

## Addendum to the study “An Embargo of Russian Gas and Security of Supply in Europe”

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The Institute of Energy Economics at the University of Cologne (EWI) is a so called An-Institut annexed to the University of Cologne and is supported by the Gesellschaft zur Förderung des EWI e.V. [Society of Benefactors]. The EWI is headed by two professors of the University of Cologne's Faculty of Management, Economics and Social Sciences as well as by two senior lecturers.

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## 1 INTRODUCTION

This document is intended as an addendum to the main study “An Embargo of Russian Gas and Security of Supply in Europe”. In this analysis, we investigate the question on which elements of the European gas infrastructure would need to be extended in order to fully supply each European country (including Turkey) during a Russian gas embargo.<sup>1</sup>

Since this analysis focuses on the need of additional infrastructure, but not on the availability of additional supply opportunities, we assume the hypothetical case that LNG volumes are freely available on the world market. We cannot stress enough the fact that this assumption clearly is fictitious: amongst others due to existing long-term supply contracts, e.g., between LNG exporters and Asian importers, the major part of global LNG would not be available for European gas importers (this is discussed in more detail in the main study). The analysis at hand is intended to assess which infrastructure elements (i.e., pipelines, LNG import terminals and gas storage) have to be extended given that additional LNG supply would not be a concern.

We assess three scenarios: a 3-month embargo of Russian gas, a 6-month embargo and a 6-month embargo plus a cold spell in February 2015. For each simulation, the embargo is assumed to begin on November, 1<sup>st</sup> 2014.

In order to identify the required infrastructure investments, we use the numerical simulation model TIGER. In addition to the main study, we enrich the model with the functionality to derive endogenously, which pipelines, borderflow capacities, storages and LNG terminals have to be extended to fully supply Europe with gas.

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<sup>1</sup> Finland is excluded from this analysis, since it is entirely dependent on Russian gas and does not have neither a gas storage, nor an LNG terminal.

## 2 ASSUMPTIONS AND LIMITATIONS OF THE ANALYSIS

The basic assumptions of this analysis are identical to the main study, with the exception of the following aspects:

### Gas storage

The initial storage level assumed for November, 1<sup>st</sup> 2014 has been updated with current data provided by Gas Infrastructure Europe.<sup>1</sup>

### LNG volumes available to the European market

In order to simulate, which investments into gas infrastructure would be needed to fully supply Europe with gas, we assume no limitations to the availability of LNG on the world market. However, LNG imports can be limited due to missing regasification capacity, which is what we aim to identify in this study.

### LNG terminals currently under construction

As in the main study, we assume that the Lithuanian LNG terminal in Klaipeda is already available. In contrast to the main study, we assume that the Polish LNG terminal in Świnoujście is also online as of November, 1<sup>st</sup> 2014.<sup>2</sup>

### Infrastructure investment

We assume that the capacity of pipelines, gas storages and LNG terminals can be extended. Thus, in order to limit complexity, we exclude the option of green field projects, i.e., new infrastructure at locations where no infrastructure is in place currently.

In order to reduce complexity of the TIGER simulation, the analysis is somewhat limited concerning the following aspects:

### Demand reaction

As in the main study, we do not assume gas demand to be flexible. Therefore, as an alternative to building new infrastructure, the reduction of gas demand could diminish the severeness of a gas embargo as well, at least in some European countries. Demand reduction could be realized, e.g., by adapting the heating behaviour.

### No n-1 security

The needed infrastructure identified in this study only represents a minimal solution to realize full gas supply in Europe. We do not account for n-1 security. That is, if one crucial part of the

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<sup>1</sup> <http://transparency.gie.eu/>

<sup>2</sup> Whether or not the Polish LNG terminal is assumed to be online is however not crucial to the results: even if assuming the terminal not to be operational yet, the TIGER simulation would identify the Polish LNG terminal as necessary to be extended.

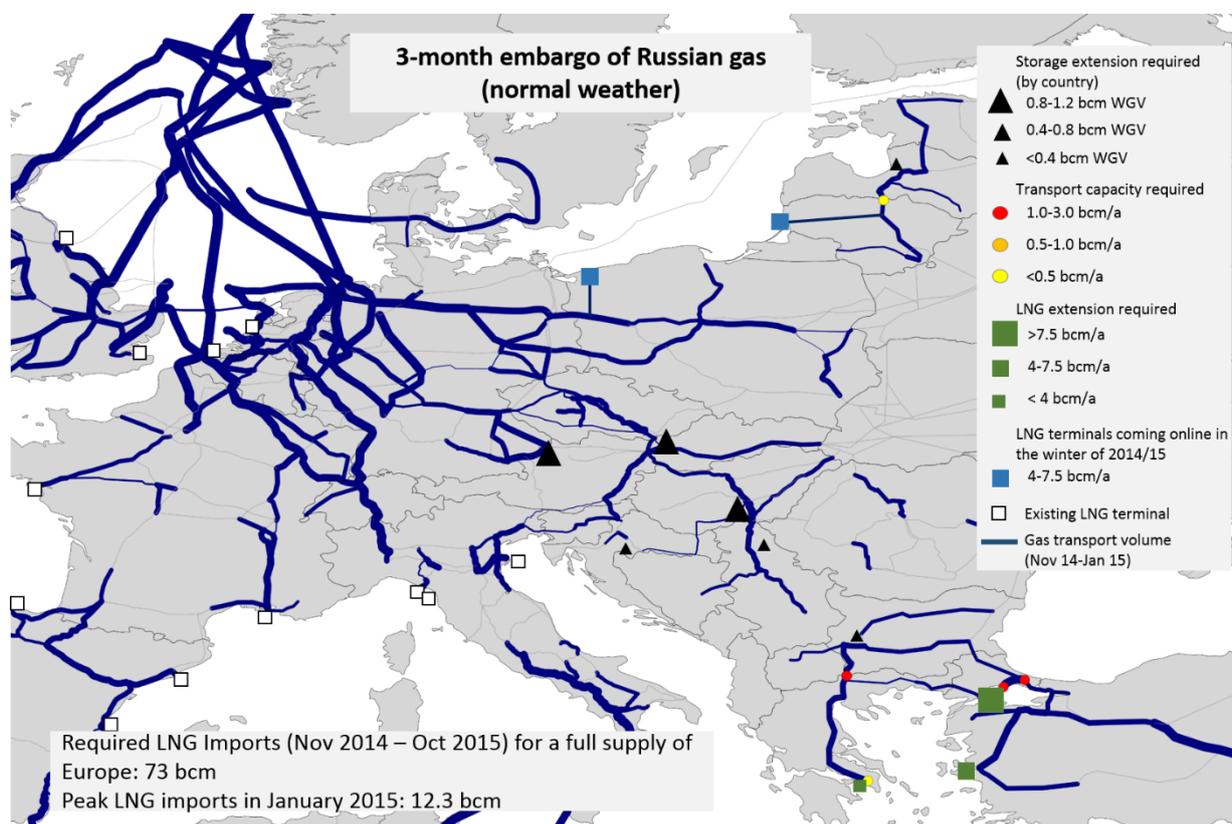
infrastructure would become inoperative during the disruption (e.g., an LNG import terminal), full supply would not necessarily be realized.

### **Technical details**

The TIGER model accounts for numerous technical aspects of gas infrastructure, such as the capacities of pipeline flows, LNG regasification, storage injection and withdrawal, each on a daily basis. However, we do not account for technical problems which could materialize during a crisis such as missing pipeline pressure.

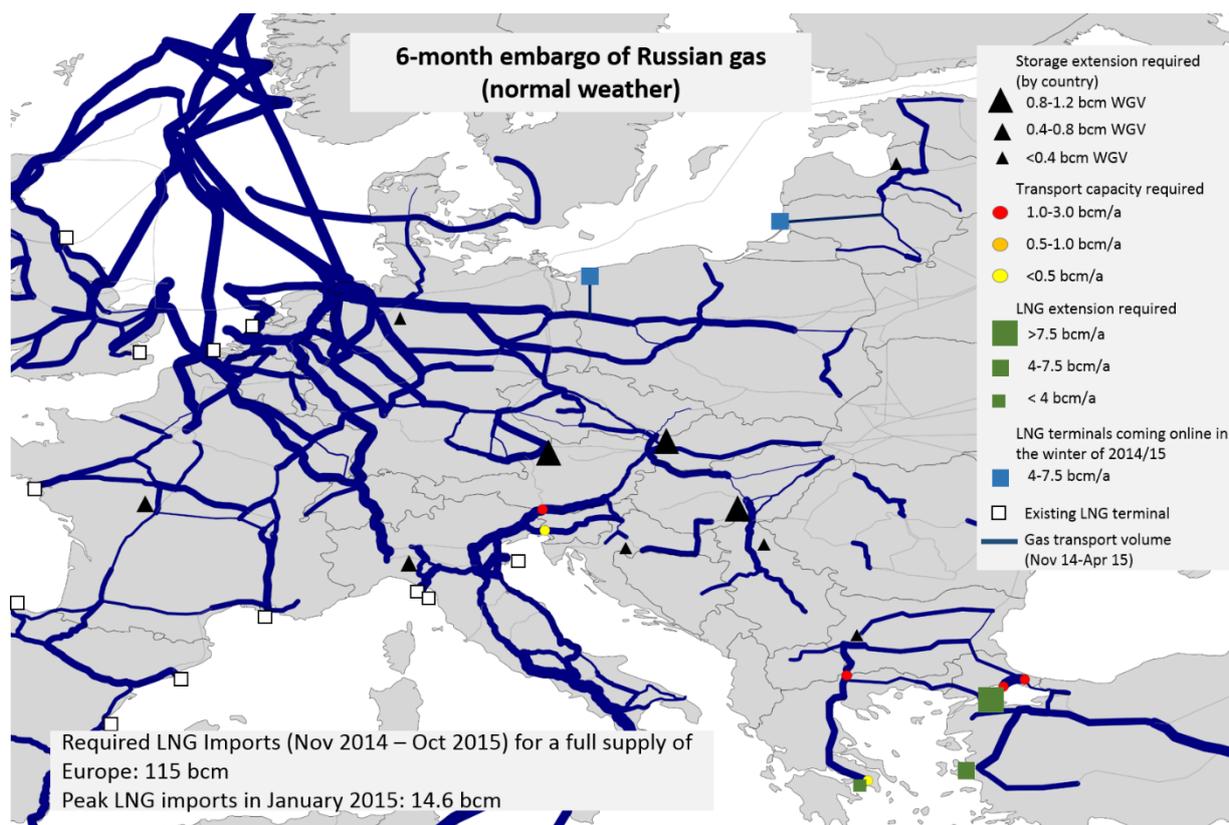
### 3 RESULTS

**How to interpret Figures 1 to 3:**  
 The blue lines illustrate those pipelines which transport gas during the crisis. The thicker a line is, the higher is the transported gas volume during an embargo. Red and yellow dots indicate the need for additional transport capacity, i.e., either pipeline capacity or border flow capacity. Black triangles flag those countries where additional gas storage would be needed to realize full gas supply in Europe. Green squares indicate, where additional LNG import terminals would be required. The blue squares represent the LNG terminals in Poland and Lithuania, which are assumed to be operational during the crisis.



**FIGURE 1: REQUIRED GAS INFRASTRUCTURE EXTENSION IN A 3-MONTH EMBARGO**

In each of the scenarios, the LNG terminals in Greece and Turkey have to be extended as well as the according pipeline infrastructure in order to transport the additional volumes of regasified LNG into the respective country. In the case of Turkey, LNG import capacity is particularly important to provide additional gas during winter time. Thus, although capacity is increased here, the extended LNG capacity is not fully utilized over the course of a year, but only in those months when demand is high.



**FIGURE 2: REQUIRED GAS INFRASTRUCTURE EXTENSION IN A 6-MONTH EMBARGO**

In the case of Greece, additional LNG import capacity is needed, amongst others, to supply Bulgaria. This explains, why capacity at the cross-border interconnection point between Sidirokastron/Greece and Kulata/Bulgaria has to be extended as well.

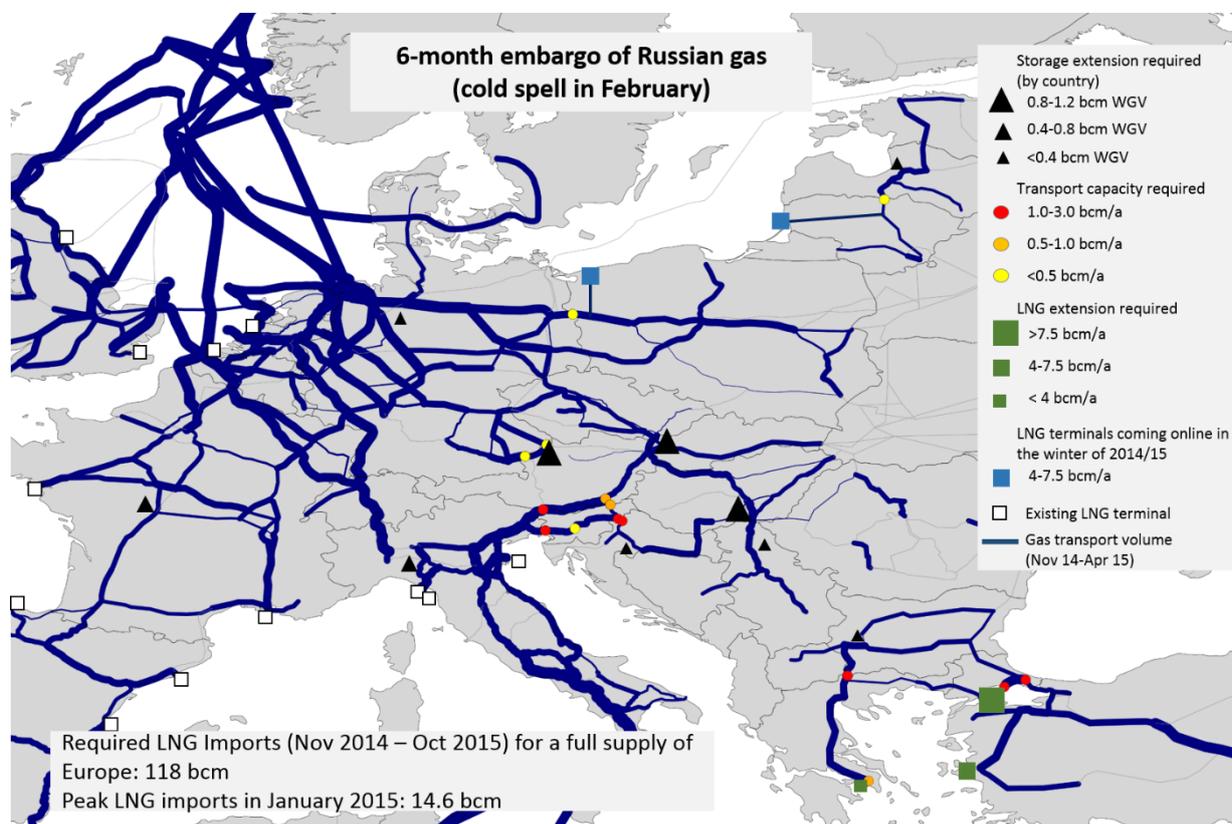
The longer the embargo would take, the more important would additional reverse flow capacities between Italy and Austria as well as between Italy and Slovenia become. The capacity would be needed to transport LNG imported by Italy to Eastern Europe.

All of the results outlined are based on the assumption that a sufficient amount of LNG would be available. The required LNG volumes highly depend on the duration of an embargo and the temperature level. Between 1<sup>st</sup> November 2014 and 1<sup>st</sup> November 2015, European importers would have to import 73 bcm (3-month embargo), 115 bcm (6-month embargo) and 118 bcm (6-month embargo plus cold spell) of LNG. Compared to the all-time high of 87 bcm in 2010<sup>1</sup>, annual European LNG imports would have to be more than 30 percent higher during a 6-month embargo with a cold spell.

The monthly LNG import volumes required to satisfy gas demand in January would amount to 12.3 bcm (3-month embargo) and 14.6 (6-month embargo). Thus, LNG imports are essential for satisfying peak demand. However, acquiring LNG deliveries on the world market of more than 14

<sup>1</sup> See IEA Natural Gas Information (2014).

bcm within a month might be very challenging – especially when the all-time highest monthly imports of 9 bcm (January 2011) are taken into account.<sup>1</sup> More details on the market characteristics of the global LNG market and the availability of LNG during an embargo can be found in the main study.



**FIGURE 3: REQUIRED GAS INFRASTRUCTURE EXTENSION IN A 6-MONTH EMBARGO WITH COLD SPELL**

Besides the difficulties to purchase the required amounts of LNG (both on an annual and a monthly basis), we cannot stress enough the point that the required gas infrastructure cannot be extended immediately in preparation for the next winter. Gas infrastructure projects can take several months up to years.

<sup>1</sup> <http://www.iea.org/gtf/index.asp>