



Objectives and Aims/Goals

The 37th IAEE International Conference will take place in New York City between June 15 and 18, 2014, and will focus on the relationship between economic growth and energy. This relationship grows ever more important as economies around the world struggle to reinvigorate themselves and to develop energy resources in sensible, sustainable ways. Can economic growth be stimulated even with pressure to reduce if not forego certain forms of energy for environmental or safety reasons? Alternatively, can energy development be a major force that stimulates economic growth? What policy framework would maximize the contribution of energy to growth while encouraging efficient substitution of sustainable for less sustainable sources?

New York City is the financial center of the United States, a place where multi-billion dollar bets are laid on future economic growth and on energy technologies, and therefore a place where analysis of subjects like these is constantly in demand. Some of the very best minds in energy economics in the world will assemble there for what promises to be one of the best and biggest IAEE Conferences ever. Already, the Administrator of the US Energy Information Administration has committed to address the opening session of the Conference on the renaissance in U.S. energy and what it means for the country and the world. Other high level policy makers will talk about the challenges they face, while business professionals and academics will offer practical and analytically-based approaches to meeting such challenges. The agenda will be filled with topnotch speakers plus a number of concurrent sessions, places where the results of specific topical research will be presented and absorbed.

The conference also will offer networking opportunities through informal receptions, breaks between sessions, and student recruitment. These provide opportunities for attendees to renew acquaintances and to forge new ones. There will be special events for students, including paper, poster and case competitions, and side trips to interesting energy-related locations. New York City offers a myriad of cultural attractions from museums to musical, dramatic and athletic performances, not to mention some of the best shopping in the entire world. It's a conference program and a venue not to be missed.

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Who Should Attend?

- Energy Company Executives and Managers
- Energy Policy Analysts
- Governmental Employees in Energy Resource Planning
- Academics Specializing in Energy Policy and Analysis
- Electricity Pricing and Market Analysts
- Energy Consultants
- Energy Company Planners
- Economic Energy Risk and Derivatives Specialists
- Oil and Natural Gas Executives
- Energy Rate Executives
- Electric and Utility Supervisors
- Energy Environmental Analysts
- Geologists and Engineers
- Environmentalists
- Energy Journalists

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Security of natural gas supply for Europe in the special case of Austria under consideration of grid and storage expansion

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Abstract—Basic guidelines for the preparation of a technical paper for an IEEE Power & Energy Society Conference are presented. This electronic document is a “live” template. The various components of your paper [title, text, headings, etc.] are already defined, as illustrated by the portions given in this document. The abstract is limited to 150 words and cannot contain equations, figures, tables, or references. It should concisely state what was done, how it was done, principal results, and their significance.

Index Terms—Austria, Central Europe, Linear Optimization, Natural Gas, Security of Supply, Sensitivity Analysis, Transmission Grid Expansion,

I. INTRODUCTION

Natural Gas is one of the most significant energy carriers for the European Union. Natural gas demand in the EU member states is expected to grow from 461bcm per annum in year 2012, up to about 500bcm per annum in year 2020 (Smith 2013; IEA 2013; EUROSTAT 2013). Another reason besides the economic competitiveness is that natural gas is not producing as much carbon dioxide as coal by using it to generate electrical power. Electricity and heat generated by the combustion of natural gas is generally considered to have a lower emissions intensity per unit electricity than that generated by burning coal (Broderick and Anderson 2012). To guarantee economic and technical competitiveness of the European Union an undisturbed supply of natural gas is essential. The EU imports over 60% of its gas in the year 2013. For that reason the European Commission declared security of supply as one of the cornerstones in the European energy policy, alongside environmental objectives and economic competitiveness (Le Coq and Paltseva 2009; European Commission 2011).

Gas disruptions like the Ukraine-Russian gas conflict in 2009 have shown the vulnerability of the European natural gas supply. The disruption in natural gas supply during an

extended cold period particularly affected Eastern and South-Eastern Europe. Reasons for undersupply in these regions were small natural gas storage capacities and a bad developed natural gas transmission grid (Kovacevic 2009). The non-existing connection of storages to main centers of consumption is another reason for cut off of natural gas supply (Bettzüge and Lochnerprich 2009). As a consequence of this incident the European Parliament adapted the European Energy Policy to clearer and more transparent rules on security of supply (Fischer et al.). Some countries like Austria increased the storage capacities and improved the transmission grid e.g. enabled reverse gas flow, to avoid situations like the January 2009 (E-Control 2012).

In concern of the current Ukraine –Russian tensions resulting in the Crimean Crisis 2014, Europe’s Energy Policy is in an urgent discussion. Figure 1 shows the dependency of European countries on Russian gas import at present time. The dependence of the South Eastern and Eastern European countries is evidence. Austria, a typical transit land is importing 60% of its annual natural gas consumption from Russia. Currently it appears as if the European Member States tries to diversify their natural gas supplier and reducing the dependence on Russian gas imports. This is only possible by a transmission grid expansion and an increase of imported of LNG (Zachmann 2014).

Most of today’s available literature analyze Europe’s security of natural gas supply by investigating the impact of supply disruptions on the natural gas market (Abada and Massol 2011), or qualify EU member countries by risk indices (Le Coq and Paltseva 2009). The problem of these methods is the missing quantification of supply disruptions via short-term simulation of the gas flow. Motivated by supply uncertainties of natural gas, as described above this work describes a Central Europe transmission gas grid model. It consists of the current natural gas storages and transmission lines. Thus it is

possible to investigate the impacts of bottlenecks and supply disruptions, in the case of Austria, similar to the TIGER model of (Lochner 2011; Dieckhöner 2013). A second task of the model is to show the sensitivity of supplier countries and transmission routes. Furthermore it shows the change in security of supply caused by additional transmission capacity. The focus remains on the possibility and the impact of natural gas supply disruptions to Austria. A weakness of the transmission grid view is the lack of information at local level, concerning natural gas shortage.

For this reason the next step is a detailed investigation of a predefined urban region, to determine impacts of natural gas breakdown to residential and industrial consumers on a local level. Because natural gas shortage concerns both heat and electricity production, the local model consists of multiple energy carriers (natural gas, electricity, fuel oil, biomass and renewable energy sources). The energy sector's components are predefined and consist of producers, consumers and transmission capacity. If the natural gas supply breaks down, the local model quantifies the effect on energy consumers. This effect depends on redundancy of the consumers energy supply. For example a natural gas supplied consumer with an additional wood fired furnace is able to use the second heating system instead of the primary. If the consumer has no secondary heater and installs an electric heating appliance, the simulation shows the effect on the electric grid. The analysis of the local model indicates effects of natural gas supply at the consumer level and specify emergency plans.

II. METHOD

This work's security of supply analysis consists of two separate simulations, as shown in Figure 2.

1. The first simulation with a Central European model describes the sensitivity of existing transmission lines. The model consist of predefine load nodes connected by transmission lines. Natural gas imports to Central Europe (e.g. Russian and Norwegian imports) are modelled by exogenous sources, connected by transmission lines as well. To show the sensitivity of sources or lines the element is disconnected and the impact on nodes is examined. If an impact is affecting security of supply, the results are the input parameter of the local simulation.
2. In addition to Central Europe model the local submodel identifies shortage effects on certain energy carriers at local level. As pictured in Figure 2 the model consists of producers, transmission capabilities and consumers.

A. eTransport

SINTEF eTransport,
Some equations especially the undersupply formulation
Without market model

B. Central Europe Gas Grid Model

A strong reason to diversify natural gas supply routes to the European Union.

UK and Norway modelled as a market (interfaces) to reduce the amount of nodes

C. Input Data

Price Gas cost map
Pipes Capacity Table
Storage Table
National gas production
Literature

D. Scenarios

Focus on undersupply, therefore is no investigation of oversupply

III. RESULTS

IV. CONCLUSION

V. REFERENCES

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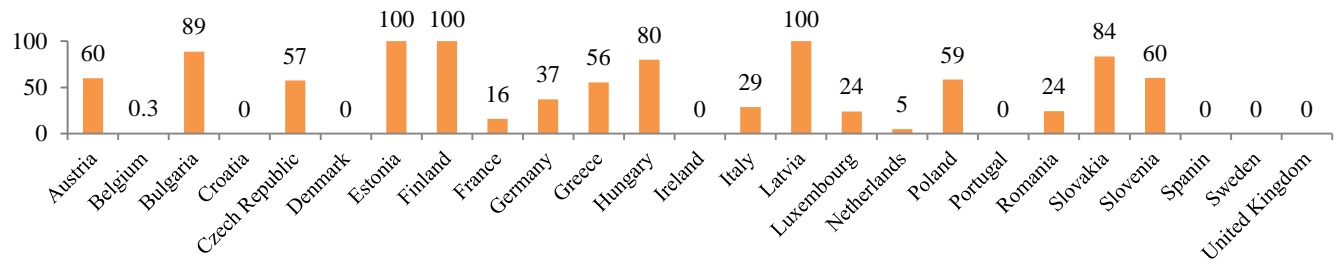


Figure 1. Dependency on Russian gas imports sorted to countries according to (Eurogas 2013)

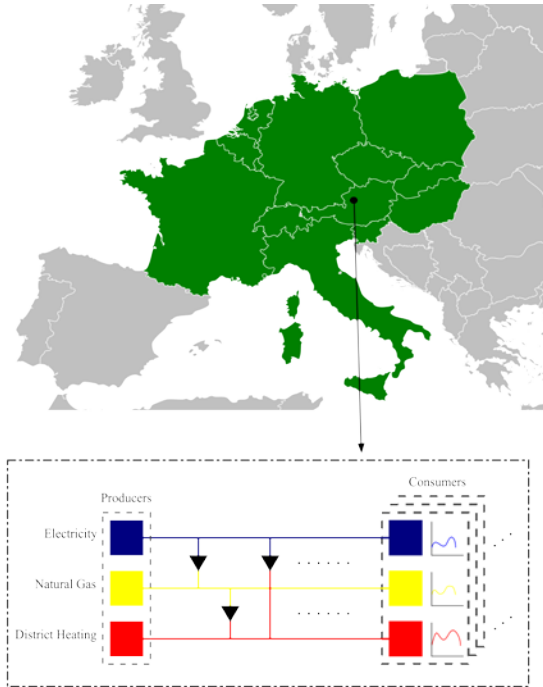


Figure 2. Modelled region by the Central Europe model (top) and simplified local model (bottom)

The equations are an exception to the prescribed specifications of this template. You will need to determine whether or not your equation should be typed using either the Times New Roman or the Symbol font (please no other font). To create multileveled equations, it may be necessary to treat the equation as a graphic and insert it into the text after your paper is styled. Use of the Microsoft Equation Editor or the *MathType* commercial add-on for MS Word for math objects in your paper is permissible (Insert | Equation or MathType Equation). "Float over text" should *not* be selected.

Number equations consecutively. Equation numbers, within parentheses, are to position flush right, as in (1), using a right tab stop. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash, as shown in (1), rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in

$$\alpha - \beta + \delta = \chi. \quad (1)$$

Note that the equation above is centered using a center tab stop. Be sure that the symbols in your equation have been defined before or immediately following the equation. Use "(1)", not "Eq. (1)" or "equation (1)", except at the beginning of a sentence: "Equation (1) is . . ."

A. Footnotes

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the reference list. Use letters for table footnotes.

B. Some Common Mistakes

- The word "data" is plural, not singular.
- The subscript for the permeability of vacuum μ_0 , and other common scientific constants, is zero with subscript formatting, not a lowercase letter "o".
- In American English, commas, semi-/colons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
- A graph within a graph is an "inset", not an "insert". The word alternatively is preferred to the word "alternately" (unless you really mean something that alternates).
- Do not use the word "essentially" to mean "approximately" or "effectively".

- In your paper title, if the words "that uses" can accurately replace the word "using", capitalize the "u"; if not, keep using lower-cased.
- Be aware of the different meanings of the homophones "affect" and "effect", "complement" and "compliment", "discreet" and "discrete", "principal" and "principle".
- Do not confuse "imply" and "infer".
- The prefix "non" is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the "et" in the Latin abbreviation "et al."
- The abbreviation "i.e." means "that is", and the abbreviation "e.g." means "for example".

VI. USING THE TEMPLATE

This document should be used as a template for preparing your Conference paper. You may type over sections of the

Figures and tables should be numbered consecutively. Use Arabic numerals for figures and Roman numerals for tables.

Figure 1. Example of a figure caption. (*figure caption*)

document, cut and paste into it, and/or use markup styles.

Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper.

A. Authors and Affiliations

The template is designed so that author affiliations are not repeated each time for multiple authors of the same affiliation. Please keep your affiliations as succinct as possible (for example, do not differentiate among departments of the same organization). This template was designed for two affiliations.

1) *For author/s of only one affiliation (Heading 3):* To change the default, adjust the template as follows.

a) *Selection (Heading 4):* Highlight all author and affiliation lines.

b) *Change number of columns:* Select the Columns icon from the MS Word Standard toolbar and then select "1 Column" from the selection palette.

c) *Deletion:* Delete the author and affiliation lines for

Table Heading	Table Column Heading		
	Table subheading	column	Subheading
copy	More table copy ^a		

the second affiliation.

2) *For author/s of more than two affiliations:* To change the default, adjust the template as follows.

a) *Selection:* Highlight all author and affiliation lines.

b) *Change number of columns:* Select the “Columns” icon from the MS Word Standard toolbar and then select the number of columns desired from the selection palette.

c) *Highlight author and affiliation lines of affiliation 1 and copy this selection.*

d) *Formatting:* Insert one hard return immediately after the last character of the last affiliation line. Then paste down the copy of affiliation 1. Repeat as necessary for each additional affiliation.

e) *Reassign number of columns:* Place your cursor to the right of the last character of the last affiliation line of an even numbered affiliation (e.g., if there are five affiliations, place your cursor at end of fourth affiliation). Drag the cursor up to highlight all of the above author and affiliation lines. Go to Column icon and select “2 Columns”. If you have an odd number of affiliations, the final affiliation will be centered on the page; all previous will be in two columns.

B. Identify the Headings

Headings are organizational devices that guide the reader through your paper. There are two types: component headings and text headings.

Component headings identify the different components of your paper and are not topically subordinate to each other. Examples include ACKNOWLEDGMENTS and REFERENCES and, for these, the correct style to use is “Heading 5”. Use “figure caption” for your Figure captions, and “table heading” for your table title. Run-in headings, such as “Abstract”, will require you to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the heading from the text.

Text headings organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text heading because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level heading (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheadings should be introduced. Styles named “Heading 1”, “Heading 2”, “Heading 3”, and “Heading 4” are prescribed.

C. Figures and Tables

1) *Positioning Figures and Tables:* Large figures and tables may span across both columns. Figure captions should be below the figures; table headings should appear above the tables. Insert figures and tables after they are cited in the text as close to the citation as possible. Use the abbreviation “Fig. 1”, even at the beginning of a sentence.

TABLE I. TABLE TYPE STYLES

a. Example of a Table footnote. (*Table footnote*)

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity “Magnetization”, or

“Magnetization, M”, not just “M”. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write “Magnetization (A/m)” or “Magnetization {A[m(1)]}”, not just “A/m”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K)”, not “Temperature/K”.

Figures and tables should be numbered consecutively. Use Arabic numerals for figures and Roman numerals for tables.

We suggest that you use a text box to insert a graphic (which is ideally a 300 dpi TIFF or EPS file, with all fonts embedded) because, in an MSW document, this method is somewhat more stable than directly inserting a picture.

To have non-visible rules on your frame, use the MSWord “Format” pull-down menu, select Text Box > Colors and Lines to choose No Fill and No Line.

Figure 2. Example of a figure caption. (*figure caption*)

ACKNOWLEDGMENT (*HEADING 5*)

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression, “One of us (R. B. G.) thanks . . .” Instead, try “R. B. G. thanks”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

The following is an example of an acknowledgment.

The authors gratefully acknowledge the contributions of T. Edison, G. Westinghouse, N. Tesla, A. Volta and A. Ampere to the electric power industry.

REFERENCES

References are important to the reader; therefore, each citation must be complete and correct. There is no editorial check on references; therefore, an incomplete or wrong reference will be published unless caught by a reviewer and will detract from the authority and value of the paper. References should be readily available publications.

List only one reference per reference number. If a reference is available from two sources, each should be listed as a separate reference.

The template will number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Multiple references [3], [4] are each numbered with separate brackets [4]-[6]. Refer simply to the reference number, as in [7]—do not use “Ref. [7]” or “reference [7]” except at the beginning of a sentence: “Reference [7] was the first . . .”

Unless there are six authors or more give all authors' names; do not use “et al.”. Papers that have not been published, even if they have been submitted for publication, should be cited as “unpublished” [8]-[10]. Capitalize only the first word in a paper title, except for proper nouns and element symbols. For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [11]. Papers that have been accepted

for publication, but not yet published, should be cited as “in press” [12].

Samples of the correct formats for various types of references are given below [1]-[16].

Periodicals:

- J. F. Fuller, E. F. Fuchs, and K. J. Roesler, "Influence of harmonics on power distribution system protection," *IEEE Trans. Power Delivery*, vol. 3, pp. 549-557, Apr. 1988.
- R. J. Vidmar. (1992, Aug.). On the use of atmospheric plasmas as electromagnetic reflectors. *IEEE Trans. Plasma Sci.* [Online]. 21(3), pp. 876-880. Available: <http://www.halcyon.com/pub/journals/21ps03-vidmar>

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- E. Clarke, *Circuit Analysis of AC Power Systems*, vol. I. New York: Wiley, 1950, p. 81.
- G. O. Young, "Synthetic structure of industrial plastics," in *Plastics*, 2nd ed., vol. 3, J. Peters, Ed. New York: McGraw-Hill, 1964, pp. 15-64.
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Technical Reports:

- E. E. Reber, R. L. Mitchell, and C. J. Carter, "Oxygen absorption in the Earth's atmosphere," Aerospace Corp., Los Angeles, CA, Tech. Rep. TR-0200 (4230-46)-3, Nov. 1968.
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Unpublished Papers:

- D. Ebehard and E. Voges, "Digital single sideband detection for interferometric sensors," unpublished, presented at the 2nd Int. Conf. Optical Fiber Sensors, Stuttgart, Germany, 1984.

Process Corp., Framingham, MA. "Intranets: Internet technologies deployed behind the firewall for corporate productivity," unpublished. Presented at INET96 Annu. Meeting. [Online]. Available: <http://home.process.com/Intranets/wp2.htm>

- G. N. Lester and J. H. Nelson, "History of Circuit Breaker Standards," unpublished. Presented at the IEEE/PES General Meeting, 24 July 2008. [Online]. Available IEEE/PES Switchgear Committee web site: <http://www.ewh.ieee.org/soc/pes/switchgear/Presentations/2008CBtutorial/speaker1paper.pdf>

Papers Published in Translation Journals:

- Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," *IEEE Transl. J. Magn. Japan*, vol. 2, pp. 740-741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

Papers Accepted for Publication (but not yet published):

- E. H. Miller, "A note on reflector arrays," *IEEE Trans. Antennas Propagat.*, in press.

Papers from Conference Proceedings (Published):

- J. L. Alqueres and J. C. Praca, "The Brazilian power system and the challenge of the Amazon transmission," in *Proc. 1991 IEEE Power Engineering Society Transmission and Distribution Conf.*, pp. 315-320.

Dissertations:

- S. Hwang, "Frequency domain system identification of helicopter rotor dynamics incorporating models with time periodic coefficients," Ph.D. dissertation, Dept. Aerosp. Eng., Univ. Maryland, College Park, 1997.

Standards:

- IEEE Guide for Application of Shunt Power Capacitors*, IEEE Std. 1036-2010, Sep. 2010.

Patents:

- G. Brandli and M. Dick, "Alternating current fed power supply," U.S. Patent 4 084 217, Nov. 4, 1978.