would concede Gazprom a market dominant position in the Czech Republic. The Brandov OPAL IP has 31 bcm/y of interconnection capacity that can be fully used by OPAL's 32 bcm/y. Guaranteeing access capacity to other participants would only be possible by limiting OPAL's access to the interconnector. Data from Czech and German TSOs show fully booked capacity at the southern end of the pipeline with no available capacity left for the coming two years at the Brandov point.

Under the existing Exemption on Regulation for the OPAL Interconnection Capacities Gazprom and/or its affiliated company WINGAS can only book up to 50% of OPAL's interconnection capacity. Increasing this booking would require Gazprom conducting a gas release programme for 3bcm/year. For this reason, the status of the pipeline is ambivalent with 31.6GWh/h (24.7 bcm/y) of interconnection capacity exempted as above described (between Greifswald and Brandov); and with an additional 4.6GWh/h of entry capacity at Greifswald, which is linked to the GASPOOL market area, that is operated under fully regulated conditions as any other capacity in the GASPOOL market area[113].

Modelling results

During 2014 the possibility of gas cuts through the Ukrainian corridor raised attention about implications OPAL's TPA regulation for security of supply[114]. Under a limited supply scenario, OPAL's caped access to interconnection capacity at Brandov could undermine Europe's emergency supplies. To assess the implications of OPAL's regulation for security of supply, two

[111] Further details regarding EC's gas infrastructure exemptions can be found at: https://ec.europa.eu/energy/sites/ener/files/documents/exemption_decisions_15.pdf
[112] Ruling from the Commission was postponed on March, July, September and finally October 2014
[113] ICIS Heren European Spot Gas Markets 16 July 2014
[114] ENTSOG has modelled scenarios varying the Gazprom access to Brandov IT in a similar way as this study here shows (European Commission, 2014a).

scenarios have been designed with an interruption lasting for 6 months. In one scenario OPAL's access to the Brandov IP is set at 100% (no TPA) and on the other one it is set at 50% (TPA access granted as of regulation in place during 2015). These scenarios are set to understand the implication of TPA regulation for security of supply specifically for the case of OPAL. Scenario details are included in Table VI:

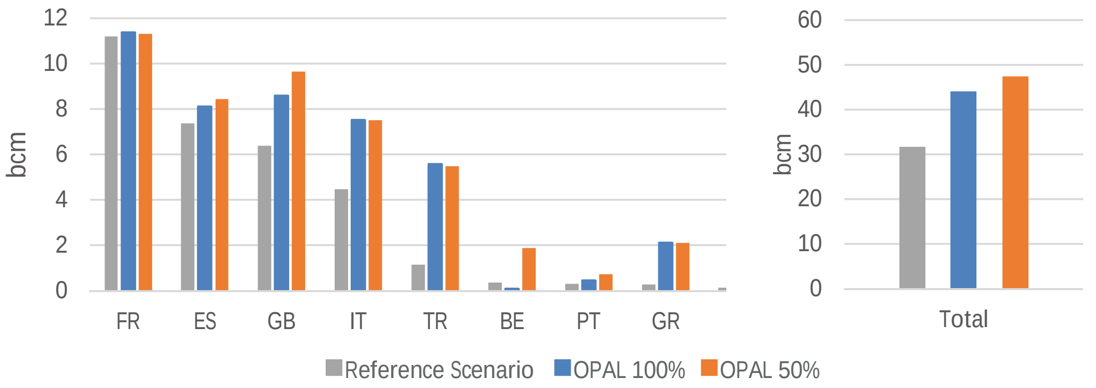
TABLE VI: OPAL MODELLED SCENARIOS (TIGER MODEL)

Scenario	Disruption duration	OPAL's access at Brandov	TPA regulation
Reference	No disruption	50%	TPA access
OPAL 50%	6 months	50%	TPA access
OPAL 100%	6 months	100%	No TPA access

LNG imports and storage

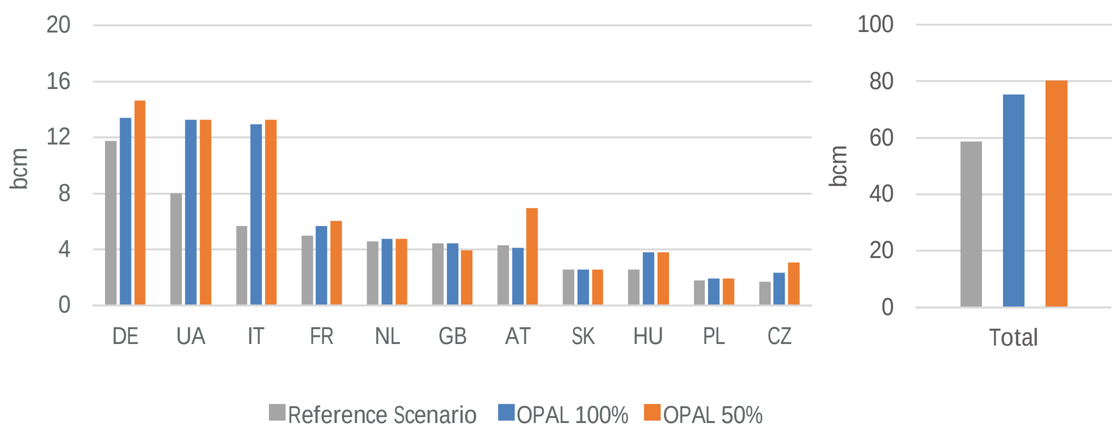
During the 6 month disruption LNG imports amount to 44.2 bcm (OPAL 100%) and 47.5 bcm (OPAL (50%). This represents a difference of 7.4% in LNG imports (3.3 bcm) during the 6 month period. Countries with greater increases of LNG imports are the UK (+12%) and Belgium. Results are represented in Figure XLVII.

FIGURE XLVII: LNG IMPORTS IN MODELLED SCENARIOS, IN BCM/ (6 MONTH OPAL 50% AND 100%).



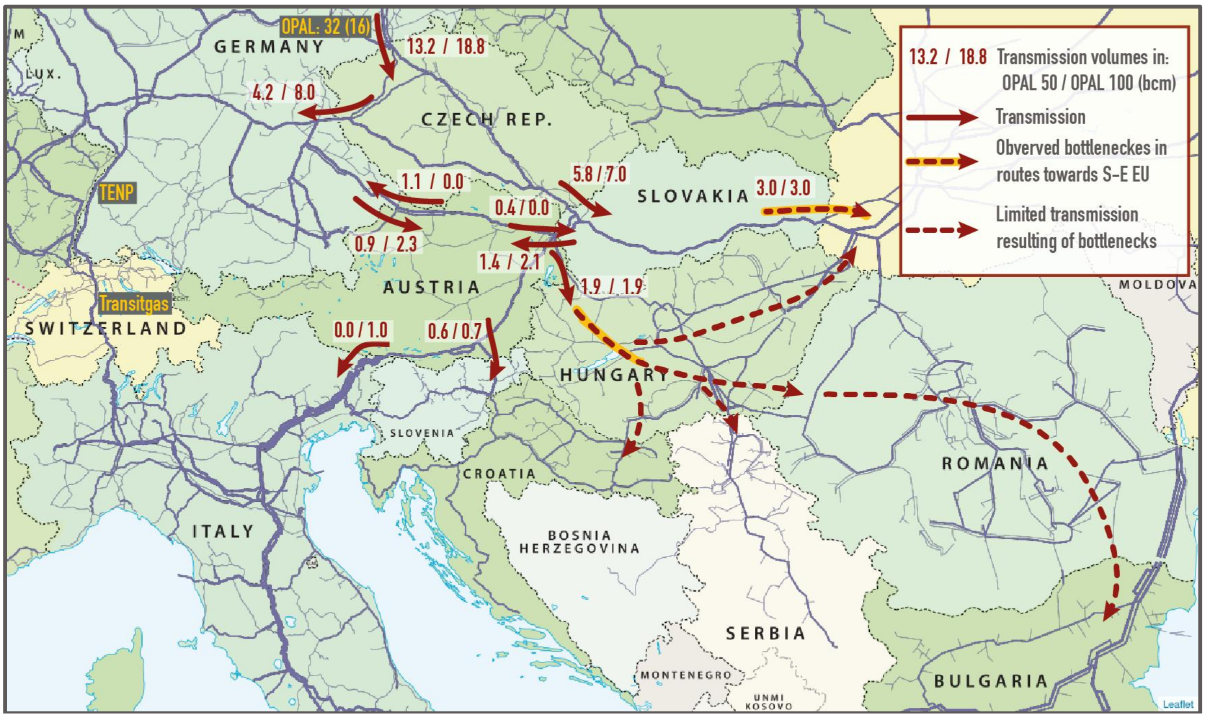
In regards to storage, during the 6-months disruption, withdrawals amount to 62.2 bcm (OPAL 100% scenario) and 67.1 bcm (OPAL 50% scenario). This represents withdrawals to be 7.8% (4.9 bcm) higher in the OPAL 50% scenario. Countries experiencing higher increases in withdrawal rates are Austria (+68%; 2.84bcm), the Czech Republic (+32%; 0.68bcm) and Germany (+8%; 1.2 bcm).

FIGURE XLVIII: STORAGE WITHDRAWALS IN OPAL SCENARIOS, (BCM/Y)



In the case of pipeline transmission, several limitations configure the redistribution of flows between both scenarios. They are represented in Map VII. Figures show transit during the 6 month duration of the scenario. The numbers to the left represent figures for the OPAL 50 scenario while the figures to the right represent transmission on the OPAL 100 scenario. Exceptionally, OPAL's capacity represent full year volumes (16 bcm/y and 32 bcm/y under a TPA exception).

MAP VII: SELECTED IPS AND TRANSMISSION VOLUMES IN OPAL SCENARIOS (BCM / 6 MONTHS)



Note: Figures refer to total transmission volumes crossing selected IPs only during the duration of the disruption (6 months). OPAL's figures represent transmission capacity under a TPA exception (32 bcm/y) and under no TPA exception (16 bcm/y)

Source: Own illustration based on pipeline map from ENTSOG Transparency Platform.

Several comments are worth pointing. Effects refer to the changes observed when OPAL's access to the Brandov IP increases from 50% to 100% during a 6 month disruption of Russian gas flows to and via the Ukraine:

- Transit from Germany to the Czech Republic increases by 5,6 bcm. These volumes further transit to both Slovakia (21%) and back to Germany.
- The transit increase to Czech Republic results in higher volumes flowing from Slovakia to Austria. Reverse gas flows from Slovakia to Ukraine are unaffected from the OPAL capacity since the capacity limit in the SK-UA interconnector is reached even in the OPAL 50% case.
- Additionally, as a result of higher flows moving from the Czech Republic back to Germany at Waidhaus, the net transit from Germany to Austria increases.
- The resulting excess volumes to Austria (both from Germany and Slovakia) increase exports from Austria to Italy. This means that a higher OPAL capacity actually improves security of supply in Italy during transit disruption in Ukraine.
- Transit from Austria to Slovenia increases slightly from 0.6 to 0.7 bcm.
- On the other hand, gas flowing from Austria to Hungary does not change due to limitations in the Hungarian network.

OPAL's contribution to security of supply in South East Europe

The last part of this assessment looks at the contribution of OPAL to security of supply in South East Europe. This topic gathered some attention in 2014 in line with the interruption of export to Ukraine. Questions were raised about the implications of limiting OPAL's access to Brandov for South East European supply. As this region was severely hit by the 2009 crisis, the role of OPAL was questioned in regards to the contribution it made to securing supply in this region.

Currently there are two main supply routes from North EU towards the South and South East. One crosses through Italy (TENP and TRANSITGAS pipelines) and another one is farther Eastwards through Austria and Czech Republic (OPAL and Gazelle pipelines). Both routes are represented on Map VII. Several conclusions can be pointed out regarding the limitations in the EU network to further distribute south eastwards additional volumes from OPAL. They include bottlenecks which prevent the distribution of greater gas volumes in this direction[115]:

- Regarding gas being shipped to Ukraine, there are limitations in the SK-UA IP that prevent additional volumes from OPAL reaching Ukraine (see SK – UA border on Map VII).
- Regarding OPAL's gas reaching South East Europe, limitations in Hungary's network prevent imports entering the country from Austria further transiting to Croatia, Romania, Serbia and Ukraine. Resulting of this, transmission from Romania to Bulgaria is also limited (Bulgaria being the country experiencing worst shortages in modelled scenarios

[115] When comparing modelling results with contractrual congestion as presented by ACER (2013) there are some links between physical and contractral bottlenecks. Similar to modelling results, congestions was reported by ACER in IP Mosonmagyarovar (AT HU) and IP Lasow (DE PL) (ACER 2013, cf. map in annex 6 / table in annex 2 of the congestion report).

out of all EU-28). Limitation in Hungary exist within the country's network after gas has crossed the AT – HU IP.

- A minimal increase in volumes reaches Slovenia through Austria.
- Finally, regarding the Italian market, routing gas from OPAL to Italy seems too expensive compared to LNG imports directly arriving to Italy. However, an increase of 1 bcm in transmission from Austria to Italy is observed during the interruption (see AT – IP border on Map VII).

Pointed bottlenecks are identified as IPs which work at full capacity in the OPAL 50 scenario and cannot increase flows when these are made available in the OPAL 100 scenario. The only point fulfilling this condition is the SK – AU IP, however there are limitations also in Hungary that prevent greater utilisation of the AU – HU IP. Other key points in East EU work below their nameplate capacity when flows through OPAL are duplicated. In this scenario the Lanzhot IP (CZ – SK) transports 7 bcm while its capacity is 11.4 bcm/half year. Additionally, the AU – SK IP has capacity for 4.1 bcm/half year while it transports 2.1 bcm during this period.

Overall, these findings suggest, that the full utilisation of OPAL's capacity increases security of supply in Czech Republic, Germany, Slovakia, Austria and Italy, while this potential is rather limited in Hungary, Croatia, Serbia, Romania, Bulgaria and Ukraine. The effect of a 100% OPAL capacity on total gas supply volumes is rather small. However, it is important to stress the point that during a peak demand situation, additional OPAL volumes allow additional peak capacity and therefore increase security of supply in countries such as Czech Republic, Germany, Austria, Slovakia and Italy.

CONCLUSIONS

Part III of this study has reviewed changes in infrastructure and regulation in the EU network during the 2009-14 period. Together with changes in exogenous factors (e.g. LNG pricing), these factors account for a great deal of Europe's increased security position. In order to weigh the importance of these changes, the section compares additions in these segments with the sustainability of current capacity levels. A large part of the evolution of gas infrastructure results from unrealised demand projections due to the sectors underperformance. This has resulted in large unused capacity contributing to Europe's energy security but not sustainable basis.

Key additions in infrastructure capacity include additional storage capacity (30 bcm of working gas volume between 2006-13 representing a 39% increase), new import capacity (e.g. Nord Stream) and improvements in the transmission network resulting in bi-directional cross-border implemented in 25% more IPs (and increase from 15% to 40%). Overall, these changes have allowed better diversification between MS and in 2014 reverse flows have surpassed traditional East to West transit in relevant IPs (e.g. Lanzhot)

The section further assesses the sustainability of these increments in infrastructure by looking how each segment of the network has absorbed recent decreases in the demand.

- In the case of storage, low gas demand and high market integration have resulted in resulted in low summer/winter spreads. This has affected storage profitability and as a result a decrease in the number of operation facilities in the coming years.
- Regarding LNG regasification terminals, utilization has been low since the Fukushima accident. As opposed to storage further LNG regasification terminals are under construction or planned in Europe (e.g. Croatia and Poland).
- For transmission infrastructure, the exposition to lower demand is lower given the segment is mostly regulated. However, changes in transmission dynamics have been observed as a result of decreasing demand. This is partially the result in changes in the supply mix to adapt to lower demand levels.

During the 2009-14 period the EC has approved security of supply regulation and financial mechanisms to support the implementation of security of supply infrastructure. These efforts have contributed to increasing cross-border capacity as a market instrument to diversify away from Ukrainian transit.

While Parts I and II of this study conclude that Europe is in a better off position in regards to diversification, Part III has assessed the sustainability of these levels. It concludes that under current market conditions and with existing regulation and network codes, free capacity for security purposes is likely to decrease. While Europe has enjoyed a favourable security position during 2014, sustaining current gains will require the revision of Europe's approach to security.

Part IV: The implications of the crisis for Ukraine

SECTION XII: THE 2014 GAS ‘WINTER PACKAGE’

The main focus of this paper is Europe’s security of supply in face of the 2014 Ukrainian crisis. In this last part the study analyses the consequences of the crisis for Ukraine. As a one of the largest importers of Russian gas, it is important to note that transit interruptions both to Ukraine and to Europe have always resulted from disputes between Russia and Ukraine. Causes triggering these confrontations have often exceeded the energy sector and have had a political, economic and military imprint. To examine events in 2014 and 2015, two sections look at two different levels to assess the reliability of Ukraine as a transit route to supply Europe

Section XII reviews recent legal, regulatory and institutional affairs concerning the gas network linking Europe, Ukraine and Russia. This review examines the complex net of multi-layered legal frameworks (used in concluding majority of gas trades), and the credit offerings by the IMF and Europe to re-structure Ukraine’s gas sector. The absence of a strong common international legal footing, in combination with Ukraine’s week macro-economic position, are complicating the country’s role as an essential transit corridor for Russian supplies.

Section XIII expands the analysis to include simulation results from the TIGER Model to assess the current state of the Ukrainian gas sector and its resilience to supply disruptions. Under an unfavourable political situation, the country’s reliance on Russian supplies remains critical. In 2014 Ukraine decreased its gas consumption by approximately 20%. Despite reverse flow arrangements with the EU, government policy for further demand reductions are the only alternative at hand to compensate for missing Russian supplies. However the severity of these reductions are, it is likely that further shortfalls will occur. This creates doubts over the reliability of Ukraine as a transit corridor and its capacity to guarantee supply security.

Gas ‘Winter Package’ – the deal between Ukraine and Russia

The latest hostility between Russia and Ukraine was again represented in June 2014 when Gazprom turned off gas supplies to Ukraine. According to Russian authorities this decision was a response to Kiev’s unpaid invoices for the commodity, which amounted to $3.1 billion[116]. The overall amount of Naftogaz debt remains to be decided by International Arbitration Court. Ukraine claims this to be $3.1 billion (an amount that has agreed to pay) while Russia argues this quantity is $5.3 billion.

[116] $3.1 billion undisputed amount, Russia further claims $2.2 billion. Ukraine Business Online; http://www.ukrainebusiness.com.ua/news/13973.html

On the 30th of October 2014 Ukraine and Russia signed a binding protocol[117] for the restoration of gas deliveries to Ukraine for the period going from November 2014 to March 2015. Together with addendum to the Gazprom and Naftogaz Contract No. KP (from 2009), parties agreed on the following points:

- Schedule of payment for unpaid invoices
    - $1.45 billion must be paid before first delivery, also the condition for deliveries
    - $1.65 billion must be paid before the end of 2014
- The overall amount of Naftogaz debt remains to be decided by International Arbitration Court. Ukraine claims it to be $3.1 billion (an amount that it has agreed to pay) while Russia settles this amount at $5.3 billion.
    - Purchase price is set for $378 per 1000 cm in 2014 and $365 in the first quarter of 2015. It partially reflects discount of $100 from previous agreements[118]. Previous discount of 30%, capped at $100 per 1000 cm, in exchange for 25 years lease of the naval base in Crimea and
    - Prior to any gas deliveries, Ukraine must meet advance monthly payments.

According to the deal Ukraine paid $3.1 billion of accumulated debt and $378 million as an advance payment for December 2014 that bought about 1 bcm and gas deliveries reassumed on December 9th. At the end of 2014 Ukraine paid additional $150 million for January deliveries. Out of 1 bcm purchased for December 2014 Ukraine used only 300 mcm and the rest of paid gas was shipped in January 2015. Obviously the government seeks at minimizing gas purchases from Gazprom. Alternative policies to this supply reduction consist of gas demand reduction, reverse flow imports from the EU, and its own storage/production capacity.

At the end of February 2015 the amount of pre-paid gas stood between 204-287 mcm[119]. At the same time Russia accused Ukraine of not taking responsibility for supplying conflict hit regions by not allowing gas to flow to rebel-held eastern areas. Ukraine expressed its disaccord for having to pay for gas supplies for its political and military opposition in Donetsk and Luhansk and, as a result, Gazprom has accepted to discount the gas served by Ukraine to these regions from the overall bill to Ukraine. Under this deal Gazprom continues to serve Ukraine at the time of writing.

[117] Binding Protocol regarding the conditions for gas delivery from the Russian Federation to Ukraine for the period from November 2014 until 31st of March 2015. The Agreement was reached with assistance of the EC. It can be accessed in the following link: http://ec.europa.eu/commission_2010-2014/oettinger/headlines/news/2014/11/doc/20141030_trilateral_protocol.pdf

[118] Previous discount of 30% (capped at $100/mcm, in exchange for 25 years lease of the naval base in Crimea which was cancelled when Russia annexed the peninsula in March 2014. Equally Gazprom pulled down 33% discount as a part of its substantial finance and trade offering when Yanukovitch government failed.

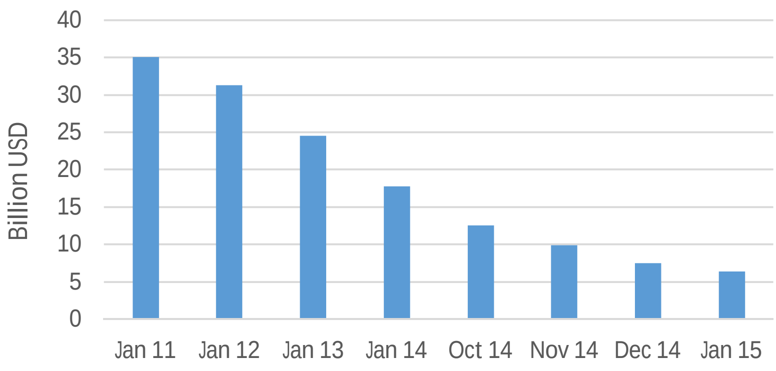
[119] At the time of writing it was unclear how much gas was still to be shipped. Gazprom claimed 204 mcm and Nagtogaz 287. Dispute over this amount might be explained by the fact that it is the amount of gas that flowed to rebel-held Donbas region. http://www.euronews.com/2015/02/26/russia-s-gazprom-excludes-rebel-held-areas-from-ukraine-s-gas-contract/

Rising international bail-out

A question remains open about how pre-payments will be met in the coming months. This adds up to additional spending required for achieving macroeconomic stability. Ukraine must pay external creditors $9 billion by the end of 2015 (including $3 billion to Russia), in addition to $5 billion in 2016 and $8 billion in 2017. There is also domestic debt due and overdue bills for gas from Gazprom. Foreign-exchange reserves are drying up fast, having fallen from $37 billion in 2011 to $ 6,4 billion in January 2015. In a statement, the National Bank of Ukraine blamed the steep decline largely as a result of servicing foreign debt (IMF included). Notably, as represented in Figure XLIX, only during January 2015 FX reserves had further fallen by 15%, to a large extent spent on to fund natural gas imports[120].

In total, the IMF in September 2014 admitted Ukraine might need another $19 billion if war affairs do not end[121]. In February 2015, the Washington-based bank announced a preliminary agreement to increase its bail-out package for Ukraine to $40 billion covering the next four years. At the time of writing the structure of the new package has not been revealed but from the fast deterioration of FX reserves we can observe that a top-up is urgently needed.

FIGURE XLIX: UKRAINIAN FOREIGN EXCHANGE RESERVES (BILLION USD)



Source: National Bank of Ukraine

In dealing with Ukraine's inability to finance its economy, the country has at its disposal a number of international financial means. First, there is the two-year IMF financial assistance program (to be restructured in the new package)[122]. The budget amounts to $16.6 billion of loans and the instrument seeks at supporting the government's economic guidelines which include restoring macroeconomic stability, strengthening economic governance and transparency, and launching sound and sustainable economic growth at the same time then protecting vulnerable groups. Total disbursements of $4.51 billion were already concluded (the last tranche in

[120] See: http://www.ft.com/fastft/273921/ukraine-fx-reserves-plunge-just
[121] See: http://www.bloomberg.com/news/2014-09-02/imf-says-ukraine-may-need-19-billion-more-aid-amid-war.html
[122] IMF Completes First Review Under Stand-By Arrangement for Ukraine and Approves US$1.39 Billion Disbursement. .IMF Press Release No.14/399, August 29, 2014. Accessible at: https://www.imf.org/external/np/sec/pr/2014/pr14399.htm

September 2014) and further tranches of the programme are subject to reviews over Ukraine's commitments to long-term reforms.

Second, Ukraine is also a beneficiary country of the EU macroeconomic financial assistance programme (MFA). This consists of loan support for Ukraine amounting to €1.61 billion and already disbursed by 2014. In January 2015 the European Commission proposed another MFA of €1.8 billion in the context of ongoing balance of payments crisis. Additional financial support from the EU is provided to Ukraine by means of its partnership in the European Neighbourhood Policy.

In both of the schemes, the financial assistance is supposed to be subject to several conditions being met. These include a sharp currency devaluation (which will increase the cost of all imported goods), a government-funded bailout for domestic banks, government spending cuts, measures to regulate money laundering, a sharp increase in energy prices, and the implementation of various EU energy acquis. It must be understood that in addition to gas sector payments and reforms, Ukraine faces more serious task of financially consolidating its economy. These challenges refer to its macro-economic position and both include but also come to exceed the Russian gas supply deal.

Multilayer legal framework between the EU – Ukraine - Russia: lacking a common ground

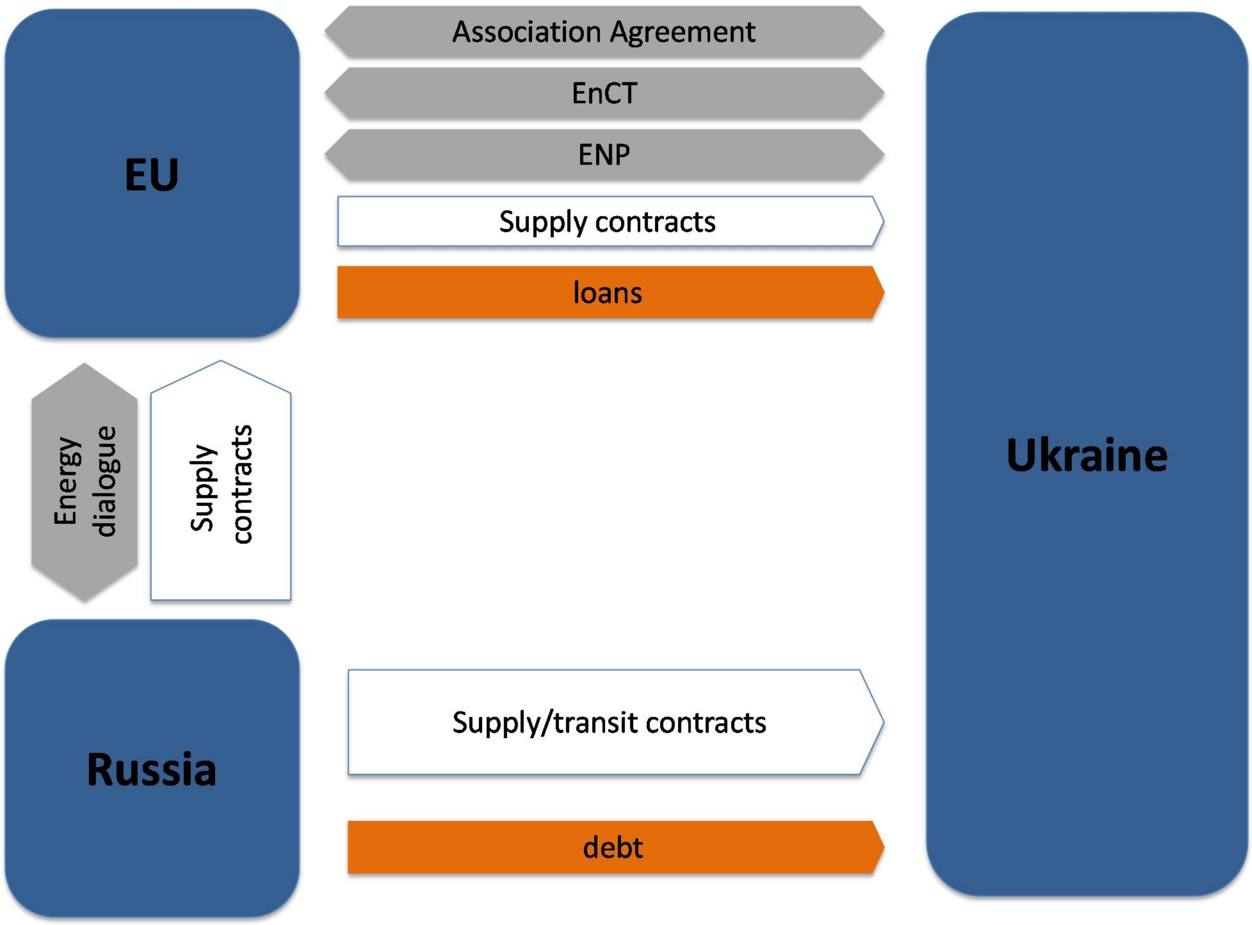
Any gas relationship between Russia and Ukraine requires both commercial and political settlements. To assess these interactions the section proceeds by analysing the current crisis on the basis of the most vocal and energy-specific frameworks both in their bilateral and multilateral dimension. Only serious examination of this matrix can allow understanding the difficult foundation for Ukraine's gas supplies and transit arrangements, which have been the central element of EU-Russia gas trade, given its magnitude.

A simplified picture of the multilayer legal framework in which actors act, illustrates that despite being part of a multilateral relationship around gas, participants often interact with each other excluding one of the parts. This includes EU-Ukraine, Russia-EU and Ukraine-Russia interactions. The different interests and expectations of each party drive actions in each bilateral exchange embedding relationships on complex asymmetrical interdependence[123] and preventing the creation of an inclusive multilateral setup. When the interests of the parts differ, the lack of a common ground prevents solutions from being achieved.

[123] For Yafimava this asymmetrical interdependence arises from the fact that "the gas supply and transit contracts do not exist in isolation, but take place within broader areas of other flows, the existing asymmetries are influenced by external factors arising from other relationships of interdependence, and hence may change over the time independently on state' actions. Whereas states can exercise the power created by asymmetries, their ability to influence the strength of this power is heavily restricted by existing patterns of asymmetry arising from multiple relationship of complex interdependence" {Yafimava:2011tr p.41}. Additional information is available in the original work by Yafimava (2011)

Intergovernmental agreements between Russia and Ukraine are general and aim at exerting a guardian role over supply and transit contracts that are negotiated between Naftogaz and Gazprom. In practice this has meant that it is mainly governments who have attempted to resolve disputed matters instead of national courts or international arbitrators. Arguably such a hierarchy may just reflect weak concept of rule of law between these actors, but it nevertheless leaves the ends to be subject of political means.

FIGURE L: EU, UKRAINE AND RUSSIA MULTILAYER LEGAL AND TRANSIT FRAMEWORK



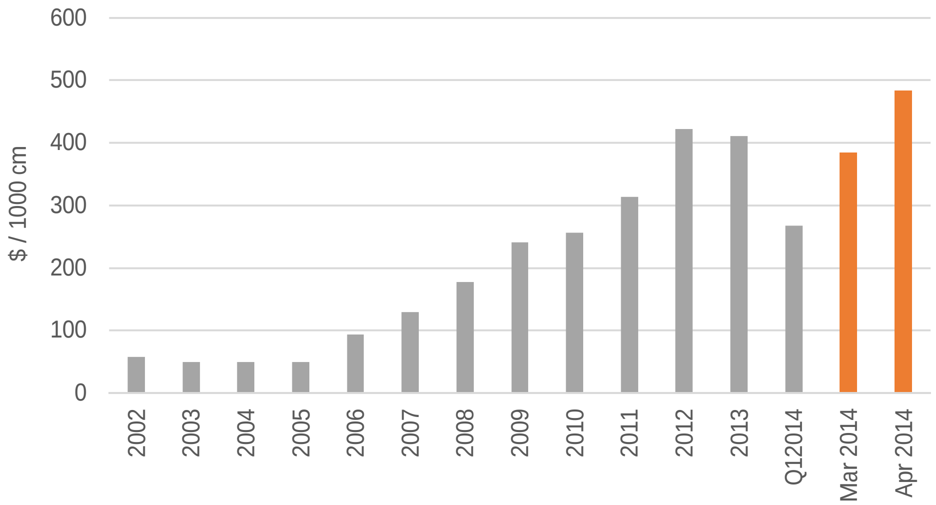
Instead, Ukraine's relationship with the EU exclusively centres on reforming the country's energy sector according to EU-tailored energy policies (acquis communautaire). From the framework of the European Neighbourhood Policy (ENP) and their Action Plants in 2005 throughout the membership in the Energy Community Treaty (EnCT) to the recently adopted Association Agreement, the desired adoption of energy acquis and approximation of Ukraine towards EU's internal energy sphere play prime. However, without any real possibility of EU membership, it is difficult to achieve many of benefits Ukraine could opt for. This can also explain the lack of progression in the implementation of energy acquis throughout the years.

The 2014 Crisis brings to these relationships some fundamental changes. In regards to this multilayer framework, Ukraine will have to pursuit extensive transformation of its energy sector (mainly the deregulation of prices and breaking up of Naftogaz) by having agreed on a massive financial assistance program by the IMF. EU’s Macro-financial assistance sees similar targets with further approximation of the country system to the EU’s internal energy sphere – adoption of energy acquis. Other financial programs from the World Bank, EIB, and EBRD also highlights newly establishing enforcement structure that we believe are about to become a decisive factor in upcoming perceptible transformation of Ukraine’s energy sphere.

SECTION XIII: THE UKRAINIAN NATURAL GAS SECTOR, MODELLED SCENARIOS

It was the times of cheap gas and trustful relationship with its main supplier where Ukraine's independent gas sector laid its roots. Today, enormous economic losses and hostile relations with Russia mark the sector's unsustainability. Ukraine's natural gas consumption has decreased in the last decade as a result of increasing gas prices set by Russia as shown in Figure LI.

FIGURE LI: RUSSIAN GAS PRICES FOR UKRAINE ($/1000 CM)



Note: Highlighted columns correspond to price increases resulting of the cancellation of the 2010 Kharkiv accords (31sr March 2014) and the cancellation of the December 2013 gas deal (1st April 2014)

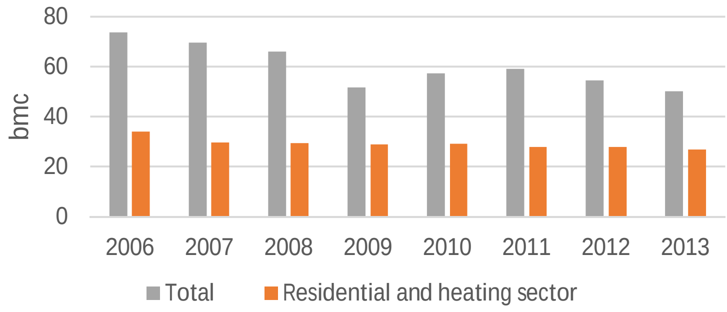
Source: Kong Chyong (2014)

Previous Ukraine's governments benefited from substantial discounts on gas prices that fostered demand[124]. Traditionally this demand is divided between three sectors: industrial (45%), residential (35%), and district heating sector (20%)[125]. The system is dominated by state-led Naftogaz and covers every part of value chain in the country, from production/imports, through transit/transmission/storage to distribution and sales.

[124] Previous discount of 30% (capped at $100 per 1000 cm, in exchange for 25 years lease of the naval base in Crimea which was cancelled when Russia annexed the peninsula in March 2014. Equally Gazprom pulled down 33% discount as a part of its substantial finance and trade offering when Yanukovitch government failed.

[125] IHS CERA and Ministry of Energy and Coal Industry of Ukraine (2012)

FIGURE LII: TOTAL UKRAINE'S CONSUMPTION 2007 - 2013 (BCM)

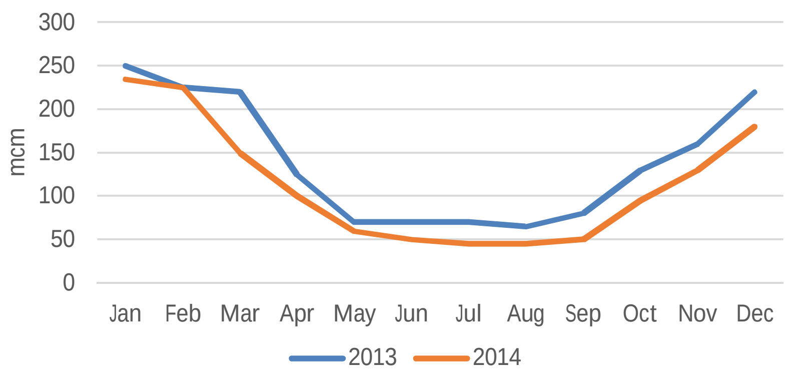


Source: Naftogaz Europe

Demand

The imbalance of the old-designed scheme with modern reality is best described by a vast decrease in Ukraine's consumption. Figure LII shows how Ukraine has decreased its total consumption over the years. According to the Ministry of Energy and Coal, in the past decade Ukraine was able to reduce its annual natural gas demand by 52%. This reduction was due to different factors. Higher gas prices for industry (and partly to other consumer groups) led to increasing energy efficiency together with fuel switching from gas to other energy means, mainly coal and biomass. Slow economic growth and a sector shift to less energy intensive sectors also further downgraded overall gas demand. Despite these various elements, the largest drops in Ukraine's consumption have been always timely driven by circumstances in Russo-Ukraine disputes in 2006, 2009, and 2014, especially as a result of price increase set by Gazprom.

FIGURE LIII: 2013 AND 2014 UKRAINE'S DEMAND (MCM/MONTH)



Source: Ukraine Ministry of Coal and Energy

Total consumption during 2014 dropped significantly compared to previous years. This is mainly the result of industrial production falling by 11% in 2014, government policies to reduce consumption (e.g. industrial and commune consumption by 30%, and schools and hospitals by

10%), and also of the military confrontations taking place in the country. Overall, demand during the 2014 summer was down by 30% compared to 2013, however, it is unlikely that such reductions can be maintained in the winter as seasonal consumption during these months is more inelastic due to its heating component. This effect is inexistent during the summer allowing greater reductions to be achieved. Assumptions used for modelled scenarios are based on demand levels for the 2013/14 winter and for the 2014 summer as shown in Figure LIII: [127].

Production

Ukraine's production has been stable over the years and covers around 30% of the country's annual demand, 22 bcm. Recently annexed Crimea counts to only 1.6 bcm annually and it is roughly self-sufficient in covering its own demand. About 90% of total gas production in Ukraine is concentrated in the Dnieper-Donets Basin, primarily in Poltava and Kharkiv regions. Only small parts of these fields are located in self-proclaimed rebel-held Luhansk and Donetsk republics. For the purpose of this study we take 2013 country's production discounted by Crimea region that is 20 bcm. Overall Ukraine's production is stable and counts on around 50 mcm per month.

Storage

Ukraine has also the largest natural gas storage system in Europe. Its working capacity is close to 32 bcm. The majority of these facilities are located close to its western border and have traditionally used by Russia to balance seasonal demand from EU customers. Other facilities are located close to demand sites in the east of the country. All mainland Ukraine's storage is owned and managed by Ukrtransgaz, a subsidiary of Naftogaz. Usually the storage levels, before the withdrawal season starts, are between 18 - 20 bcm to guarantee transit smoothness. At the end of the 2014 injection period, Ukraine's storage amounted to 16.6 bcm. The fact that the gas stored is traditionally used for a smoothing Gazprom exports to the rest of Europe and not for Ukraine's own consumption is certainly one of the biggest threat for Europe's supply as this gas could be re-directed to satisfy Ukrainian demand during the 2014/15 winter.

It is important to understand that Ukraine's gas network is a sophisticated technological system and an integrated part of the Unified Gas Supply System (UGSS) of the former USSR. It does not distinguish between transit routes and Ukraine's destined supplies. This also means that the whole system must remain under high pressure and underground storage facilities and distribution stations of Ukraine can operate only under balanced supplies of gas to all import terminals[128]. It is therefore very difficult, and also unrealistic, to count on large use of Ukraine gas storage for its own domestic consumption during a complete halt of Russian transit to

[127] Normally, Ukraine's winter demand is three times larger than its summer consumption. This allows to highlight the fact that demand side policies have a larger reduction margin on summer than on winter months. This is due to the heating component of consumption during colder months.

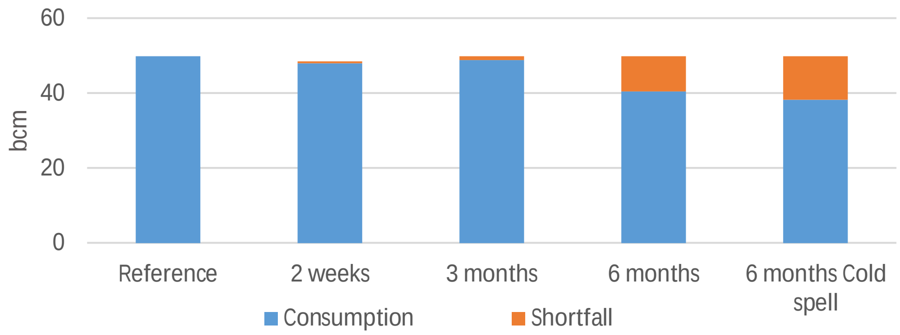
[128] Furthermore Mikhail Korchemkin, East European Gas Analysis, observes that a reliable transit of gas, as it was during the most of the post-Soviet history, can be provided only by the synchronized and coordinated operations of both parties. Available online on: http://www.eegas.com/ukr_090115e.htm

Europe throughout the country. Nevertheless for the purpose of our study we assume that all of Ukraine's 16.6 bcm stored gas can be withdrawn independently of the status of transit in the rest of the network. Designed scenarios take into account storage dynamics for the next two years and assume a 3 bcm critical bottom level below which storage cannot further withdraw any more gas. One reason for such a critical bottom level is that the geological structure of gas storage weakens with very low storage levels. Thus, storages cannot be emptied to such low levels or if so, only for very short amount of time. Therefore we account for such a limitation.

Simulations confirm Ukraine's dependence on Russian gas

As already mentioned it is difficult to simulate what would be the impact of a complete halt of Russian supplies to and throughout Ukraine on the country itself because of the system's import terminals and the overall pressure. Thus, the analysis focuses on the gas supply/demand balance and leaves aside supply problems that could results from pressure drops. In the reference scenario Ukraine is supplied from Gazprom volumes varying between 90 and 135 mcm per day during the winter months. During the disruption, the country is left with 50 mcm/day of its own production in addition to its own storage. In all disruption scenarios Ukraine suffers serious shortfalls (see Figure LIV).

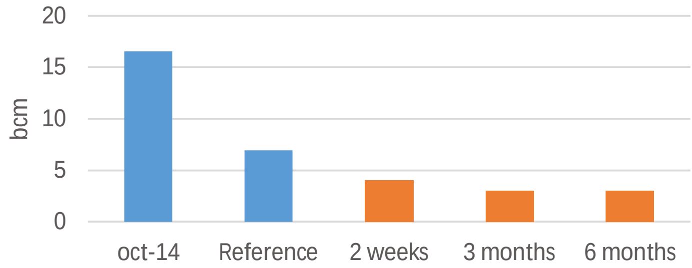
FIGURE LIV: REDUCTIONS IN CONSUMPTION DURING DISRUPTIONS, TIGER MODEL (BCM/Y)



During the six months disruption with cold spell in the end of February Ukraine could not serve 12 bcm of its annual demand with major supply shortages occurring in February 2015 when the country would need to reduce its consumption by 152 mcm per day (almost 50% of its demand). Natural gas in storage again plays a crucial role, as observed in Figure LV, the withdrawals during all scenarios are close to the critical levels of 3 bcm. As already explained above, the model takes into account two years projections, which unable it to empty the storage entirely.

Modelling results show that it is unrealistic for Ukraine to satisfy its pre-2014 winter demand levels, even more without Russian supplies. It is true that government policies and overall military occurrences have led to a demand reduction of almost 20%, but as already mentioned, the industrial fall (main reason for this reduction) has little to do with winter demand, which is closely connected to the heating sector. Modelling results further suggest that additional demand reduction and cuts are likely to take place. The interesting line here is to observe where the new government stands and what are its intentions in dealing with this situation.

FIGURE LV: STORAGE LEVELS BEFORE THE WINTER SEASON AND AFTER MODELLED DISRUPTIONS (BCM)



Note: Pre-winter levels are taken as of 31st October 2014. Levels after modelled disruptions are taken as of 30 April 2015.

The government's response

Ukraine secured a temporary restoration of Russian supplies under the assistance of the EU in October 2014. The deal guarantees Ukraine as much gas as it needs under the conditions of advance payments and repayment of previous debts. However as a consequence of massive difficulties over Ukraine's macro-economic situation and expensive continuation of war in the east, the case of gas demand being fully met does not come necessary to the top of agenda for the Ukrainian government, despite the fact that the provision of unlimited and affordable access to natural gas always played an important role in keeping Ukraine's elites in power. Obviously good relationship with Moscow had to be pursued and any side-lining of its main supplier evolved in uncomfortable confrontations over these gas trades.

Concerning Gazprom deliveries, Ukraine is aware that in the future, gas could be priced to European levels and that any discounts are difficult to achieve without a profound change in the political dialogue with Moscow. The new government follows these developments considering the possibility of distancing away from the traditional design of political pricing and uncertain continuation of Gazprom supplies. It instead focuses on serious reduction in consumption. At the moment, Ukraine does not have at its disposal alternative sources of supply aside from Europe. Reverse flow from the EU is currently functioning and is based on border capacity with Slovakia (40 mcm/day of which 27 mcm/day are firm technical capacity), Hungary (17 mcm/day) and Poland (4 mcm/day). For the time being this alternative cannot fully substitute for Russian gas and it will result in shortages for the residential and industrial sectors until the time the government is able to strike a deal with Russia.

CONCLUSIONS

The Winter Gas Package Deal agreed in October 2014 guarantees Russian supplies at discounted price only until March 2015. Hence the risk from supply cuts to both Ukraine and Europe prevail. Modelling results show that Ukraine does not have any alternatives to Russia's supplies but demand reductions. Additionally reverse flow capacity from Europe would be key to increasing Ukraine's supply alternatives.

In the 6 months disruption of Russian gas with harsh weather conditions Ukraine would be forced to reduce its consumption by 23% (11.5 bcm). Important element in face of 2015 are the levels of gas stored at the end of the withdrawal season. Ukraine has at its disposal one of the largest storage system. Its capacity reaches to 32 bcm and has a complimentary function to balance Russian transit to Europe. At the time of writing these levels stand above 8 bcm. In all modelled disruptions storage levels remained above 3 bcm but with serious demand curtailments. It is to highlight that Ukraine's gas storage cannot be taken as indefinite in securing the country's demand.

Alternatives in form of EU reverse flows, notably Slovakia's interconnection at Budince, have seen important developments in supplying Ukraine throughout 2014. However, these are yet not able to fully substitute for Russian volumes on the long-term. Within the range of technical characteristics and political willingness of MSs, Slovakia's total IP capacity has already increased from 27 mcm/day in September 2014 to 40 mcm/day in January 2015. Its firm technical capacity stands at 27 mcm/day at the time of writing. On the other hand, reverse flow capacities mark an important milestone and show how much the European gas network has changed since 2009. In this regard it is Ukraine's consumers who approximate to more transparent European hub-based pricing than what was traditionally negotiated with Gazprom.

EU's role as a guarantor of Ukraine's payments for Russian supplies is emphasized by its expanding debt service towards Kiev, which only in loan assistance reaches €3.4 billion. In addition to this, Ukraine signed to a major IMF bail-out amounting to $16.6 billion that is likely to increase to $40 billion. This practically confirms Europe's replacement of Russia as a close partner with wide responsibilities towards Ukraine's economy, and especially its gas sector. The complex situation in which Ukraine is to be found is further underlined by the fact it is not able to diversify from Russian supplies and the dialogue over gas trades with Gazprom is a must for both as well as for Europe.

APPENDIX I: THE EUROPEAN GAS INFRASTRUCTURE MODEL TIGER

In order to quantify the effects of a disruption of Russian gas flows to and through the Ukraine for the European gas market, we apply the gas market simulation model TIGER. The model description below has been taken from Hecking et al. (2014). In that study, the TIGER model has been applied as well.

The TIGER (Transport Infrastructure for Gas with Enhanced Resolution) model is a highly-detailed European infrastructure and dispatch model that is able to simulate gas production, LNG imports, storage operations and pipeline flows. The model minimizes the total cost for serving European gas demand with a given infrastructure and supply structure. TIGER simulates the gas market on a daily basis in order to assess short-term changes in the infrastructure utilization. The high degree of both spatial and temporal resolution enables a detailed analysis of a potential outage of Russian gas flows to and via the Ukraine.

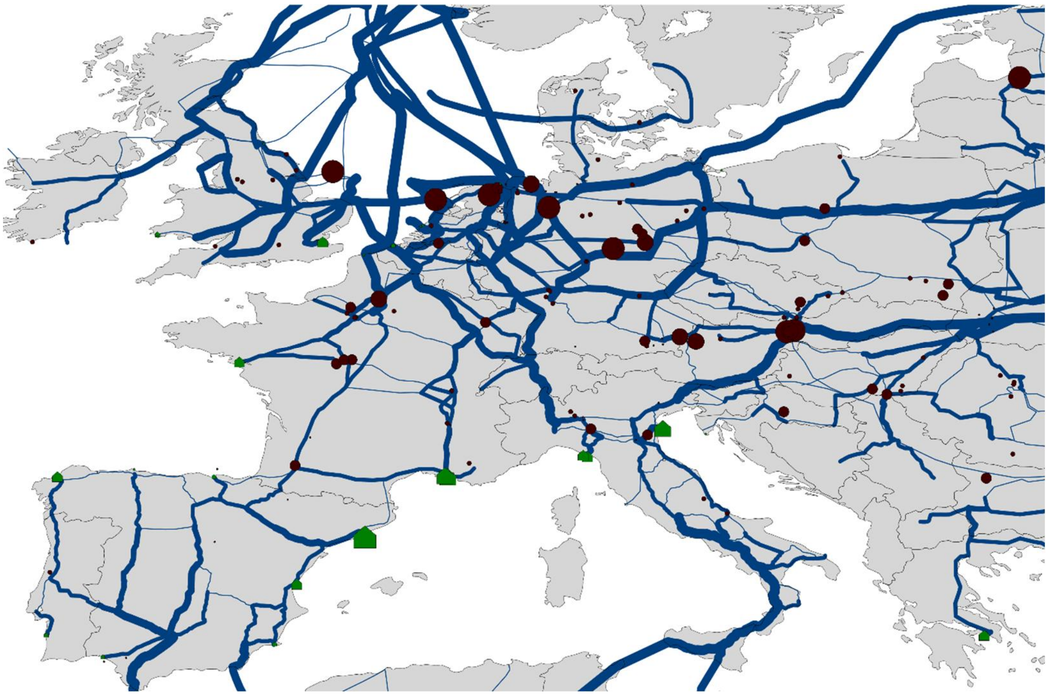
The TIGER model is a linear network flow model with nodes and edges. The edges represent European pipelines. The nodes represent production sites, demand regions, LNG terminals, storages, connections between pipelines or exit and entry points to the grid. In total, more than 600 nodes and more than 900 pipeline sections are included in TIGER, allowing for a very high spatial resolution of the infrastructure.

TIGER includes 58 European demand regions. Germany, for example, is subdivided into 8 demand regions. In each region, shares of the total demand are assigned to 3 sectors: power generation, household and industry. Different demand sectors exhibit different seasonal demand patterns. Household gas demand is mainly driven by heating. Therefore, there are substantial differences in demand over the course of a year, which are derived from historic data. On the contrary, industrial gas demand is rather constant. Besides the seasonal effects, gas demand also differs on a daily basis. Therefore, the model accounts for differences in demand conditions on weekdays and weekends, which are relevant in all of the three sectors.

Gas supply is represented by 22 production regions in and around Europe. These production regions include the big gas exporting countries Russia, Norway, Algeria and the Netherlands as well as countries with smaller gas production such as Germany and Denmark. The model accounts for production flexibility. For example, the Groningen field in the Netherlands is characterized by high production flexibility due to its geological conditions. Additionally, long-term contracts both for LNG and pipelines are included in the model.

The infrastructure elements are modelled according to a wide range of technical details. A pipeline is characterized by its length, diameter, pressure, capacity, availability and flow direction. The flow direction is of particular importance in this analysis since reverse flows from Western Europe to Eastern Europe can become relevant given a Russian supply outage. Concerning storages, TIGER includes three different types of storages with different injection and depletion profiles: depleted oil or gas fields, salt or rock caverns and aquifers. In addition to the storage type, the injection rate, withdrawal rate and working gas volume determine the technical features of the storages. More than 200 storages, i.e. all relevant storages in Europe, are modelled in TIGER. LNG terminals are characterized by import capacity (hourly and yearly), LNG storage capacity and regasification capacity. TIGER accounts for all of the European LNG terminals.

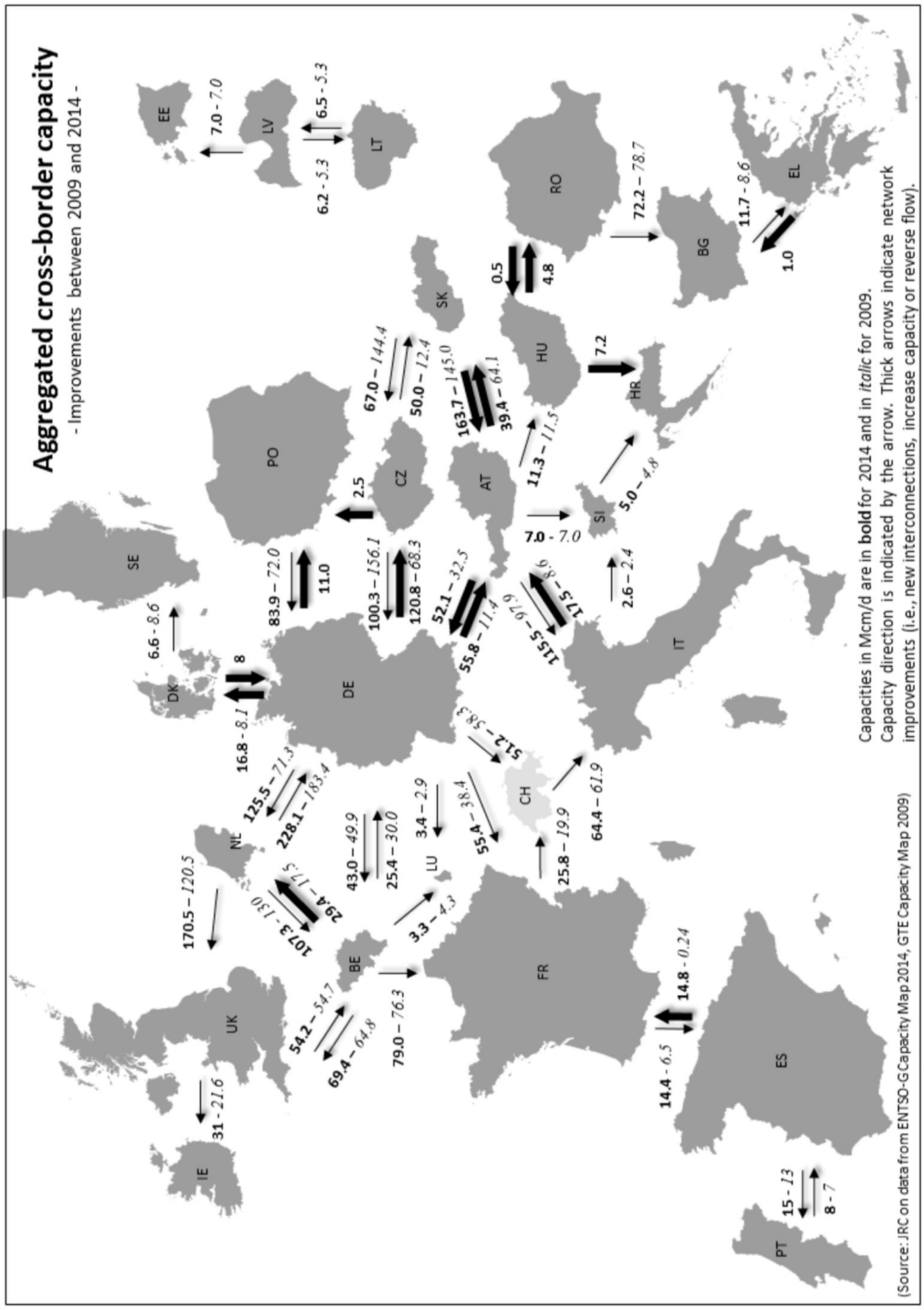
MAP VIII GAS FLOW MAP FROM THE EUROPEAN GAS INFRASTRUCTURE MODEL TIGER



Source: Hecking et al.(2014)

APPENDIX II: AGGREGATED CAPACITY IN THE 2009-14 PERIOD

MAP IX: AGGREGATED CROSS-BORDER CAPACITY 2009-14



Source: European Commission (2014d)

APPENDIX III: GAZPROM SALES TO EU AND CIS

TABLE VII: GAZPROM SALES TO EU AND CIS. 2006-2013 (RUSSIAN BCM)

Countries	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Austria	5.1	4.9	5.2	6	6	6.8	6.6	5.4	5.8	5.4	5.6	5.4	5.4	5.2
Belgium	0	0	0	0	0.2	2.0	3.2	4.3	3.4	3.3	0.5	0.5	0	0
Bulgaria	3.2	3.3	2.8	2.9	3	2.6	2.7	2.8	2.9	2.2	2.3	2.5	2.5	2.9
Croatia	1.2	1.2	1.2	0.6	0.4	1.2	1.1	1.1	1.2	1.1	1.1	0	0	0.2
Czech Republic	7.5	7.5	7.4	7.4	6.8	7.4	7.4	7.2	7.9	7.1	9	8.2	8.3	7.9
Estonia	0.6	0.7	0.6	0.8	0.9	1.3	0.7	0.9	0.6	0.8	0.4	0.7	0.6	0.7
Finland	4.3	4.6	4.6	5.1	5	4.5	4.9	4.7	4.8	4.4	4.8	4.2	3.7	2.9
France	12.9	11.2	11.4	11.2	13.3	13.2	10.0	10.1	10.4	10.0	8.9	8.5	8.2	8.6
Germany	34.1	32.6	31.5	29.6	36.1	36.0	34.4	34.5	37.9	33.5	35.3	34.1	34	41
Greece	1.6	1.5	1.6	1.9	2.2	2.4	2.7	3.1	2.8	2.1	2.1	2.9	2.5	2.6
Hungary	6.5	8	9.1	10.4	9.3	9.0	8.8	7.5	8.9	7.6	6.9	6.3	5.3	6
Italy	21.8	20.2	19.3	19.7	21.6	22.0	22.1	22.0	22.4	19.1	13.1	17.1	15.1	25.3
Latvia	1	1	1.1	1.2	1.5	1.4	1.4	1.0	0.7	1.1	0.70	1.20	1.10	1.10
Lithuania	2	2.2	2.4	2.9	2.9	2.8	2.8	3.4	2.8	2.5	2.80	3.20	3.10	2.70
Netherlands	0	0.1	1.4	2.3	2.7	4.1	4.7	5.5	5.3	5.1	4.3	4.5	2.9	2.9
Poland	6.8	7.5	7.2	7.4	6.3	7.0	7.7	7.0	7.9	9.0	11.8	10.3	13.1	12.9
Romania	3.2	2.9	3.5	5.1	4.1	5.0	5.5	4.5	4.2	2.5	2.6	3.2	2.5	1.4
Slovakia	7.9	7.5	7.7	7.3	5.8	7.5	7.0	6.2	6.2	5.4	5.8	5.9	4.3	5.5
Slovenia	0.7	0.5	0.6	0.7	0.2	0.7	0.7	0.6	0.6	0.5	0.5	0.5	0.5	0.5
UK	0	0	0	0	0	3.8	8.7	15.2	7.7	9.7	10.7	12.9	11.7	16.6
Total EU-28	120.4	117.4	118.6	122.5	128.3	140.7	143.1	147	144.4	132.4	129.2	132.1	124.8	146.9
Serbia	1.2	1.7	1.7	1.9	2.3	2.0	2.1	2.1	2.2	1.7	2.1	2.1	1.9	2
Bosnia	0.3	0.2	0.2	0.2	0.3	0.4	0.4	0.3	0.3	0.2	0.2	0.3	0.3	0.2
Macedonia	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0
Turkey	10.2	11.1	11.8	12.8	14.5	18	19.9	23.4	23.8	20	18	26	27	26.7
Switzerland	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.4
Other countries	0	0	0	0	0	0	0.4	0.5	0.6	1.2	2.1	2.3	1.4	1.2
Total EU + TK	132.6	130.8	132.7	137.8	145.8	161.6	166.4	173.8	171.7	155.9	152	163.2	155.8	177.4
Ukraine	27.2	22	26.1	26	34.4	37.6	59.0	59.2	56.2	37.8	36.5	44.8	32.9	25.8
Belarus	10.8	11.6	10.2	10.2	10.2	19.8	20.5	20.6	21.1	17.6	21.6	23.3	19.7	19.8
Moldova	1.8	2.1	2.1	1.5	1.8	2.8	2.5	2.7	2.7	3	3.2	3.1	3.1	2.4
Total CIS	39.8	35.7	12.3	37.7	46.4	60.2	82	82.5	80	58.4	61.3	71.2	55.7	48
Total	172.4	166.5	145	175.5	192.2	221.8	248.4	256.3	251.7	214.3	213.3	234.4	211.5	225.4

Note: Data in Russian cubic metres – to convert to European units reduce by 7.97%

Source: Data compiled according to Gazprom (2006.2010, 2011.2014). An alternative source is OIES both in Henderson and Pirani (2014. table 3.1) and Stern et al. (2015). For figures previous to 2006 there is differences between both of these sources (particularly for Germany)

LIST OF ABBREVIATIONS

$ –US-Dollar
€ – Euro
ACER – Agency for the Cooperation of Energy Regulators
ACQ – Annual Contract Quantity
ATC – Available Transfer Capacities
BAFA – German Federal Office of Export Control
Bcm – Billion cubic metres.
Bcm/y – Billion cubic metres per year
BNetzA – German Federal Network Agency (Bundesnetzagentur)
CCGTs – Combined-cycle gas turbines
CEER – Council of European Energy Regulators
CO_2 – Carbon dioxide
CWE – Central Western Europe
DG COMP – EU Director General for Competition
DG ENER – EU Director General for Energy
DSM – Demand Side Management
DSO – Distribution System Operator
EC – European Commission
EE zone – Entry-Exit Zone for gas transmission
ENTSO-E – European Network Transmission System Operators – Electricity
ENTSO-G – European Network Transmission System Operators – Natural Gas
ETS – Emissions Trading System
EU – European Union
EUR – Euro
EU-28 – The 28 Member States comprising the European Union
EWI –Institute of Energy Economics at the University of Cologne (Energiewirtschaftliches Institut an der Universität zu Köln)
FID – Final Investment Decision
FOM – Fixed Operating & Maintenance
GIE – Gas Infrastructure Europe
GSE – Gas Storage Europe
GTE – Gas Transmission Europe
GTM – Gas Target Model
IEA – International Energy Agency
IED – Industrial Emissions Directive
IEM – European Internal Energy Market
IMF – International Monetary Fund
JCC – Japanese Customs-cleared Crude Oil Prices.

LNG – Liquefied Natural Gas
Mcm – Million cubic metres
MMbtu – Million British thermal units
MMtCO$_2$eq – Million tons of carbon dioxide equivalent
MMtoe – Million tons of oil equivalent
MS – Member States
MW – Megawatt
MWh – Megawatt hour
NBP – National Balancing Plan
NCG – Net Connect Germany
NTC – Net Transfer Capacities
RES – Renewables
SSO – Storage System Operator
TEP – Third Energy Package
TCM – Thousand cubic metres
TSO – Transmission System Operator
TYNDP – Ten-Year Network Development Plan

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