Energy Policy 114 (2018) 30–38

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Defining a composite index for measuring natural gas supply security - The Croatian gas market case

Darko Pavlović[a], Eraldo Banovac[b,*], Nikola Vištica[b]

[a] Plinacro d.o.o., Savska cesta 88a, HR-10000 Zagreb, Croatia
[b] Croatian Energy Regulatory Agency, Ulica grada Vukovara 14, HR-10000 Zagreb, Croatia

ARTICLE INFO

Keywords:
Aggregated index
Energy supply security
Indicators
Natural gas

ABSTRACT

This paper presents a robust composite index aimed to measure natural gas supply security. The Composite index (CI) includes the following indicators important for natural gas supply security: Energy Import Dependency Index, Energy Intensity, Gross Inland Consumption, Index of National Economy Dependence on Natural Gas, Herfindahl-Hirschman Index and Shannon-Wiener Index. The aggregated CI incorporates the normalized values of the aforementioned indicators and their weighted factors. A higher value of the CI indicates a lower level of natural gas supply security and vice versa. An analysis relevant for defining natural gas supply security for Croatia, over the period 2001–2015, is conducted in this research. The CI reached the maximal value of 0.58 in 2001, and the minimal value of 0.37 in 2015. These values indicate the increase of natural gas supply security in Croatia in the considered period. A favorable CI of 0.30 could be achieved in the year 2019 with the precondition of an operational LNG terminal on the island of Krk in the North Adriatic. This means that natural gas supply security in Croatia would increase significantly in 2019.

1. Introduction

Over the past ten years, considerable attention has been paid to energy security. Researching the energy supply security is a complex task that includes analyses of geopolitical situation and economical processes, specific risk analysis, the issues of energy supply, reliability of energy infrastructures, emergency situations in energy systems as well as political, social and technical consequences (Jansen and Seebregts, 2010; Correlje and Van der Linde, 2006; Augutis et al., 2008). Energy supply security also covers some specific issues, such as prediction of energy consumption (Vištica et al., 2015) as well as the implication of shutting down coal-fired plants with respect to the need for power sector decarbonisation (Pavić et al., 2016).

According to IEA (2001), energy security is defined as the availability of a regular supply of energy at an affordable price. At this point, it is important to emphasize that managing future energy consumption should include uncertainties regarding energy demand. A high energy demand may jeopardize energy security. Large energy systems, such as both the electric power industry and national gas system, are characterized by a complex structure, which requires a planning approach, selection of a maintenance strategy and engagement of considerable resources, manpower and time. Expert approach to reliability is essential for the safe functioning of these systems (Banovac and Kozak, 2008; Banovac and Kuzle, 2009).

Conducting a research of the threat indicators is crucial for defining the energy position of any country. Gnansounou (2006) proposed a set of energy threat indicators. It is surely unacceptable that the net energy import covers a large portion of GDP of a certain country. A presentation of energy dependence of four countries, including Croatia, is given in the document "Europe's vulnerability to energy crises" (World Energy Council, 2008). Slavov and Moncomble (2007) gave a similar presentation. Furthermore, the main indicators dealing with security and/or vulnerability of the energy system are established in UK Energy Sector Indicators (2008).

Furthermore, the following papers should be accentuated as primary sources when considering the energy supply index development: the Green Paper (European Union, 2000) in which the European Union's long-term strategy for energy supply security is explained, and the valuable paper in which Jansen et al. (2004) claims that the Shannon index is retained as the best simple indicator of diversity. Furthermore, it should be pointed out that recent papers in this field encompass quite different approaches to the research of security of energy supply. Thus, Le Coq and Paltseva (2009) introduced an index that combines measures of energy import diversification, the political risks of the supplying country, risk associated with energy transit, and the economic impact of a supply disruption. Dike (2013) introduced two indexes: the

* Corresponding author.
E-mail address: eraldo.banovac@zg.t-com.hr (E. Banovac).

https://doi.org/10.1016/j.enpol.2017.11.029
Received 23 March 2017; Received in revised form 10 November 2017; Accepted 15 November 2017

first index, which indicates the level of energy export demand security risks for OPEC members and the second index, which indicates the individual contribution of the OPEC members to OPEC's risk exposure. Yang et al. (2014) used the diversification index approach to attempt to assess external oil supply risks of oil importers with consideration of two key factors associated with oil suppliers, country risk and potential oil export capacity. Akhmetov (2015) used disaggregated risky external energy supply (REES) and risky energy exports demand (REED) indexes to measure the securities of energy supply and energy demand in Central Asia.

According to Kruyt et al. (2009) the majority of indicators had a greater heuristic role – capturing a particular aspect of security of supply and indicating a relative position or direction of change. Löschel et al. (2010) suggested dividing the indicators into ex-ante indicators (to estimate how energy security may evolve in the future) and ex-post indicators (to assess whether energy security existed in the past).

The indicators, as components of energy dependence, differ in terminology and complexity. Economic indicators include a small number of variables because many economic variables correlate with each other. In theory, the concept of energy dependence could cover a lot of variables, resulting in a very complex composed index of energy dependence, which could combine environmental and economic dependence. With regard to the problem of mathematical design of such a complex index there are some difficulties related to their evaluation.

It should be accentuated that even accepted individual indicators have certain disadvantages, mainly induced by the selection of variables and the method of measurement. In general, different individual indicators should be expressed in the same unit to provide a composite index calculation. However, it is very difficult to quantify the impact of different indicators of energy dependence and it is possible that the overestimation of one indicator influences the composite index negatively. There are also difficulties in the integration of various indicators, because each complex index is a certain average of different indicators it was created from. Therefore, the loss of important information or divergence between indicators occur easily. There is also a possibility that the effect of one indicator cancels the effect of another. It is very challenging to overcome such an occurrence completely. Therefore, the acceptability of a certain composite index should be analyzed from both aspects – the selection of variables and the determination of the measurement method.

In general, using a security indicator (index) is a suitable way to assess the level of energy security. However, some aggregated indicators published in the literature during the past years do not record performance during time bands and are, therefore, unable to show trends in energy security performance (Franki and Višković, 2015).

Considering the issues relevant to the energy sector, the importance of regulation should be accentuated. Since the mid-1990s, a lot of countries have established national regulatory authorities (NRAs) empowered to regulate energy-related activities. The NRAs set energy prices by using performance-based regulation (Banovac et al., 2007). The NRAs introduce more and more complex methods, thus trying to achieve the ultimate goals of economic regulation: efficiency and productivity improvement, without undermining the quality of supply (Banovac and Štritof, 2005). Furthermore, monitoring of energy activities still remains an important duty of NRAs (Banovac, 2004). In a broader sense, an implemented regulatory policy may influence energy supply security. A more detailed discussion on regulation is interesting, however, it is outside the scope of this paper.

The Russo-Ukrainian gas dispute of January 2009 has put the natural gas supply to Europe at risk. As a consequence, there is a better understanding of the importance of energy dependence in gas import countries. The risks relevant to natural gas supply present the threat with respect to the functioning of economies of member states and integral gas market in the EU. In general, natural gas supply security is connected with demand variability, inelastic demand, price fluctuations, restrictions in control of the quantities of natural gas, sources and transportation and the possibilities of political interventions that may cause interruption of the current supply. Although literature sources (European Commission, COM 2002; Greene and Leiby, 2006; Streimikiene and Šivickas, 2008; Krishnan, 2010) discuss various indicators and measures of energy supply security, it is important to emphasize that a unique methodology for quantification of energy supply security is neither developed for the energy system as a whole nor for the gas system specifically. Therefore, this paper presents a methodology of integrating six important indicators into the aggregated index – a useful tool in energy policy management.

The readers of specialized journals for energy issues could be interested in the practical use of the energy supply security indicators. No doubt, the problem of energy supply security may influence the way we use energy. Thus, promoting the energy supply security and ensuring a good public response to the significance of the use of energy supply security indicators in decision making processes are essential. Henceforth, evaluating any large energy infrastructure project without considering its influence to energy supply security is not acceptable.

The contribution of the paper is in providing a methodology for evaluating natural gas supply security by using the composite index created for measuring natural gas supply security. Having the general objectives in mind, the rest of the paper is organized as follows. Section 2 describes the aggregated index, i.e. the Composite index aimed to measure natural gas supply security. Section 3 summarizes the discussion and analysis of the empirical results. Section 4 presents the most relevant conclusions.

2. Measuring the natural gas supply security

2.1. The natural gas import dependency

Croatia depends on import of natural gas (production-import ratio is about 60:40). Import of natural gas will increase in the near future due to the depletion of gas fields in the North Adriatic and Pannonian Basin. Several important projects have been considered since the end of 1990s to decrease natural gas import dependency. As a result, the Croatian gas system received a second input in 2011 by completing the Croatian-Hungarian gas interconnection pipeline (Drávaszerdahely-Donji Miholjac interconnection). This project was realized in line with the European energy policy to diversify gas supply routes. The Croatian-Hungarian pipeline with a capacity of 19.2 million cubic meters of natural gas daily is important for supply security, however, at the moment gas flow is only possible in the direction from Hungary to Croatia. Furthermore, a low capacity utilization of this pipeline was recorded because there is no gas available for shipping to Europe without the construction of the Croatian LNG terminal and/or the realization of the Ionian-Adriatic Pipeline project. Hence, the Croatian gas transmission system operator Plinacro has been carrying out activities in order to enable gas flow in the reverse direction. At the same time, LNG Croatia, which is a joint venture company owned by Plinacro and HEP (the power utility), has been carrying out activities to implement a liquefied natural gas (LNG) import terminal project – the Croatian LNG terminal on the island of Krk in the North Adriatic. The Union list of Projects of common interest with 195 key energy infrastructure projects includes the project "Phased development of LNG terminal in Krk (HR)" as a "project allowing gas to flow from the Croatian LNG terminal to neighboring countries" (Commission Delegated Regulation (EU) 2016/89, Official Journal of the European Union, L 19/1). The Croatian LNG terminal could be operational in the year 2019. Therefore, the EU has participated in the preparation of the necessary studies with the financial support covering 50% of the total cost regarding the studies for the terminal (IENE Study Project, 2015). The LNG terminal on the island of Krk could operate as a regional LNG hub.

According to the EU rules, LNG Croatia planned the following three stages within the Open Season Binding Phase procedure: Market