

## About the Author

\* 1977,  
Odessa / Ukraine



2013 Ph.D. in Economics (Dr. rer. pol.), Europa-Universität Viadrina Frankfurt / Oder, Germany (magna cum laude)

2000 M.Sc. in International Economics, Odessa State University of Economy, Ukraine (summa cum laude)



This dissertation investigates security of European gas supply (*gas-SoS*) giving particular consideration to gas infrastructure, notably gas transport and transit. Gas-SoS is endangered mainly by a disruption to existing supplies. For Europe, gas supply infrastructure acts as a tool to gain, maintain and expand access to new gas sources and consolidate access to existing ones. So the SoS-related (infrastructure) strategy has been assessed in the dissertation theoretically and practically, qualitatively and quantitatively.

The research objective pursued is: *To describe and evaluate gas-SoS for Europe, as well as to specify prospective ways for the SoS enhancement, with a focus on European infrastructure [...].* From this, two research questions have been derived:

- (1) How secure are the European countries in terms of their natural gas supplies?
- (2) How can the gas-SoS in Europe be improved (with emphasis on infrastructure)?

The central discussion of the study is in assessing the level of security risks which single European countries face. Thereupon, the family of SoS-indices *HHI'14* has been developed. The ultimate aim is to apply and test indices. With their application the author hopes to gain insights into the indices adequacy as a policy tool for energy security developments. While the existing literature offers a number of SoS indicators to date, their usefulness has never been tested. For the first time, this dissertation has been testing the predictive success of SoS-indices. It confronted them with the economic losses in the 2009 interruption of Russian gas flows to Europe, and with the EU subsidies under the EEPR programme.

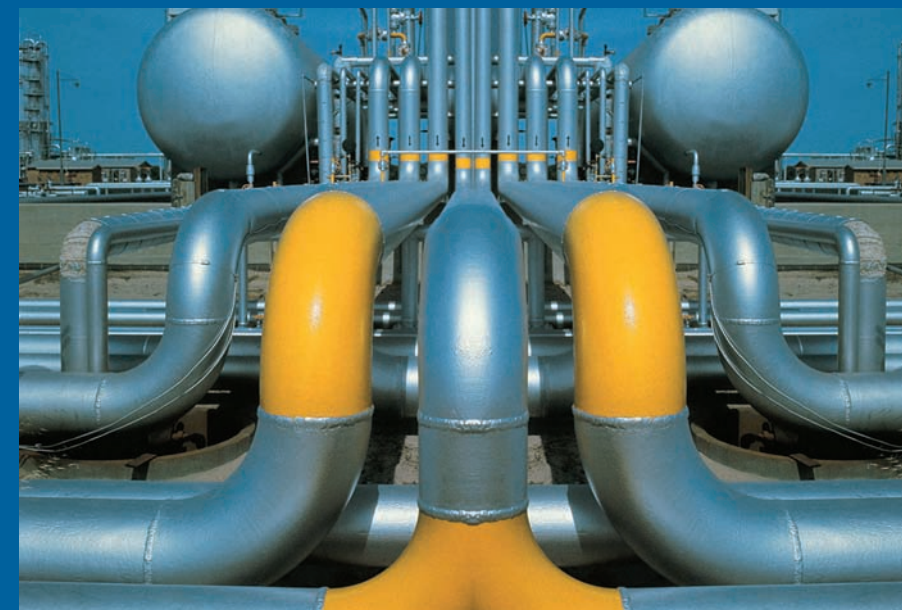
This investigation sets out that SoS-indices are rather important for a quick and coherent overview over the state of energy security for a large and diversified region like Europe. They cannot completely substitute, however, a detailed discussion of the situation in each member state.

..... ISBN 978-3-939290-46-9

Rostyslav Ruban

The European Natural Gas Supply, under Particular Consideration of Gas Transit

Rostyslav Ruban



# The European Natural Gas Supply, under Particular Consideration of Gas Transit

EUROPA-UNIVERSITÄT  
FRANKFURT (ODER)

viademica.verlag berlin 2013

**Edition**  
**Wirtschaftswissenschaften**

Reihe EUV | Band 01

Europa-Universität Viadrina Frankfurt (Oder)  
Faculty of Business Administration and Economics  
Chair of Economic Theory (Microeconomics)

Rostyslav Ruban

**The European Natural Gas Supply,  
under Particular Consideration  
of Gas Transit**

D i s s e r t a t i o n  
in Fulfilment of the Requirements  
for the Degree of "Doktor der Wirtschaftswissenschaften"  
(Dr. rer. pol.)

submitted by: Mag. Rostyslav Ruban  
supervisor: Prof. Dr. Friedel Bolle  
examiner: Prof. Dr. Reimund Schwarze

submitted on: 4 March 2013  
Ph.D. viva examination: 25 March 2013

**viademica.verlag berlin**

v.vb



Ihr Partner für wissenschaftliche Fachliteratur

ISBN 978-3-939290-46-9

Berlin 2013

# Rostyslav Ruban



© 2013 **viademica.verlag berlin**

Tieckstraße 8  
10115 Berlin

Telefon (0 30) 23 45 70 68 + (0335) 4 14 59 16

Telefax (0335) 4 14 59 23

www.viademica.de | eMail: info@viademica.de

Mobilfunk 0171 / 6 95 43 38

## Die Deutsche Bibliothek – CIP-Einheitsaufnahme

RUBAN Rostyslav:

The European Natural Gas Supply, under Particular Consideration  
of Gas Transit · Dissertation in Fulfilment of the Requirements for the  
Degree of "Doktor der Wirtschaftswissenschaften" (Dr. rer. pol.)

Rostyslav Ruban.      Erstaufgabe viademica.verlag berlin.      Berlin 2013  
ISBN 978-3-939290-46-9

..... EDITION Wirtschaftswissenschaften .....  
\_\_ Reihe EUV · Europa-Universität Viadrina Frankfurt (Oder) · Band 01 \_\_

Das Werk ist urheberrechtlich geschützt. Jede Verwertung außerhalb der Grenzen des Urheberrechtsgesetzes ist ohne Zustimmung des Verlages unzulässig und strafbar. Das gilt insbesondere für Vervielfältigungen, Übersetzungen in fremde Sprachen und Mikroverfilmungen sowie für die Einspeicherung in elektronische Systeme oder auf mechanische Datenträger.

..... ISBN 978-3-939290-46-9

Bezug: Direkt über den Verlag oder über den Buchhandel

Verbindlicher Buchhandelsverkaufspreis: 69,60 € .....

## **Acknowledgements and Dedication**

The present thesis was produced during my post-graduate studies at the European University Viadrina Frankfurt (Oder), being a holder of research grants by the German Academic Exchange Service/DAAD, the Federal Ministry of Education and Research/BMBF (“Europa Fellows 2”), and by the German gas supply company E.ON Ruhrgas. It was accepted as dissertation in March 2013 by the Faculty of Business Administration and Economics.

The thesis was created in a most warm and inspiring atmosphere, and I owe special and deepest thanks to my supervisor – Professor Dr. Friedel Bolle. He constantly found time to discuss and teach all that a Ph.D. candidate should know. The scientific and human assistance of Professor Bolle has substantially contributed to my professional and personal development. His willing support concerning formalities has made my research stay in Germany easier. Not least of all, it was Professor Bolle who enabled my doctorate in Frankfurt (Oder) and has taken over the first report.

I am also very grateful to Professor Dr. Reimund Schwarze, who has kindly agreed to take over the coreport.

When a Ph.D. candidate has a best friend as I have in my twin brother Andrey, even difficult days end in laughter and hours of telephone calls. Thank you for the best personal support and energy whenever I needed it!

I dedicate this thesis to my wonderful parents Alexandra and Gennadiy, who have never given up encouraging me with their endless love and so much more. A very special acknowledgement to them for the understanding and everyday advice, which they have brought from the beloved home country, Ukraine, into my time-consuming work on the following energy-economic research project.

Full responsibility for errors or omissions rests with the author alone.

Frankfurt (Oder), March 2013

Mag. Rostyslav Ruban

# Table of Contents

<b>Table of Contents</b> .....	<b>i</b>
<b>List of Figures, Tables and Boxes</b> .....	<b>iv</b>
<b>List of Abbreviations</b> .....	<b>vii</b>
<b>Chapter 1</b>	
<b>Introduction</b> .....	<b>1</b>
<b>Chapter 2</b>	
<b>Fundamentals of the European Gas Industry</b> .....	<b>4</b>
2.1 Energy Resources, and Particularly Natural Gas, in the Economic Process .....	4
2.1.1 Energy and the Economic Growth .....	4
2.1.2 Gas Usage .....	5
2.1.3 Demand Fluctuations .....	8
2.1.4 Gas Benefits .....	9
2.2 Supply Chain Fundamentals for Natural Gas .....	10
2.2.1 Gas Transmission: Pipelines and LNG .....	10
2.2.2 Gas Storage .....	16
2.3 European Supply with Natural Gas .....	18
2.3.1 Geographical Region Under Study .....	18
2.3.2 The European Regional Gas Sector .....	19
2.3.2.1 Demand Vs. Supply .....	19
2.3.2.2 Unconventional Gas and the European Security .....	21
2.3.2.3 Transportation and Transit .....	22
2.3.3 Physical Configuration of the Gas Supply Chain .....	26
2.3.3.1 Pipeline Entry Points and Interconnection Points (IPs) .....	26
2.3.3.2 LNG Entry Capacity .....	26
2.3.3.3 Storages .....	27
2.3.4 System Operators – Focus on Gas Transmission .....	28
2.4 Collective Interests and Conflicts among Exporting, Transporting and Importing States .....	29
2.4.1 Interdependence in the Gas Chain .....	29
2.4.2 Conflicts of Interests among Chain Members .....	29
<b>Chapter 3</b>	
<b>Gas Supply Security: Methodology of Analysis</b> .....	<b>32</b>
3.1 Conceptual Framework for Natural Gas Security .....	32
3.1.1 Defining Supply Security .....	32
3.1.2 Security Types .....	33
3.1.3 Security Risks .....	34

3.1.4	Adopted Definition on SoS.....	35
3.2	The Basic SoS-Related Acts of European Legislation.....	36
3.2.1	Directive 2004/67/EC.....	36
3.2.2	Regulation (EU) No 994/2010.....	37
3.3	Gas Consumption Insights – with Emphasis on Protected Customers.....	39
3.4	The Tools of Supply Security Management.....	43
3.4.1	Supply-Side Measures.....	43
3.4.2	Demand-Side Measures.....	51
3.4.3	Vertical Integration in the Gas Industry and SoS.....	53
3.5	Selected Facets of Security Economics.....	55
3.5.1	Graphic Interpretation of SoS and of a Supply Disruption.....	55
3.5.2	Costs of Security.....	57
3.5.2.1	SoS Cost Curves.....	59
3.5.3	Effects of Gas Supply Disruptions.....	61
3.6	Measuring Gas Supply Security in Europe.....	62
3.6.1	Opening Arguments for Research.....	62
3.6.2	Literature Review.....	63
3.6.3	Commonly Used Simple Indicators.....	66
3.6.4	Designing an Advanced Composite SoS-Indicator.....	69
3.6.4.1	Construction of an Index: Methodology.....	69
3.6.4.2	SoS According to the Implicit Weights Approach.....	72
3.6.4.2.1	The HHI'14 <sub>1</sub> Index's Structure and Data.....	72
3.6.4.2.2	Discussion and Calculation of Parameters for the Index HHI'14 <sub>1</sub> .....	75
3.6.4.2.3	Results.....	85
3.6.4.3	An Approach with Alternative Weighting and Aggregation.....	86
3.6.4.4	Closing Remarks.....	93
3.6.5	The “N-1” Approach.....	94
3.6.6	Discussion.....	97
3.6.6.1	Interpretation of HHI'14 Vs. “N-1”.....	97
3.6.6.2	Correlation between “N-1” and Other Indices.....	98
3.6.7	Contrastive Patterns of Behaviour: HHI'14 Vs. “N-1”.....	104
3.6.8	Usefulness of SoS-Indices.....	105
3.7	Stylised Facts Concerning Supply Security.....	106
3.7.1	Security Incidents.....	106
3.7.2	Russia's Contributing to Supply Disruptions.....	108

## **Chapter 4**

### **Reliable European Gas Supply – Focus on Central/South-East Europe ..... 112**

4.1	Europe's Future Demand for Gas and its Coverage.....	112
4.2	The EU Eastern Enlargement and its Impact on Community's Gas Security.....	116
4.2.1	CMEA Legacies.....	116
4.2.2	Challenges Concerned with the EU Enlargement.....	122
4.2.3	Perspectives.....	125
4.3	Gas Security in CSEE at Work: The January 2009 Gas Supply Disruption.....	126
4.3.1	Real-time Crisis Management.....	126

4.3.2	Lessons to Learn .....	133
4.3.3	SoS-Indices as a Reflection of the Supply Disruption Costs .....	134
4.4	Sustainable Development of the Pan-European Network for Gas .....	138
4.4.1	Gas Supply Infrastructure Adequacy .....	139
4.4.1.1	Capacity Saturation .....	139
4.4.1.2	Exemplary Network Gaps and Bottlenecks .....	143
4.4.2	Centralized Framework for Networks Development .....	144
4.4.2.1	TEN-E .....	144
4.4.2.2	EEPR .....	145
4.4.3	SoS-Enhancing Prioritised and Advanced Infrastructure Projects .....	147
4.4.3.1	Projects and their Principles .....	147
4.4.3.2	Reverse Flows .....	148
4.4.3.3	Cross-Border Interconnections .....	154
4.4.3.4	Infrastructure Initiatives Providing New Gas to Europe .....	164
4.4.3.4.1	LNG .....	164
4.4.3.4.2	Pipelines .....	167
4.4.3.5	Gas Storage .....	174
4.4.4	SoS-Indices as Predictors of the EEPR Funding .....	176
4.4.5	EEPR Implications for the European Gas Security .....	179
4.4.5.1	Impact on HHI'14 and "N-1" .....	179
4.4.5.2	The SoS Costs Burden .....	182
4.5	Bringing the European Gas Networks Together .....	182

**Chapter 5**

<b>Conclusions and Discussion .....</b>	<b>189</b>
---	------------

<b>Appendix 1: Principal Existing, FID-Proposed and non-FID-Proposed Pipeline Infrastructures in Europe, 2010 .....</b>	<b>195</b>
---	------------

<b>Appendix 2: LNG Regasification Terminals in Europe, 2010 .....</b>	<b>199</b>
---	------------

<b>Appendix 3: Natural Gas Storage in Europe, 2010 .....</b>	<b>200</b>
--	------------

<b>Appendix 4: European TSOs and their Ownership .....</b>	<b>201</b>
--	------------

<b>Appendix 5: Breakdown of Natural Gas Consumption by Sector, 2008 (in %)....</b>	<b>203</b>
--	------------

<b>Appendix 6: Results of the HHI'14<sub>1</sub> Stepwise Calculation.....</b>	<b>204</b>
--	------------

<b>Appendix 7: The HHI'14<sub>1</sub> Design's Adjustment.....</b>	<b>205</b>
--	------------

<b>Bibliography.....</b>	<b>207</b>
--------------------------	------------

# Chapter 1

## Introduction

**Research Background** COM [2008:3] points out: “Europe’s energy networks are the arteries on which we all depend for the energy to fuel our homes, businesses and leisure. The EU’s energy policy sets out clear goals and objectives<sup>1</sup> for sustainable, competitive and secure energy. [...], the EU will not achieve its ambitions unless its energy networks change considerably, and fast”.

European gas demand declined in 2009 upon the economic crisis. Capros et al. [2010] expect it to decline further in the coming decades. At the same time, European gas production is predicted to decline even more, causing increasing gas import dependency. To offset this trend, new gas supplies from sources outside the EU will be necessary, and therefore significant investment is in order to facilitate that the gas reaches the European customer. In this respect, many EU countries have announced and started to implement gas infrastructure projects, with financial support occasionally granted under the EEPR. In parallel, the European gas market is undergoing a change driven by EU directives, aimed inter alia at integrating national markets into a single European gas market. This change precipitates the need for greater interregional gas flows. Seeing that the regional gas markets, primarily in Central/South-East Europe (CSEE), began their development in relative isolation, they have to become more inter-linked. It is in this environment that we began examining the issue of *gas supply security* (SoS), and viewing it specifically in connection with the enlarged Europe. The impulse of the present dissertation was given by the situation of particular vulnerabilities of the individual national markets to disturbances in the gas supply. This is against the background where the EU Commission has established a Union-wide framework for the SoS in terms of common infrastructure and supply standards, including fixing a mandatory “protected customers” category.

High costs are involved in gas supply disruptions. It was mainly due to the recent gas disputes between Russia and Ukraine, which in January 2009 resulted in serious gas shortages notably in CSEE, that the SoS notion has been put at the top of the European agenda. This has led to a drive on the part of many CSEE countries to promote containment of their dependencies on Russian gas. So, they are in strong support of gas flows that increase diversification away from Russia, particularly from the Caspian/Middle East.

Given the above (and other) gas market changes, systematic analysis is required to fully understand the gas supply security and its application to the most vulnerable part of Europe by far – CSEE. Providing this analysis is the aim of this dissertation. In this study, we will develop a stylised approach to assess the SoS category in both theoretical and practical terms, both qualitatively and quantitatively. While the existing literature offers quite a number of SoS-related composite indicators, their use-

---

1. The so-called “20-20-20” targets: 20% reduction in greenhouse gas emissions, 20% share of renewable energy in EU final energy consumption, and 20% improvement in energy efficiency by 2020.



fulness has never been tested. In this investigation we will, for the first time, test the predictive power of SoS-indices – by confronting them with the economic losses in the 2009 interruption of Russian gas flows to Europe and with the EU subsidies for its member states within the EEPR.

**Research Objective and Research Questions** With regard to the above-mentioned situation, this study pursues the following research objective: *To describe and evaluate Europe’s gas supply security, as well as to specify prospective lines for the SoS enhancement, with a focus on European infrastructure projects, in accordance with individual countries’ need/priority.*

In order to meet this objective, the research questions are qualified as:

- (1) How secure are the European countries in terms of their natural gas supplies?
- (2) How can the gas-SoS in Europe be improved (with emphasis on infrastructure)?

**Overview of the Study** The study is organised into three conceptual parts. Among them, Chapters 3 and 4 aim to answer the two research questions above. The approach of the present work gives particular consideration to gas transport and transit.

The Introductory Chapter 1 first describes the background that our research is embedded in. It presents the problem and provides the reader with the chapter summary.

Chapter 2 is an overview of the gas industry. While contributing to the SoS discussion later on, Section 2.1 refers to gas user types and their differing consumption profiles throughout a year. Section 2.2 provides gas supply chain fundamentals. Section 2.3 describes the European gas sector and, countrywise, its gas transmission and storage facilities (or more precisely, “entry points” for gas). Here it becomes clear that the national gas markets strongly differ in their key market data and their infrastructure characteristics. Section 2.4 ends by addressing the nature of conflicts among country-actors of gas transportation.

The theoretical underpinnings of the SoS notion are outlined in Sections 3.1, 3.2 and 3.5 of Chapter 3. While Section 3.1 develops the conceptual framework and Section 3.5 provides the graphic interpretation along with the “costs of security” idea, Section 3.2 discusses the legal environment for SoS in the EU. A detailed review of the tools of gas supply security management follows in Section 3.4. The tools are discussed regarding gas market-relevant cases. From here, it becomes possible to evaluate the SoS. Section 3.6 suggests an evaluation framework and stepwise quantifies a set of parameters serving the comparability of the SoS situations in individual markets. This, on the one hand, reflects the country-specific gas market and infrastructure characteristics (partly shown in Chapter 2) and, on the other hand, discusses the first research question qualitatively and quantitatively. The evaluation is preceded by “protected customers” issues (Section 3.3), and followed by the empirical observations of SoS incidents from the past (Section 3.7), with a focus on Russia.

The largely descriptive Chapter 4 aims to approach the second research question of the study. It shifts focus to CSEE, after Subsection 3.5.3 gave us the intuition and Section 3.6 confirmed numerically that the CSEE region generally enjoys lower SoS than the EU-15. Section 4.2 is an in-depth explanation regarding the CMEA background for CSEE vulnerabilities in the energy field. We address it as a major challenge for the enlarged EU. The consequences of that background, which have im-

peded to effectively respond to the January 2009 gas crisis, are explored in Section 4.3. For this real emergency situation, the SoS tools introduced in Section 3.4 are discussed. The central result of Chapter 4 is reported in Section 4.4 with its various insights into the sustainable development patterns of the CSEE gas supply, based on the restrictions by capacity saturation (Subsection 4.4.1), network gaps/bottlenecks, and the import dependency projections (Section 4.1). A focus throughout Section 4.4 is on CSEE gas infrastructure projects, in accordance with countries' needs. Those needs are indirectly expressed in the EEPR financial envelope, dealt with in Subsection 4.4.2. The ultimate aim of the infrastructure projects' (and of the January 2009 gas crisis) analysis is to provide and apply security-of-supply (SoS) indices developed in Chapter 3. While the academic literature offers a wide range of SoS-related metrics, their usefulness has never been tested. Subsections 4.3.3 and 4.4.4 will, for the first time, test the predictive power of such composite indicators – by confronting them with the economic losses in the 2009 interruption of Russian gas flows and with the EU subsidies under the EEPR program. In Subsection 4.4.5, an adjustment is made compared with Section 3.6, which did not involve the EEPR influence on country SoS scores. Section 4.5 closes with an expose of European networking initiatives enabling a higher level of cooperation/integration between the TSOs, ultimately destined to bring the gas networks together.

The Conclusions in [Chapter 5](#) summarise the findings of this study, and finally recommend considering further research.

# Chapter 5

## Conclusions and Discussion

This dissertation investigates security of European gas supply with a focus on infrastructure, in particular gas transport/transit. Gas-SoS is endangered mainly by a disruption to existing supplies. For Europe, gas supply infrastructure acts as an option in gaining, maintaining and expanding access to new gas sources and consolidating access to existing ones. As emphasized already in the Introduction, the EU will not be able to meet its energy goals without new and improved networks. So the SoS-related (infrastructure) strategy has been assessed in the dissertation by theoretical and practical approaches, qualitatively and quantitatively. This chapter provides conclusions of the accomplished study and deals with recommendations for further research.

**Summary and Conclusions** The research objective has been posed as: *To describe and evaluate Europe's gas-SoS, as well as to specify prospective lines for the SoS enhancement, with a focus on European infrastructure projects, in accordance with individual countries' need/priority.* From this objective, two research questions have been derived and addressed in Chapters 3 and 4. This analysis could not be carried out without describing the European gas industry itself. Therefore [Chapter 2](#) has highlighted the role of energy/natural gas in the economic process and the gas usage peculiarities per consumer group, as well as it has accentuated the differences in the national markets' characteristics and, of course, in their gas supply infrastructures, etc. The main results of Chapter 2 are:

- a strong correlation between economic growth and energy consumption in the EU-15 ( $r = 0.95, p = <0.0001$ );
- ever-increasing peak demand loads for natural gas in the residential sector which can imply dangers for SoS;
- permanently declining gas reserves and gas production all over Europe, while import dependence increases. (Upon that, most of the local pipelines supplying the increased imports pass through various states with different objectives.);
- actors of the multi-country vertical gas supply chain which are inclined to conflict, undermining gas supply reliability.

These basic facts have provided necessary insights into why gas economics, transportation, and security of supply have assumed importance and turned into the focus of this study. This enabled to proceed to research questions directly.

[Chapter 3](#) addressed the first research question – that is, “*How (in-)secure are the European countries in terms of their gas supplies*”. It states that factors determining the degree to which a country can cope with gas supply interruptions include the supply infrastructure set-up, the structure of gas use, and the SoS tools in place to mitigate security risks. Pursuing this research question, Chapter 3 contributed to analysing the countries gas consumption make-up and it traced the use of different SoS tools in European markets. As a result, Section 3.3 displayed how vulnerable the residential sector turned out to be – which offered an explanation of why the common “protected

customer” standard has been established for households (OJL [2010]). On the other hand, Section 3.4 laid out how dependent upon certain SoS instruments individual countries were. In Section 3.5, we argue that the quantity of imported gas is a security problem and it imposes a cost on society, being prompted by society’s expectations that gas will continue flowing. On the back of it, however, we have conclusively illustrated that, while enjoying some of the lowest gas prices in the EU, the CSEE region had relatively little (unlike EU-15) “manoeuvre space” for increased costs due to SoS considerations. (In contrast, it is just high pricing which can help markets attract the necessary diversified supplies and, thus, to enhance SoS.) Finally, because some believed that Russia’s disputes with transit countries Ukraine and Belarus lately were the biggest threat of supply disruptions (to Europe), Section 3.8 presented the track record of Russia’s 20-year experience of “gas wars” with former Soviet republics. Such a detailed narrative is essential as these facts are currently accompanied with speculative discussions of Russia’s ability and readiness to use gas supply disruptions as a political weapon even against its EU customers.

The central discussion addressing the first research question is in Section 3.6. A pure characterization of country-specific SoS situations (even combined with some kind of collation) enabled better understanding of the discrepancies of individual SoS conditions. Such a description is valuable in itself. But for the real intercomparison among countries, quantification is needed. Based on a carefully designed set of parameters and on sophisticated measurement techniques, Section 3.6 has therefore assessed the level of security risks which single European countries face. The research question has led us to thinking about *SoS-indices* in principle, to constructing new SoS-indices, and to comparing them with the existing ones. We have developed the composite indicator *HHI’14* and calculated it according to three different statistical methods – in search of the best method. The research question has also led us to measuring the “*N-1*” infrastructure standard proposed by the EU (OJL [2010]). The EU Commission itself did not calculate country values – it only communicated what it approximately meant by “N-1”.

This study is not the first attempt to put figures on the SoS. The added value of our approach, however, involved a more advanced underpinning. And as compared with simply introducing the SoS-management tools (Section 3.4), the value lies also in the all-inclusive evaluation of gas market-relevant cases. Benefits are the explicit SoS indication and the country ranging possibility – while the pure discussion of SoS tools is more of conceptual nature. The presented approach has contributed to pursuing quantitatively the research objective of this dissertation. Summarising the course of Section 3.6, the following outcomes become available:

- small European nations suffer from lower SoS than large ones;
- the CSEE region suffers from lower SoS than the EU-15;
- SoS is crucially influenced by diversity of country-specific factors.

Our focus on exploring the applicability/usages of the SoS-indices developed in Section 3.6 (*HHI’14s*) and of those adopted (“N-1” plus several composites stemming from other authors) appears to be even more significant and novel. With their application we hope to gain insights into the indices adequacy as a policy tool for present and future energy security developments. While the existing literature offers quite a number of energy security indicators to date, their usefulness has never been tested.

Within Chapter 4, in closing of the January 2009 gas crisis analysis (Section 4.3) and of the infrastructure projects analysis (Section 4.4), we have – for the first time – been testing the explanatory power of SoS-indices. We confronted them with two measurable phenomena: (a) with the economic losses in the 2009 interruption of Russian gas flows to Europe; and (b) with the EU subsidies under the EEPR programme.

The clarification of “how secure the countries were” led to the second research question. Chapter 4 thus aims to address “*How the SoS in Europe can be improved (with emphasis on infrastructure)*”. Upon that, the study’s focus has been shifted to CSEE – based on the relatively bad local SoS scores (as judged by quantifications in Section 3.6). A profound analysis in the case of CSEE could not be carried out without investigation of the background of gas supply vulnerabilities. CMEA “baggage”, restricting the energy-political discretion of the region, has been explained in Section 4.2. Our analysis covered the inherited distortions like excessive seasonality of gas demand, lack of supply diversity, and inefficiency of infrastructure. It concluded that the unidirectional and non-integrated networks architecture has turned into a major obstacle to the CSEE goal of overcoming the single-source dependency (on Russia). Overcoming of that dependency is considered necessary on the understanding that a prolonged disruption of the gas inflows from Russia would have had a catastrophic impact on the region. In January 2009, the degree of CMEA-caused vulnerabilities became painfully evident in CSEE. They proved to be an impediment to dealing with the supply cut. In terms of this real emergency situation, Section 4.3 has thus explored implications of the CMEA inheritance for the enlarged EU and discussed the practical use of the SoS tools presented in Section 3.4. As was to be proved, we confirmed that mainly the inadequacies in gas transport (in terms of capacities, bi-directional capabilities, networks isolation) constrained flows towards CSEE throughout the duration of the gas cut, rather than an overall shortage of substitute gas.

As previously mentioned, factors determining the ability to cope with supply disruptions also comprise the gas supply infrastructure set-up. This is why, following up on this topic that was introduced in Subsection 2.3.3, Section 4.4 committed to an in-depth discussion of advanced infrastructural issues. There needs to be flexibility, redundancy, and alternative options in the system if gas disruptions are to be managed. Our examination of the infrastructure utilization (Subsection 4.4.1) has detected, however, that Europe’s gas transmission, production and storage capacity was totally or nearly totally exhausted in the extreme cold winter days. Infrastructure concerns were mainly related to CSEE. Still, bottlenecks and missing pipeline links *within* Europe were jeopardising decisions concerning capital outlay *outside* Europe. COM [2010b: 11] instructs that “every European region should implement infrastructure allowing physical access to at least two different sources”. This suggested that a common European strategy was needed. It is where the *EEPR* emerged as a financial mean to facilitate necessary investments – being addressed in Subsection 4.4.2. In line with COM [2008] etc., Subsection 4.4.3 has subsequently examined the priority corridors anticipated to strengthen the European GTS. With relevance to CSEE and emphasis on the *EEPR* projects, it dealt with making the two-way gas flows possible, making up for lacking cross-country links (in terms of the shaping *Baltic Gas Ring*, *North-South gas corridor* in CSEE, and the *SEE Gas Ring*), with infrastructure initiatives providing new gas to CSEE (in the form of LNG and pipeline gas), as well as with the increased

storage. Against this background, critical requirements have been addressed such as:

- ensuring that some vital projects are not dismissed as ineffective. (The key here is introducing reliability with respect to the completion of associated projects.);
- avoiding of the multiplicity of infrastructures. (The project development thus requires a more balanced approach.);
- incentives: e.g., for suppliers it is access to a larger pool of demand, whereas for consumers it is increased diversity of supply, new trading opportunities<sup>225</sup> or (with respect to LNG) enabling market integration wherever no direct pipelines exist.

In Subsection 4.4.5, we eventually set out that the SoS-index development (Section 3.6) has contributed to pursuing the *second* research question on a par with the *first* one. HHI'14 and "N-1" are capable of communicating both "the level of (in-)security" and "required measures to be taken in order to improve the SoS scores". What is meant here is the measurable impact of the EEPR on EU's security. It can be calculated – on the understanding that the centralised Community financing made the relevant projects extremely credible for implementing. So Subsection 4.4.5 has estimated how the country scores have changed, in terms of both indices, in response to the EEPR. In trying to reply to the second research question, we have finally (in Section 4.5) reported on a highly promising project NETS (abbreviated for the "New Europe Transmission System") and a forward-looking European Transmission System Operator (ETSO) idea, aimed to unify gas grids – in, respectively, CSEE and EU – by replacing national TSOs and creating a common TSO. SoS will benefit from a progressive unification of gas networks. However, progress is slow. For the time being, notably the German gas market has taken steps towards complete integration. Results from the other declared initiatives remain to be seen.

**Discussion and Further Research** This section evaluates the major, quantitative, findings of the dissertation. It ultimately outlines approaches to future research, based on this study's limitations.

This investigation integrates a number of characteristics of gas-consuming and -supplying countries into indices which promise to describe/evaluate a country's SoS situation best. It may be an important step for improving the understanding of the multifaceted concept of SoS. We pursued the idea to check (for policy decisions) the *usefulness* of differently defined SoS-indices. This has been achieved by testing their predictive success – which has never been done before. Our major findings are presented in Subsections 4.3.3 and 4.4.4. They add up to the following:

- With respect to HHI'14 (more precisely HHI'14<sub>2</sub> and HHI'14<sub>5</sub>), we weakly supported the hypothesis that European nations with "good" SoS scores have coped better with the January 2009 gas crisis than those with "bad" scores. This result is based, however, on a small sample of countries for which economic losses have been estimated. Figures of reduced industrial production as the consequence of the 2009 gas crisis did not show significant relation to any of the HHI'14s. In terms of "N-1", no significant relation could be found.
- Our conjecture that the EU nations with "worse" SoS scores might have enjoyed stronger EEPR subsidies could neither be supported (for both classes of indices).

---

225. CSEE countries that are buying natural gas for oil-linked formula price are losing out in the market situations, when traded spot prices are lower.

As we have discovered a correlation of some of those indices with the amount of losses in a gas crisis, this puts in doubt whether the EEPF funding is well-founded.

- On the other hand, investment in infrastructure, made after the gas cut of January 2009, resulted that many EU member states now meet the common SoS standard expressed in terms of “N-1”.

Based on our findings we have concluded that the HHI’14 index of ours together with one more other index (i.e., REES, suggested by Le Coq & Paltseva [2009]) somewhat favoured the ability to explain/predict measurable SoS-relevant phenomena like supply problems and economic losses. But this clearly was insufficiently to firmly recommend their adoption by policymaking.

Some other energy policy recommendations could be:

- In January 2009, enlarged Europe paid the price for its poorly interconnected gas infrastructure. This lesson has been learned and it should be kept in mind in the years to come where gas is expected to substitute more and more other fossil fuels and, in some countries, also nuclear energy resources;
- Some believe that Russia intends to strengthen its influence in Europe by promoting politically motivated infrastructure projects. This might encourage diversification away from Russia – notably for CSEE;
- A constructive dialogue EU–Russia is strongly needed in order to grant transit via Russia to Turkmenistan, Kazakhstan, and Uzbekistan.

Despite the important findings of this investigation, it had its limitations. Occasionally we had measuring problems or were not able to collect the data we really wanted. Therefore further work on aspects not covered in the research, and on shortcomings we ran across when trying to quantify specified indices and consequences of crises, is worthwhile. A few viable areas of future study could be:

- A modified “N-1” method. The current N-1 calculation is sensitive to large infrastructures (pipes, storages, etc.) not necessarily destined for one country. Herefrom it appears not quite correct, e.g., that each preceding transit country in a multiple-country pipeline chain has assigned all its entry capacity to itself by the N-1 design fixed in OJL [2010]. So an adjusted common approach – at least at research level – needs to be developed for the N-1 calculation.
- While our analysis of measuring SoS has provided interesting insights, a few improvements are possible. First, our current SoS-index is static, while policy reform is a dynamic process. Further work should thus look at HHI’14 changing in time (in the manner of, say, Sovacool & Brown [2010]<sup>226</sup>). Second, some arbitrariness present in HHI’14 may be inherent but should be discussed. For instance, why using the “share in TPEC” and not “share in value of TPEC” as weight of a component-parameter? Or why using an adjustment factor for “gas substitutability” on a [1, 2] scale and for “offshore risks” on a [1, 4] scale? – instead of, say, on a [1, 10] scale? Third, the analysis could benefit from the inclusion of some, but not too many, additional factors. For example, we have assumed that domestic production is free from supply risk. Still, disruptions in domestic supply (due to strikes or infrastructure-related breakdowns) should also be addressed. The credible SoS-index should additionally approach diversity in terms of “*independent*” sources and

---

226. Based on their SoS-index, Sovacool & Brown [2010] have assessed the relative energy (gas and oil) security performance of 22 OECD nations from 1970 to 2007.

transport routes. In this context, Jansen & Seebregts [2010] indicate: “The *Nord Stream* gas pipeline certainly has value for improving energy [...] security in the EU. Yet, the *Nabucco* project would add more”. Finally, one may criticize our concept of using two families of SoS-indices (HHI’14 and “N-1”) like “one index instead of two would make comparisons easier and more readily communicable”. Although we had good reasons for using two indices, extra efforts might make sense towards that goal too.

- Our focus in this paper has mainly been gas-consuming Europe. Its extension by incorporating an analysis of incentives and behaviour of gas-exporting and transit nations could be desirable – specifically as regards the Middle East/Caspian gas stockroom. One idea might be a game-theoretic analysis involving existent and potential gas suppliers and shippers to Europe – based on the experiences of, e.g., Chollet et al. [2001]. In the light of continuous efforts of CSEE to diversify away from Russian gas, it might also be intriguing to try quantitatively access the judgement like: “It is not clear – given the number of borders which [Middle East/Caspian gas supplies] will need to cross and the potential for problems within and between countries along the route – whether such pipeline routes can be considered more reliable than existing and new supplies from and through Russia which they are intended to displace” (Stern [2006:15]).
- Finally, one should think about other SoS tools. One measure not discussed in this study is a stronger integration of the gas-producing and gas-consuming states. Bolle & Ruban [2007] have investigated gas supply disruptions in vertical structures. They have shown that SoS will be improved should the producers invest (and, in the case of Gazprom, be allowed to invest) in the European downstream market as gas traders. Therefore, the incorporation of vertical integration into a complex SoS analysis might be worth including in future research endeavours.



## Bibliography

- ANN.Az (2012). *EU Sees No Obstacles for Trans-Caspian Gas Pipeline Construction*. 14 June. URL: <http://ann.az/en/?p=49845>, 4.07.2012.
- APEREC (Asia Pacific Energy Research Centre) (2007). *A Quest for Energy Security in the 21st Century: Resources and Constraints*. Institute of Energy Economics, Japan.
- ATG (1990). *Aide-Mémoire de L'Industrie du Gaz*. Quatrième Edition. Association Technique de L'Industrie du Gaz en France, Paris. (Published in Russian as: Basniev, K.S. (ed.) (1994). *Ėnciklopedija Gazovoj Promyšlennosti*. [The gas industry encyclopaedia.] JSC Tvant, Moscow.)
- Austvik, O.G. (2003). *Norwegian Natural Gas: Liberalization of the European Gas Market*. Europa-programmet, Oslo.
- Balmaceda, M.M. (ed.) (2000). *On the Edge: Ukrainian–Central European–Russian Security Triangle*. CEU Press, Budapest.
- Balmaceda, M.M. (2002). *EU Energy Policy and Future European Energy Markets: Consequences for the Central and East European States*. Untersuchungen des FKKS 27/2002, Forschungsschwerpunkt Konflikt- und Kooperationsstrukturen in Osteuropa, Universität Mannheim.
- Balmaceda, M.M. (2004). "Der Weg in die Abhängigkeit: Ostmitteleuropa am Energietropf der UdSSR." *Osteuropa*, Vol. 54, No. 9–10, pp. 162–179.
- Barton, B., C. Redgwell, A. Rønne, and D.N. Zillman (2004). *Energy Security: Managing Risk in a Dynamic Legal and Regulatory Environment*. Oxford Univ. Press.
- BBJ (2011). "Hungary, Slovakia sign gas interconnector agreement." *Budapest Business Journal*, 28 January. URL: [http://www.bbj.hu/energy/hungary-slovakia-sign-gas-interconnector-agreement\\_55749](http://www.bbj.hu/energy/hungary-slovakia-sign-gas-interconnector-agreement_55749), 31.07.2011.
- Belgrave, R., C.K. Ebinger and H. Okino (eds.) (1987). *Energy Security to 2000*. Gower Publ., Aldershot/Westview Press, Boulder.
- BEMIP (2009). *Baltic Energy Market Interconnection Plan*. Final report of the HLG. European Commission, Brussels.
- BMJ (Bundesministerium der Justiz) (2010). "Verordnung über den Zugang zu Gasversorgungsnetzen (Gasnetzzugangsverordnung, GasNZV)" of 3 September 2010. *BGBI. I*, p. 1261ff.
- Bolle, F. and R. Ruban (2007). *Competition and Security of Supply: Let Russia Buy into the European Gas Market!* Discussion Paper No. 258, European University Viadrina Frankfurt (Oder).
- Bollen, J. (2008). *Energy Security, Air Pollution, and Climate Change: An Integrated Cost Benefit Approach*. Milieu- en Natuurplanbureau (MNP), Bilthoven.
- Boltz, W. (2009). *Security of Supply and Competition*. E-Control/Vienna Presentation at the Forum Alpbach, 2 September.
- BP (2010). *BP Statistical Review of World Energy*. British Petroleum, London.
- BP (2011). *BP Energy Outlook 2030*. British Petroleum, London.
- BP (2012). *Shah Deniz*. British Petroleum, London. URL: [207](http://www.bp.com/sec-</a></p></div><div data-bbox=)

- [iongenericarticle.do?categoryId=9006668&contentId=7015092](http://www.iongenericarticle.do?categoryId=9006668&contentId=7015092), 4.07.2012.
- Burchett, K. (2011). *KOGAS May Join AGRI to Build Romanian LNG Terminal*. 25 November. URL: [http://www.downstreamtoday.com/news/article.aspx?a\\_id=28661&AspxAutoDetectCookieSupport=1](http://www.downstreamtoday.com/news/article.aspx?a_id=28661&AspxAutoDetectCookieSupport=1), 28.05.2012.
- Cabalu, H. (2010). "Indicators of security of natural gas supply in Asia." *Energy Policy*, Vol. 38 (1), pp. 218–225.
- Capros, P., L. Mantzos, V. Papandreou, and N. Tasios (2008). *European Energy and Transport – Trends to 2030: Update 2007*. Prepared for the EU Commission DG TREN. National Technical University of Athens (ICCS-NTUA).
- Capros, P., L. Mantzos, N. Tasios, A. De Vita, and N. Kouvaritakis (2010). *EU Energy Trends to 2030: Update 2009*. Prepared for the EU Commission DG TREN. National Technical University of Athens (ICCS-NTUA).
- Chandra, V. (2006). *Fundamentals of Natural Gas: An International Perspective*. PennWell Corp., Tulsa.
- Chester, L. (2010). "Conceptualising energy security and making explicit its polysemic nature." *Energy Policy*, Vol. 38 (2), pp. 887–895.
- Chollet, A., B. Meinhart, C. von Hirschhausen, P. Opitz (2001). *Options for Transporting Russian Gas to Western Europe – A Game-theoretic Simulation Analysis*. Discussion Paper 261, Dt. Institut für Wirtschaftsforschung, Berlin.
- Christie, E.H. (2010). *Security of Supply: Some Theoretical Building Blocks*. Paper for the 11th IAEE European Conference, Vilnius, 25–28 August.
- Christie, E.H. (2011). *The 2009 Russia-Ukraine Gas Supply Cut: Economic Effects and Policy Reactions*. In E.H. Christie, P.K. Baev and V. Golovko. Vulnerability and bargaining power in EU–Russia gas relations. FIW-Research Reports 2010/11 No 3, Forschungsschwerpunkt Internationale Wirtschaft, Vienna, pp. 1–21.
- Cohen, G., F. Joutz and P. Loungani (2011). "Measuring energy security: Trends in the diversification of oil and natural gas supplies." *Energy Policy*, Vol. 39 (9), pp. 4860–4869.
- COM (2000a). *Green Paper – Towards a European Strategy for the Security of Energy Supply*. COM(2000)769 Final. European Commission, Brussels.
- COM (2000b). *Green Paper – Towards a European Strategy for the Security of Energy Supply*. Technical Document. Brussels.
- COM (2008). *Green Paper towards a Secure, Sustainable and Competitive European Energy Network*. COM(2008)782 Final. European Commission, Brussels.
- COM (2010a). *Annex to the Report from the Commission to the Council and the European Parliament on the Implementation of the European Energy Programme for Recovery*. COM(2010)191 Final. European Commission, Brussels.
- COM (2010b). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "Energy Infrastructure Priorities for 2020 and Beyond – A Blueprint for an Integrated European Energy Network"*. COM(2010)677 Final. European Commission, Brussels.
- COM (2010c). *Report from the Commission to the Council and the European Parliament on the Implementation of the European Energy Programme for Recovery*. COM(2010)191 Final. European Commission, Brussels.
- COM (2010d). *Selection of Projects for the European Energy Programme for Recov-*

- ery. European Commission, Brussels.
- COM (2011). *Report from the Commission to the Council and the European Parliament on the Implementation of the European Energy Programme for Recovery*. COM(2011)217 Final. European Commission, Brussels.
- Cornot-Gandolphe, S. (2000). "Beitritt zum EU-Gasmarkt: Chancen und Herausforderungen für die Länder Mittel- und Osteuropas." *Zeitschrift für Energiewirtschaft*, Vol. 24, No. 4, pp. 217–224.
- Cornot-Gandolphe, S., O. Appert, R. Dickel, M.-F. Chabrelie, and A. Rojey (2003). *The Challenges of Further Cost Reductions for New Supply Options (Pipeline, LNG, GTL)*. Paper for the 22nd World Gas Conference, Tokyo, 1-5 June.
- Correljé, A., D. de Jong and J. de Jong (2009). *Crossing Borders in European Gas Networks: The Missing Links*. Clingendael Energy Paper, Clingendael International Energy Programme, The Hague.
- Costantini, V., F. Gracceva, A. Markandya, and G. Vicini (2007). "Security of energy supply: Comparing scenarios from a European perspective." *Energy Policy*, Vol. 35 (1), pp. 210–226.
- Costescu Badea, A. (2010). *Energy Security Indicators*. EU Commission's Joint Research Centre (JRC) Presentation, Belgrade, 19-21 May.
- Cutler R.M. (2012). *Anatolia Gas Pipeline Races Towards Reality*. 5 January. URL: [http://www.atimes.com/atimes/Central\\_Asia/NA05Ag01.html](http://www.atimes.com/atimes/Central_Asia/NA05Ag01.html), 4.07.2012.
- Davis, J.D. (1984). *Blue Gold: The Political Economy of Natural Gas*. George Allen & Unwin Publ., London/Boston/Sydney.
- De Joode, J., D. Kingma, M. Lijesen, M. Mulder and V. Shestalova (2004). *Energy Policies and Risks on Energy Markets: A Cost-Benefit Analysis*. Special Publication 51, CPB Netherlands Bureau for Economic Policy Analysis, The Hague.
- Delcommune, M.M. (2009). *Progress Report on the New Europe Transmission System (NETS)*. Presentation at the 4th Gas Forum, Ljubljana, 11 September.
- Dolinski, U., H.-J. Ziesing and K.-D. Labahn (1978). *Maßnahmen für eine sichere und umweltverträgliche Energieversorgung*. Sonderheft 125, Dt. Institut für Wirtschaftsforschung. Duncker & Humblot, Berlin.
- ECA, Penspen, EIHP, and UGS (2009). *South East Europe: Regional Gasification Study*. Final Report. Economic Consulting Associates Ltd., Penspen, UK/Energy Institute Hrvoje Požar, Croatia/Untergrundspeicher und Geotechnologie System GmbH/Germany.
- EIA (Energy Information Administration) (2008). *Country Analysis Briefs (CABs)*. U.S. Department of Energy, Washington, D.C. Various volumes and CABs. URL: <http://www.eia.gov/countries/>.
- EIA (2010). *International Energy Outlook 2010*. U.S. Department of Energy, Washington, D.C.
- EIA (2011). *International Energy Statistics*. U.S. Department of Energy, Washington, D.C. URL: <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm>.
- EIB (2009). *Hungary–Croatia Gas Interconnection*. 24 June. URL: <http://www.eib.org/projects/pipeline/2009/20090128.htm?lang=en>, 31.07.2011.
- Ellis, J. (2010). *Dynamics of the Southern Corridor*. Presentation, Baku, 15 September.
- Energy Community (w.y.). *Gas Ring Concept*. URL: <http://www.energy-community>.

[org/portal/page/portal/enc\\_home/areas\\_of\\_work/gas/regional\\_market/Gas\\_Ring\\_Concept](http://org/portal/page/portal/enc_home/areas_of_work/gas/regional_market/Gas_Ring_Concept), 23.06.2012.

- Energy Community Secretariat (2011). *Progress Report on the Priority Gas Projects in the Energy Community*. Presentation at the 6th Gas Forum, Bled/Slovenia, 21-22 September.
- ENTSO (2009). *European Ten-Year Network Development Plan 2010-2019*. European Network of Transmission System Operators for Gas, Brussels.
- ENTSO (2011). *European Ten-Year Network Development Plan 2011-2020*. European Network of Transmission System Operators for Gas, Brussels.
- EurActiv.com (2011). *Slovakia, Poland look into 'Visegrád pipeline'*. 17 January. URL: <http://www.euractiv.com/en/energy/slovakia-poland-look-visegrad-pipeline-news-501292>, 31.07.2011.
- Eurostat (12/2009). *Energy – Monthly Statistics*. European Commission, Luxembourg.
- Eurostat (2010a). *Energy – Yearly Statistics 2008: 2010 Edition*. European Commission, Luxembourg.
- Eurostat (2010b). *EU Energy and Transport in Figures 2010*. European Commission, Luxembourg.
- Eurostat (2011). *Energy, Transport and Environment Indicators: 2010 Edition*. European Commission, Luxembourg.
- Findlater, S. and P. Noël (2010). *Gas Supply Security in the Baltic States: A Qualitative Assessment*. EPRG Working Paper 1008. Electricity Policy Research Group, University of Cambridge.
- Földgáz (2009). *14 Days Without Russian Gas: E.ON Aid to Central and South-East Europe*. Földgáz Magazine 2009/01, E.ON Földgáz, Budapest.
- Frondel, M. and C.M. Schmidt (2008). *Measuring Energy Security – A Conceptual Note*. Ruhr Economic Papers No. 52, RWI Essen.
- Fund for Peace, The (2011). *The Failed States Index 2010*. Washington, D.C. URL: <http://www.fundforpeace.org/global/?q=fsi-grid2010>.
- GASPOOL.de (2009). *Cooperation for More Competition and Simple Gas Transport*. 5 March. URL: <http://www.gaspool.de/pi-090305.html?L=1>, 11.07.2011.
- Georgiev, J. (2012). *Gas Interconnector Greece-Bulgaria (IGB Project) – An Alternative Supply Route to South East Europe by 2014*. Presentation by the Bulgarian Energy Holding, Athens, 28 March.
- Gerner, F. (2010). *The Future of the Natural Gas Market in Southeast Europe*. The World Bank, Washington, D.C.
- GGT (2010). *Croatia–Hungary Interconnection Completed*. 28 December. URL: <http://www.globalgastransport.info/archive.php?id=2361>, 31.07.2011.
- Giamouridis, A. and S. Paleoyannis (2011). *Security of Gas Supply in South Eastern Europe: Potential Contribution of Planned Pipelines, LNG and Storage*. NG 52, Oxford Institute for Energy Studies.
- GIE (Gas Infrastructure Europe). Various data and maps. Brussels. URL: <http://www.gie.eu.com/>, 20.04.2011.
- GIE (2008). *GTE+ Winter Outlook 2008/2009*. Final Version, 31 October 2008. Gas Transmission Europe.
- GIE (2009a). *GTE+ Demand Scenarios Vs. Capacity Report*. Ref. 09GTE+144, 31 July 2009. Gas Transmission Europe.

- GIE (2009b). *GTE+ Reverse Flow Study TF: Technical Solutions*. 21 July 2009. Gas Transmission Europe.
- GIE (2010a). *GLE LNG Map; GLE LNG Map Dataset; GLE LNG Investment Database*. Gas LNG Europe.
- GIE (2010b). *GSE Storage Map; GSE Storage Map Dataset; GSE Storage Investment Database*. Gas Storage Europe.
- GIE (2010c). *GTE Network Capacities Map; GTE Network Capacities Map Dataset*. Gas Transmission Europe.
- Global Research (2009). *The EU-Russia Gas Pipeline Crisis: Taking Sides with Pipelines. Review of Country-Level Impacts*. 18 January. URL: <http://www.globalresearch.ca/index.php?context=va&aid=11874>, 20.08.2011.
- Gnansounou, E. (2008). "Assessing the energy vulnerability: Case of industrialised countries." *Energy Policy*, Vol. 36 (10), pp. 3734–3744.
- Gupta, E. (2008). "Oil vulnerability index of oil-importing countries." *Energy Policy*, Vol. 36 (3), pp. 1195–1211.
- Hafner, M. (2003). *Future Natural Gas Supply Options and Supply Costs for Europe*. Observatoire Méditerranéen de l'Energie, Sophia-Antipolis.
- Hafner, M., J. Vermeire and P. Moraleda (2008). *Study on Interoperability of LNG Facilities and Interchangeability of Gas and Advice on the Opportunity to Set-up an Action Plan for the Promotion of LNG Chain Investments*. Final Report, Prepared for the EU Commission DG TREN. MVV Consulting.
- Hensing, I., W. Pfaffenberger and W. Ströbele (1998). *Energiewirtschaft: Einführung in Theorie und Politik*. Oldenbourg, München/Wien.
- Hungas (2011). *E.ON Földgáz Storage Zrt*. URL: [http://www.hungas.hu/eng/about\\_us/members/e-on-foldgaz-storage](http://www.hungas.hu/eng/about_us/members/e-on-foldgaz-storage), 20.08.2011.
- ICIS Heren (2011). *GdF Suez and E.ON Ruhrgas Interested in Yamal Backhaul*. 11 July. URL: <http://www.icis.com/heren/articles/2011/07/11/9476552/gdf-suez-and-e-on-ruhrgas-interested-in-yamal-backhaul.html>, 7.08.2011.
- ICIS.com (2011). *German Gas Zones GASPOOL and Aequamus Set to Merge*. 28 June. URL: <http://www.icis.com/heren/articles/2011/06/28/9473341/german-gas-zones-gaspool-and-aequamus-set-to-merge.html>, 11.07.2011.
- IEA (International Energy Agency) (1994). *Natural Gas Transportation: Organization and Regulation*. OECD, Paris.
- IEA (1995). *The IEA Natural Gas Security Study*. OECD, Paris.
- IEA (2002). *Flexibility in Natural Gas Supply and Demand*. OECD, Paris.
- IEA (2004). *Security of Gas Supply in Open Markets: LNG and Power at a Turning Point*. OECD, Paris.
- IEA (2005). *Energy Policies of IEA Countries: Turkey 2005 Review*. OECD, Paris.
- IEA (2007). *Energy Security and Climate Policy: Assessing Interactions*. OECD, Paris.
- IEA (2010a). *Energy Statistics of Non-OECD Countries: 2010 Edition*. OECD, Paris.
- IEA (2010b). *Energy Statistics of OECD Countries: 2010 Edition*. OECD, Paris.
- IEA (2010c). *Natural Gas Information 2010: With 2009 Data*. OECD, Paris.
- IEA (2010d). *World Energy Outlook 2010*. OECD, Paris.
- IEA (2011). *Key World Energy Statistics*. OECD, Paris.
- Jansen, J.C., W.G. van Arkel and M.G. Boots (2004). *Designing Indicators of Long-term Energy Supply Security*. ECN-C--04-007, Energy Research Centre of the

Netherlands, Petten.

- Jansen, J.C. and A.J. Seebregts (2010). “Long-term energy services security: What is it and how can it be measured and valued?” *Energy Policy*, Vol. 38 (4), pp. 1654–1664.
- Kaderják, P. (2009). *The January 2009 Gas Crisis: What Happened in Central and South East Europe?* REKK Presentation, Budapest, 16 April.
- Kaderják, P., P. Cameron and A.I. Tóth (2007). “Unilateral natural gas import dependence: A new supply security issue for Europe.” *European Review of Energy Markets*. Vol. 2, Issue 2.
- Kendell, J.M. (1998). *Measures of Oil Import Dependence*. Energy Information Administration, U.S. Department of Energy, Washington, D.C.
- Kilyakov, A. (2012). *European Commission Accuses Gazprom of Foul Play*. 10 September. URL: [http://rbth.ru/articles/2012/09/10/european\\_commission\\_accuses\\_gazprom\\_of\\_foul\\_play\\_18109.html](http://rbth.ru/articles/2012/09/10/european_commission_accuses_gazprom_of_foul_play_18109.html), 20.09.2012.
- Kovacevic, A. (2009). *The Impact of the Russia–Ukraine Gas Crisis in South Eastern Europe*. NG 29, Oxford Institute for Energy Studies.
- Kruyt, B., D.P. van Vuuren, H.J.M. de Vries, and H. Groenenberg (2009). “Indicators for energy security.” *Energy Policy*, Vol. 37 (6), pp. 2166–2181.
- Le Coq, C. and E. Paltseva (2009). “Measuring the security of external energy supply in the European Union.” *Energy Policy*, Vol. 37 (11), pp. 4474–4481.
- Lefèvre, N. (2010). “Measuring the energy security implications of fossil fuel resource concentration.” *Energy Policy*, Vol. 38 (4), pp. 1635–1644.
- LNG World News (2012). *Poland: Gaz-System Gets Award for Świnoujście LNG Project*. 12 January. URL: <http://www.lngworldnews.com/poland-gaz-system-gets-award-for-swinoujscie-lng-project/>, 28.05.2012.
- Löschel, A. (2012). *Indicators of Energy Security in Industrialized Countries*. Presentation at the Economic Challenges for Energy Workshop, Madrid, 30-31 January.
- Löschel, A., U. Moslener and D.T.G. Rübelke (2010). “Indicators of energy security in industrialised countries.” *Energy Policy*, Vol. 38 (4), pp. 1665–1671.
- Lohner, H. and E. Schmidt (2001). “Gasversorgungssicherheit in Mittel- und Osteuropa.” *Das Gas- und Wasserfach: Gas, Erdgas*, Vol. 142, No. 9, pp. 629–634.
- Maull, H.W. (1981). *Natural Gas and Economic Security: New Problems for the West*. Atlantic Institute for International Affairs, Paris.
- Mi.government.bg (2012a). *Gas Interconnection Bulgaria–Romania (IBR)*. URL: <http://www.mi.government.bg/en/themes/gas-interconnection-bulgaria-romania-ibr-911-347.html>, 12.07.2012.
- Mi.government.bg (2012b). *Gas Interconnection Bulgaria–Serbia (IBS)*. URL: <http://www.mi.government.bg/en/themes/gas-interconnection-bulgaria-serbia-ibs-912-347.html>, 20.06.2012.
- Mi.government.bg (2012c). *Gas Interconnection Turkey–Bulgaria (ITB)*. URL: <http://www.mi.government.bg/en/themes/gas-interconnection-turkey-bulgaria-itb-913-347.html>, 12.07.2012.
- Moulin-Fournier, T. (2009). *Russian Gas Crisis/ Q1 2009. What Worked/ What Did not Work – Focus on SEE*. GdF Suez Presentation for the Energy Community, Ljubljana, 11 September.
- Nardo, M., M. Saisana, A. Saltelli, S. Tarantola, A. Hoffman, and E. Giovannini

- (2008). *Handbook on Constructing Composite Indicators: Methodology and User Guide*. OECD, Paris/JRC, Ispra.
- Natural Resources Canada (2011). *Industrial Energy Intensity by Industry*. Office of Energy Efficiency. URL: [http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/tableshandbook2/agg\\_00\\_6\\_e\\_7.cfm?attr=0](http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/tableshandbook2/agg_00_6_e_7.cfm?attr=0), 19.02.2011.
- NaturalGas.org (2010). URL: <http://www.naturalgas.org/index.asp>, 17.04.2011.
- Neff, T.L. (1997). *Improving Energy Security in Pacific Asia: Diversification and Risk Reduction for Fossil and Nuclear Fuels*. Center for International Studies, Massachusetts Institute of Technology.
- NERA (2002). *Security in Gas and Electricity Markets: Final Report for the Department of Trade and Industry*. Ref. 003/08 SGEM/DH, 21 October. National Economic Research Associates, London.
- Neumann, A. (2004). *Security of Supply in Liberalised European Gas Markets*. Diploma Thesis, Europa-Universität Viadrina Frankfurt (Oder).
- Neumann, A. (2007). *How to Measure Security of Supply?* Mimeo, Dresden University of Technology.
- Neurope.eu (2009). *SPP Signs Five-year Contract with GdF Suez*. 11 October. URL: <http://www.neurope.eu/articles/96923.php>, 7.08.2011.
- News, The (2011). *Polish-Czech Gas Interconnector Goes Online*. 14 September. URL: <http://www.thenews.pl/1/12/Artykul/55074,PolishCzech-gas-interconnector-goes-online>, 23.06.2012.
- News.bbc (2009). *Gas Cut: How Europe Is Coping*. 8 January. URL: <http://news.bbc.co.uk/2/hi/europe/7815113.stm>, 20.08.2011.
- News.sky.com (2009). *Russia 'Cuts Off Gas to Europe'*. 7 January. URL: <http://news.sky.com/home/world-news/article/15198630>, 20.08.2011.
- Nitzov, B. (2004). *Transcontinental Gas Pipelines*. Presentation at the IEA-ECS Workshop, Istanbul, 5-6 May.
- Nosko, A. and P. Lang (2010). "Lessons from Prague: How the Czech Republic has enhanced its energy security." *Journal of Energy Security*, July 2010 Issue.
- Nosko, A. and P. Ševce (2010). "The evolution of energy security in the Slovak Republic." *Journal of Energy Security*, September 2010 Issue.
- Novinite.com (2011a). *Bulgaria May Build LNG Terminal as Russia Wants to Skip South Stream's Underwater Section*. 9 March. URL: [http://www.novinite.com/view\\_news.php?id=126045](http://www.novinite.com/view_news.php?id=126045), 4.07.2012.
- Novinite.com (2011b). *EU Goes for Merging Nabucco, ITGI Gas Pipelines – Report*. 18 Febr. URL: [http://www.novinite.com/view\\_news.php?id=125422](http://www.novinite.com/view_news.php?id=125422), 4.07.2012.
- Novinite.com (2012). *Germany's RWE Hints of Quitting Nabucco Project*. 14 May. URL: [http://www.novinite.com/view\\_news.php?id=139325](http://www.novinite.com/view_news.php?id=139325), 4.07.2012.
- Nunn, J. and L. Ortman (2010). *Physical Gas Flows across Europe in 2009*. Department of Energy and Climate Change, London.
- OJL (2004). "Council Directive 2004/67/EC of 26 April 2004 concerning measures to safeguard security of natural gas supply." *Official Journal of the European Union*, L 127, pp. 92–96.
- OJL (2006). "Decision No 1364/2006/EC of the European Parliament and of the Council of 6 September 2006 laying down guidelines for trans-European energy networks and repealing Decision 96/391/EC and Decision No 1229/2003/EC."

- Official Journal of the European Union*, L 262, pp. 1–23.
- OJL (2009a). “Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC.” *Official Journal of the European Union*, L 211, pp. 94–136.
- OJL (2009b). “Regulation (EC) No 663/2009 of 13 July 2009 establishing a programme to aid economic recovery by granting Community financial assistance to projects in the field of energy.” *Official Journal of the European Union*, L 200, pp. 31–45.
- OJL (2009c). “Regulation (EC) No 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No 1775/2005.” *Official Journal of the European Union*, L 211, pp. 36–54.
- OJL (2010). “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*, L 295, pp. 1–22.
- PE-Map (Petroleum Economist Ltd) (2003). *Gas in the CIS and Europe*. Petroleum Economist Cartographic, London.
- Percebois, J. (2007). “Energy vulnerability and its management.” *International Journal of Energy Sector Management*, Vol. 1 (1), pp. 51–62.
- Pirani, S., J. Stern and K. Yafimava (2009). *The Russo-Ukrainian Gas Dispute of January 2009*. NG 27, Oxford Institute for Energy Studies.
- Podgórska, A. (2012). *Greater Opportunities in Gas Imports from the West Owing to New Investment in Lower Silesia*. 25 January. URL: <http://msp.gov.pl/portal/en/16/2991/>, 15.06.2012.
- Polish Market Online (2011). *Polish–Lithuanian Gas Link Sooner than Expected*. 18 May. URL: <http://www.polishmarket.com.pl/document/:24801,PolishLithuanian+gas+link+sooner+than+expected.en.html>, 13.07.2011.
- Pustišek, A. (1995). “Erdgastransport- und -speichermärkte in Zentraleuropa – Entwicklungstendenzen und Preisbildung.” *Zeitschrift für Energiewirtschaft*, Vol. 19, No. 1, pp. 41–46.
- Pustišek, A. (2009). *Experiences of the Gas Crisis – A View on Security of Supply*. E.ON Ruhrgas Presentation at the 41st International Gas Conference and Exhibition, Siófok/Hungary, 28–29 October.
- Ramboll (2008). *Study on Natural Gas Storage in the EU*. Ref. 853102, Final Report, Prepared for the EU Commission DG TREN. Ramboll Oil & Gas, Denmark.
- Ramboll (2009). *Future Development of the Energy Gas Market in the Baltic Sea Region*. Ref. 953106, Final Report, Prepared for the EU Commission DG TREN. Ramboll Oil & Gas, Denmark.
- Ramboll (2010). *Quantitative Comparison of Different Risks, Impact and Mitigation Possibilities*. Project No 213744 “SECURE – Security of Energy Considering its Uncertainty, Risk and Economic Implications”, Deliverable No. 5.2.7. Ramboll Group, Denmark.
- Ramboll and Mercados (2008). *TEN-ENERGY Priority Corridors for Energy Transmission. Part One: Legislation, Natural Gas and Monitoring*. Ref. 753110, Pre-



- pared for the EU Commission DG TREN. Ramboll Oil & Gas, Denmark/Mercados–Energy Markets International, Spain.
- Rau, A. (2011). *Challenges in Gas Transmission: The V4+ Perspective*. Presentation at the European Economic Congress, Katowice, 17 May.
- Reuters (2009). *Factbox: 18 Countries Affected by Russia-Ukraine Gas Row*. 10 January. URL: <http://uk.reuters.com/article/2009/01/10/russia-ukraine-gas-idUKLA54196720090110>, 20.08.2011.
- Reuters (2010). *Blast Ruptures Russia–Turkey Gas Pipeline in Bulgaria*. 14 Sept. URL: <http://af.reuters.com/article/energyOilNews/idAFLDE68D1V920100914>, 7.08.2011.
- Reymond, M. (2007). “European key issues concerning natural gas: Dependence and vulnerability.” *Energy Policy*, Vol. 35 (8), pp. 4169–4176.
- Reymond, M. (2012). “Measuring vulnerability to shocks in the gas market in South America.” *Energy Policy*, Vol. 48, pp. 754–761.
- RIA.RU (2008). *Gazovye Konflikty Rossii za Poslednie 15 Let. Spravka*. [The gas conflicts of Russia within the recent 15 years. Fact sheet.]. 12 February. URL: <http://ria.ru/spravka/20080212/99021453.html>, 26.03.2011.
- Riley, A. (2012). *Gazprom vs. the Commission*. 11 September. URL: <http://online.wsj.com/article/SB10000872396390443921504577643173700034222.html>, 20.09.2012.
- Röller, L.H., J. Delgado and H.W. Friederiszick (2007). *Energy: Choices for Europe*. European School of Management and Technology, Berlin/Bruegel, Brussels.
- Rožen, A. (2007). “Formula agresivnosti, ili o tom, kak mikroby čut’ ne s”eli gazoprovod i Kievskoe metro.” [The formula of corrosivity, or how microbes all but demolished a gas pipeline and the Kiev underground.] *Zerkalo Nedeli*, No. 29 (658), 11–17 August. Kiev. URL: <http://www.zn.ua/>.
- Russian-American Business (2012). *RWE and Gazprom Close Talks on Joint Power Ventures*. 22 February. URL: [http://russianamericanbusiness.org/web\\_current/articles/953/1/RWE,-Gazprom-close-talks-on-joint-power-ventures](http://russianamericanbusiness.org/web_current/articles/953/1/RWE,-Gazprom-close-talks-on-joint-power-ventures), 4.07.2012.
- Scheepers, M., A. Seebregts, J. de Jong, and H. Maters (2007). *EU Standards for Energy Security of Supply*. ECN-E-07-004, Energy Research Centre of the Netherlands, Petten/Clingendael International Energy Programme, The Hague.
- SEC (2009a). *Accompanying document to the Proposal COM(2009)363 for a Regulation of the European Parliament and of the Council concerning measures to safeguard security of gas supply and repealing Directive 2004/67/EC “Assessment Report of Directive 2004/67/EC on Security of Gas Supply”*. SEC(2009)978 Final. European Commission, Brussels.
- SEC (2009b). *Accompanying document to the Proposal COM(2009)363 for a Regulation of the European Parliament and of the Council concerning measures to safeguard security of gas supply and repealing Directive 2004/67/EC “Impact Assessment”*. SEC(2009)979 Final. European Commission, Brussels.
- SEC (2009c). *Accompanying document to the Proposal COM(2009)363 for a Regulation of the European Parliament and of the Council concerning measures to safeguard security of gas supply and repealing Directive 2004/67/EC “The January 2009 Gas Supply Disruption to the EU: An Assessment”*. SEC(2009)977 Final. European Commission, Brussels.

- Silve, F. and P. Noël (2010). *Cost Curves for Gas Supply Security: The Case of Bulgaria*. EPRG Working Paper 1031. Electricity Policy Research Group, University of Cambridge.
- Socor, V. (2007). "NETS: Joint gas transmission network proposed in Central and South-Eastern Europe." *Eurasia Daily Monitor*, Vol. 4, Issue 228.
- Socor, V. (2009). "Hungary's MOL driving efforts to interconnect gas markets." *Eurasia Daily Monitor*, Vol. 6, Issue 44.
- Socor, V. (2010a). "Black Sea LNG project draws on gas from Azerbaijan." *Eurasia Daily Monitor*, Vol. 7, Issue 165.
- Socor, V. (2010b). "Hungary–Romania gas interconnector: First step towards region-wide network." *Eurasia Daily Monitor*, Vol. 7, Issue 186.
- Socor, V. (2010c). *Russian-Polish Gas Negotiations Testing EU's Energy Policy*. 6 October. URL: <http://www.sigurantaenergetica.ro/russianpolish-gas-negotiations-testing-eus-energy-policy.html>, 7.08.2011.
- Socor, V. (2011). "Cost and supply issues delay the Nabucco project." *Eurasia Daily Monitor*, Vol. 8, Issue 38.
- Socor, V. (2012). "Trans-Anatolia gas project: Vast impact of Azerbaijan's initiative." *Eurasia Daily Monitor*, Vol. 9, Issue 124.
- Sovacool, B.K. (2011a). "Evaluating energy security in the Asia pacific: Towards a more comprehensive approach." *Energy Policy*, Vol. 39 (11), pp. 7472–7479.
- Sovacool, B.K. (ed.) (2011b). *The Routledge Handbook of Energy Security*. Routledge, London.
- Sovacool, B.K. and M.A. Brown (2010). "Competing dimensions of energy security: An international perspective." *Annual Review of Environment and Resources*, Vol. 35, pp. 77–108.
- SPP (2009). *Press Kit "Gas Crisis in January 2009 – Review and Outlook"*. 27 January. Slovenský Plynárenský Priemysel, Bratislava.
- Stern, J. (2002). *Security of European Natural Gas Supplies: The Impact of Import Dependence and Liberalization*. Royal Institute of International Affairs, London.
- Stern, J. (2006). *The New Security Environment for European Gas: Worsening Geopolitics and Increasing Global Competition for LNG*. NG-15, Oxford Institute for Energy Studies.
- Stirling, A. (1999). *On the Economics and Analysis of Diversity*. SPRU Electronic Working Paper Series, Paper 28, University of Sussex.
- Transgaz (2011). *Presentation Sheet of the Investment Project: "Security Increase on Natural Gas Supply for Romania and Bulgaria through Reverse Flow Action on the Bulgarian Transit Pipeline"*. February 2011. SNTGN Transgaz, Romania.
- Turton, H. and L. Barreto (2006). "Long-term security of energy supply and climate change." *Energy Policy*, Vol. 34 (15), pp. 2232–2250.
- UCEPS (Ukrainian Centre for Economic and Political Studies named after Olexander Razumkov). Various articles and issues. Kiev. URL: <http://www.uceps.org/>.
- UCEPS (2002). "Ukraine's energy sector: Readiness for European integration." *National Security and Defence*, No. 9(33).
- UCEPS (2005a). "Kratkij kurs gazovyh konfliktov v SNG. Čast' I." [A course abstract of gas conflicts in the CIS. Part I.] Saprykin, V. 15 December.
- UCEPS (2005b). "Nuclear power in Ukraine: Safety and development." *National*

- Security and Defence*, No. 6(66).
- UCEPS (2008). "Gas markets of the EU and Ukraine: Problems of development and integration." *National Security and Defence*, No. 8(102).
- Umbach, F. (2003). *Globale Energiesicherheit: Strategische Herausforderungen für die europäische und deutsche Außenpolitik*. Schriften des Forschungsinstituts der Dt. Gesellschaft für Auswärtige Politik, Bd. 70. Oldenbourg, München.
- Van Aartsen, J. (2009). *Project of European Interest No NG3. Activity Report September 2007–February 2009*. European Commission, Brussels.
- Van der Linde, C., M.P. Amineh, A. Correljé and D. de Jong (2004). *Study on Energy Supply Security and Geopolitics*. CIEP Report, Clingendael International Energy Programme, The Hague.
- Vedler, S. (2012). *Estonia's Battle for the Baltic LNG Terminal*. 17 May. URL: <http://www.baltictimes.com/news/articles/31270/>, 28.05.2012.
- Vivoda, V. (2010). "Evaluating energy security in the Asia-Pacific region: A novel methodological approach." *Energy Policy*, Vol. 38 (9), pp. 5258–5263.
- Wikileaks (2009). *Bulgaria: What If the Gas Is Cut Again?* Origin: American Embassy Sofia, 22 December. URL: <http://www.balkanleaks.eu/en/09sofia716.html>, 7.08.2011.
- Wikipedia (various articles). *Wikipedia – the Free Encyclopaedia*. Wikimedia Foundation, USA. URL: <http://en.wikipedia.org/>.
- Wikipedia (2007). *Corrosion*. 23.11.2007.
- Wikipedia (2011a). *Arad–Szeged pipeline*. 31.07.2011.
- Wikipedia (2011b). *Baltic Pipe*. 13.07.2011.
- Wikipedia (2011c). *Balticconnector*. 13.07.2011.
- Wikipedia (2011d). *Blue Stream*. 14.07.2011.
- Wikipedia (2011e). *Category: Pipeline Accidents*. 3.05.2011.
- Wikipedia (2011f). *Category: Residential Heating*. 10.04.2011.
- Wikipedia (2011g). *Diversity Index*. 1.06.2011.
- Wikipedia (2011h). *Energy Charter Treaty*. 11.07.2011.
- Wikipedia (2011i). *Energy Community*. 11.07.2011.
- Wikipedia (2011j). *European Network of Transmission System Operators for Gas*. 11.07.2011.
- Wikipedia (2011k). *Gazela Pipeline*. 31.07.2011.
- Wikipedia (2011l). *Giurgiu–Ruse Pipeline*. 31.07.2011.
- Wikipedia (2011m). *Herfindahl Index*. 1.06.2011.
- Wikipedia (2011n). *List of Natural Gas Pipelines*. 20.12.2011.
- Wikipedia (2011o). *Natural gas*. 14.04.2011.
- Wikipedia (2011p). *New European Transmission System*. 11.07.2011.
- Wikipedia (2011q). *Nord Stream*. 14.07.2011.
- Wikipedia (2011r). *Skanded*. 13.07.2011.
- Wikipedia (2011s). *South Caucasus Pipeline*. 14.07.2011.
- Wikipedia (2011t). *Trans-European Networks*. 11.07.2011.
- Wikipedia (2012a). *2004 Russia–Belarus Gas Dispute*. 11.02.2012.
- Wikipedia (2012b). *2007 Russia–Belarus Energy Dispute*. 11.02.2012.
- Wikipedia (2012c). *2009 Russia–Ukraine Gas Dispute*. 11.02.2012.
- Wikipedia (2012d). *Adria LNG*. 28.05.2012.

- Wikipedia (2012e). *Azerbaijan–Georgia–Romania Interconnector*. 28.05.2012.
- Wikipedia (2012f). *Comecon*. 19.04.2012.
- Wikipedia (2012g). *Determining the Number of Clusters in a Data Set*. 10.11.2012.
- Wikipedia (2012h). *Interconnector Turkey–Greece–Italy Pipeline*. 20.06.2012.
- Wikipedia (2012i). *Ionian Adriatic Pipeline*. 20.06.2012.
- Wikipedia (2012j). *List of Nuclear Reactors*. 2.04.2012.
- Wikipedia (2012k). *Nabucco Pipeline*. 20.06.2012.
- Wikipedia (2012l). *Russia–Ukraine Gas Dispute of 2005–2006*. 11.02.2012.
- Wikipedia (2012m). *Shale gas in the United States*. 2.09.2012.
- Wikipedia (2012n). *South East Europe Pipeline*. 4.07.2012.
- Wikipedia (2012o). *South Stream*. 20.06.2012.
- Wikipedia (2012p). *Southern Gas Corridor*. 20.06.2012.
- Wikipedia (2012q). *Trans Adriatic Pipeline*. 20.06.2012.
- Wikipedia (2012r). *Trans-Anatolian gas pipeline*. 4.07.2012.
- Wikipedia (2012s). *Trans-Caspian Gas Pipeline*. 20.06.2012.
- Wikipedia (2012t). *White Stream*. 20.06.2012.
- Winzer, C. (2012). “Conceptualizing energy security.” *Energy Policy*, Vol. 46, pp. 36–48.
- World Energy Council (2008). *Europe’s Vulnerability to Energy Crises*. London.
- Zelenovskaya, E. (2012). *Impact of Shale Gas Production on the Market Fundamentals and Energy Security of Certain Countries*. International Center for Climate Governance (ICCG), Venice/Italy.
- Zygar, M.V. and V.V. Paniushkin (2008). *Gazprom. Novoe Russkoe Orujie*. [Gazprom. The new Russian weapon.] Zaharov, Moscow.

## About the Author

Name: **Rostyslav Ruban**  
Email: [Rostyslav.Ruban@web.de](mailto:Rostyslav.Ruban@web.de)

\* 1977, Odessa/Ukraine



### Academic Degrees

- 2013 Ph.D. in Economics (Dr. rer. pol.), Europa-Universität Viadrina Frankfurt/Oder, Germany (magna cum laude)  
2000 M.Sc. in International Economics, Odessa State University of Economy, Ukraine (summa cum laude)

### Professional Experience

- 2010 – 2011 Conference/Sales Manager, econique business masters GmbH & Co KG, Berlin, Germany  
2009 Trainee for Balancing Group and Portfolio Management, Gas-Union GmbH, Frankfurt am Main, Germany  
2003 – 2008 Teaching/Research Assistant, Chair of Economic Theory (Microeconomics), Europa-Universität Viadrina Frankfurt/Oder  
2004 Research visit to the German Ruhr-Region (E.ON Ruhrgas; RWE Essen; EWI Cologne; Chair of Energy Economics, University Essen)  
2001 Trainee, Ministry of Economy of Ukraine, Fuel and Energy Department, Kiev  
2000 Trainee, National Joint-Stock Company NaftoGaz of Ukraine, Kiev  
1999 – 2000 Programme Fellow “Assistant to Committee Head”, Parliamentary (Verkhovna Rada of Ukraine) Budget Committee, Kiev  
1999 Consultant, Investment Promotion Bureau, Odessa, Ukraine

### Awards

- 2006 – 2007 Research grant by E.ON Ruhrgas  
2003 – 2005 Doctoral scholarship “Europa Fellows 2”, Federal Ministry of Education and Research (BMBF), Germany  
2002 – 2003 Grant for studies, German Academic Exchange Service (DAAD)  
1998 – 2000 Municipal scholarship for excellent studies, research and social activities, Odessa City Council, Ukraine

### Languages

Ukrainian (native), Russian (native), German (fluent), English (fluent), Polish (fluent)