Tekla Sebestyénné Szép

The Theory of Energy Security in Economics

Tekla Sebestyénné Szép PhD, Lecturer of the University of Miskolc

Abstract

The examination and assessment of energy security in economics is not an entirely new phenomenon; similar studies were first conducted in the early 20th century. Nevertheless, for the past decade its importance has significantly grown, and many types of aspects and approaches have been developed. In this study, after the presentation of a historical overview, we introduce coexisting definitions and different interpretations. We provide an overview of the 4A conception, that is the 4 factors of energy security issues, and furthermore we present the main dimensions of the analysis and the procedure of risk assessment and evaluation.

Keywords: energy, energy security, vulnerability, resilience, sovereignty, robustness

Introduction

The development of energy use has seen through the history of humanity: the discovery of fire provided our ancestors with energy sources; biomass-, wind-, and hydropower dominated energy use until the 17th century. The era of fossil energy sources started with the invention of the steam engine (and the intense use of coal). The usage of petroleum and nuclear energy then opened up new opportunities in energy production; and transport became cheap and available for everyone. The spreading of electric energy significantly improved living standards. It is no coincidence that even today, one of the measures to indicate societal progress is the degree of access to that kind of energy. We cannot make ourselves independent from its use; and it indirectly also shows the level of our economic growth and development. So, when the scarcity of resources is becoming ever more urgent, the issue of security of energy supply arises.

The short history of the development of energy security

In the first half of the 20th century, the concept of energy security was evoked primarily due to worries about coal- and petroleum supplies for the marine fleets and the armies. At that

time, political and military leaders wanted to ensure the security of energy supply through the following measures: diversification of supply, replacement of the import by domestic production, limitation of energy use that was not of primary necessity, and military control over energy sources and the infrastructure (Cherp et al., 2012). In the second half of the 20th century, petroleum became the primary driving force of national economies. Many of the developed countries faced the issue of increasing oil import, and, in the 1970's, the oil embargos put the focus of interest on the issues of energy security. Various index numbers and strategies were elaborated, focusing on the cooperation among the OECD countries, the enhancement of energy efficiency, and the exploration and exploitation of oil fields outside OPEC member states. By the millennium – thanks to the above strategies – fears related to the disruptions of global oil supply decreased; however, the number of security issues regarding electricity supply – especially the operation of nuclear power plants – had grown sharply (Cherp et al., 2012). The topic of energy security within economic science has widely expanded by now: beyond the security of demand and supply, it covers e.g. the analysis of the effects of price changes, energy poverty, geopolitical risks, and the effects of climate change.

Definitions

There are many approaches regarding the notion of energy security. The International Energy Agency (IEA, 2016) defines energy security as "the uninterrupted availability of energy sources at an affordable price". According to the *Green Book* of the European Commission (2000: 1.), energy security is the uninterrupted physical availability of the energy sources at affordable prices, having regard to the environment and the principles of sustainability. According to Brown et al. (2003: 21.), it is a robust energy system, which is the combination of active, direct and passive, indirect (e.g. diversification) tools, by which tools the system is able to tackle current threats. Winzer (2012: 36.) found 36 different definitions of energy security; and, as a conclusion, defines energy security as: "the continuity of energy supplies in relation to demand". In this case, energy supply includes the exploitation, transportation, distribution, and end use of energy sources. This may involve huge distances, crossing national borders (Mansson et al., 2014).

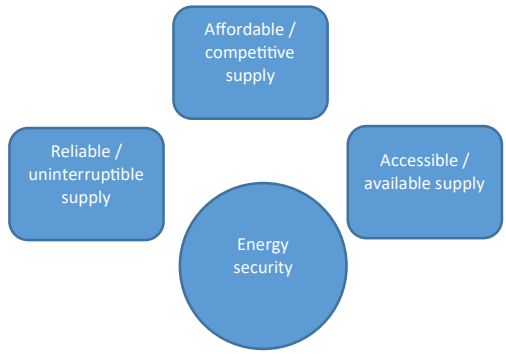

Figure 1
The factors of energy security

Source: Own editing, on the basis of IEA (2016)

In the long term, energy security means all the investments which, if carried out in time, ensure that supply can meet the demands arising during economic development (having regard to environmental sustainability). In the short term, it means the ability of energy systems to immediately react to any sudden changes, keeping the balance of demand and supply. The degree of energy security will not be satisfactory if the energy is physically not available or is sold at a price which most role-players cannot afford (IEA, 2016). This leads us to the 4A concept, which includes the following factors (APERC, 2007): 1. *affordability,* 2. *availability;* 3. *accessibility;* 4. *acceptability.* Let us note here that in this case, affordability is a subjective notion, and means price stability, competitiveness, and protection from energy poverty (Jewell et al., 2012) (Figure 1).

Even though there is no agreed definition of energy security, there are many approaches regarding its wider interpretation and its analysis. Experts have various opinions as to whether economic, environmental, and social factors should be taken into account in the measuring of energy security. According to Alhajii (2007), the answer is Yes; furthermore, he ranges also technical, foreign policy (and other international), and national security factors among the dimensions of energy security – and, according to him, these factors shall also be included in the analyses. Vivoda (2010) emphasizes that conventional energy security approaches have hardly any regard to people. In his study he explains that the population's access to energy is also a key factor (e.g. considering the degree of energy poverty). To what extent a country is willing to cooperate internationally in various fields (e.g. in the field of greenhouse gas reduction efforts in relation to climate change) shall also be examined. According to Vivoda, the commitment of a country to energy security is well characterized by the fact whether it has a consequent, well-delineated national energy security strategy, and what PR is attached to that policy.

Another key aspect is geographical delineation; where the analysis may start from huge geographic regions and go down to the level of families (however, the most widely applied analyses are on national level, because the states are responsible for the stability of energy supply). It is important to define the time period of the analysis and to take the nature of

risks into consideration (Jewell et al., 2012). Basically, there are two important elements of dangers to energy systems, i.e. risks: a risk is the damage caused by an environmental incident or by human activities (or both), or the likelihood of possible consequences (Molis, 2011). Analyses may focus on the primary energy use, the secondary energy sources, but they can also be differentiated on the basis of end use. Let us note here that, even today, most of the analyses regarding energy security are related to petroleum, namely its price changes, the stability (both political and economic) of the producing countries, and the vulnerability of the transportation infrastructure. The main cause of that is the fact that petroleum is still the basis of the lifeblood of the economy: In 2013, more than 45% of the world's energy usage was supplied through petroleum sources (IEA, 2015). Approximately 60% of this amount reaches the users through international commerce (Gupta, 2008). This fact illustrates well that it is a materially global product (Table 1).

Table 1

Aspects of the analysis of energy security

The dimensions of energy security	Geographical delineation	Time span	The nature of the risk	The nature of the energy source / energy use
• economic • environmental • social • (other, e.g. technical, foreign policy, national security)	• national • regional • local	• short-term • long-term	• geopolitical • technological • environmental • economic	• primary (e.g. petroleum, natural gas, coal) • secondary (e.g. electricity) • end use (e.g. industry, transport, household sector)

Source: Own editing, on the basis of Jewell et al., 2012

The method of analyzing energy security

Jewell et al. (2012) identifies energy security as the low risk of any disturbances of the operating energy systems. On the basis of that, − adding the methodology of Molis (2011), − the main steps of risk analysis are the following:

1. identification of the energy system (i.e. the determination of the analysis aspects of energy security);
2. identification of the dangers (if possible) and estimation of their severity;
3. examination of the vulnerability of the system;
4. determination of the indicators necessary for the calculation, and the estimation of the risk on the basis of the severity of damage and the likelihood of occurrence.

Generally, the vulnerability of a system and the degree of that can be characterized by an external effect (shock): vulnerability is high if a small external effect would cause serious damage (Christie, 2009). According to Flaherty and Filho (2013), vulnerability itself comes from the uneven geographical dispersion of energy sources. We distinguish three aspects of it: sovereignty (the possession of energy, primarily related to the institutional background, and it is considered to be the independency of the energy system), robustness (the tolerance, "insensitivity" of the infrastructure against changes), and resilience. The latter, generally, means the flexible ability of resistance, i.e. the reactive ability of a system to adopt to an external, shock-like impact (Rowies, 2015). In the analysis of long-term energy security, all three aspects shall be taken into consideration; however, we note here that they are mixed in many cases and are hard to separate. Sovereignty has been included in energetic analyses for about a 100 years, and its importance is probably not going to decrease in the future, either (Jewell et al., 2012). In the analysis of sovereignty, we primarily focus on the potential disturbances that may occur due to an external entity. This is related to terrorism, unreliability of exporters, and the activities of foreign energy companies or other market role-players with a significant power (e.g. the OPEC). The most important method of preserving sovereignty is the possible fullest control over energy systems, in military, political, economic, and technical sense (Cherp et al., 2012). As energy systems are becoming ever more developed, dynamic, and integrated, the significance of robustness is becoming more and more important. In the examination of robustness, the experts mainly focus on the problems arising as demand grows: the scarcity of resources, and the insufficiency of infrastructure and capacity. Solutions to these might be infrastructural investments, the preference for other, easier available and more secure energy sources, and the enhancement of energy efficiency.

Vulnerability to oil markets

Having processed the available literature, we have come to the conclusion that most of the vulnerability assessments are related to oil market vulnerability. No agreed definition of vulnerability to energy issues and oil markets has been elaborated so far. Oil vulnerability can be interpreted as a multi-dimensional notion, mostly dominated by the point of view of importing countries. There are two species of vulnerability: vulnerability against changes of oil prices (market risk), and exposure to other shocks occurring on the supply side (risk originating at the supply side, e.g. geopolitical conflicts, the amount of reserves). Furthermore, there are environmental risks, e.g. related to climate change, global warming, environmental pollution. At the time of increasing oil prices, most of the researches focus on the oil importing, developed countries, and the various risks and indicators of vulnerability are related to these countries. In the periods of decreasing oil prices, the viewpoint of oil producing and exporting countries dominates. We can find a wide range of approaches – such as economics, national security, geopolitical, environment ecological works. We must note that, in the analysis of vulnerability to oil markets, most researches identify the energy security as energy independence; and they think it can be achieved through the reduction of energy import and the increasing of diversification (both in the energy mix regarding the suppliers). At the same time, Cohen et al. (2011) highlights that greater dependency

on a single supplier means less energy security; however, the vulnerability itself will not necessarily be higher. Therefore, these two notions should be examined separately.

Risk assessment

During the assessment of possible damage and the external impacts, several factors shall be taken into consideration. The following shall be assessed:

- the degree of the impact (threatening change, little change, periodical change);
- the speed of its spreading (constant, slow, or quick change);
- temporality (temporal, long-lasting, continuous);
- extension (local, national, global);
- uniqueness (unique, rare, often);
- the nature of connection (deterministic, stochastic, heuristic, unknown) (Winzer, 2012).

The degree of the risk may be of three levels: acceptable (in this case, the likelihood of the event is low, and the damage potentially caused is negligible); tolerable (here, the likelihood of the event is higher, but it can be evaded through preliminary measures), and intolerable (where the event will likely happen, and the damage is considered serious) (Molis, 2011).

According to the results of risk assessment, *the methods of crisis management* can be summarized as follows, according to Brown et al. (2003):

- Various scenarios shall be elaborated for the potential crisis situations (and the already existing ones shall be continuously updated). The aim is to make these as flexible as possible. Each energetic crisis is unique, and demands different combinations of the available assets and measurements.
- Decision making – during a crisis – shall be delegated to the lowest possible level. Most of the decisions can be made on the local level; however, communication with the competent organizations is of utmost importance.
- The key role-players of decision-making shall be identified, and they shall know each other.
- In the elaboration of scenarios, the governments shall cooperate with industry experts, since the knowledge and expertise of those working in the oil-, gas-, and electricity sector is essential.

Summary

Energetic developments have always been a part of various political programs, due to the concerns about the sustainability of energy systems. Energy security is connected not only to the nation's but also the personal security. In a broader sense, it affects the security of nations, from the risk of armed conflicts to the development of national economies and to the stability of political systems. Thus, it is closely linked to not only national security, but also foreign policy, and various commercial-, development-, and investment policies. We think that the widest possible scope of examination aspects shall be involved in the assessment

of energy security. At the same time, it is a difficult task to find the boundary between the relevant and the less important aspects, so you will need to clearly identify the objectives of the assessment to delineate the boundaries of the system.

Our summary was dominated by economic aspects, but the findings of other science fields also need to be involved. The unpredictability of the future, and the dynamics of the international relations makes the planning of energy systems more difficult: potential threats must be identified on the basis of the available (and never complete) information. However, possible responses and the assets can be improved through continuous assessments, and the flexibility of the system can be enhanced. Political decision-makers play a key role in energy security; as they are the ones who have information about the whole system, and they are responsible for the synchronization of the activities of people working in the sector.

References

Alhajii, Anas F. (2007): What is energy security? *Middle East Economic Survey,* Vol. 50, No. 39.

APERC (2007): *A quest for energy security in the 21st century: Resources and Constraints.* Institute of Energy Economics, Tokió.

Brown, Matthew H. – Rewey, Christie – Gagliano, Troy (2003): *Energy security.* National Conference of State Legislatures, Washington, DC.

Cherp, Aleh – Adenikinju, Adeola – Goldthau, Andreas – Hernandez, Francisco – Hughes, Larry – Jewell, Jessica – Olshanskaya, Marina – Jansen, Jaap – Soares, Ricardo – Vakulenko, Sergey (2012): Energy and security. *Global Energy Assessment: Toward a Sustainable Future,* Johansson, Thomas B. – Nakicenovic, Nebojsa – Patwardan, Anand (eds.), Cambridge University Press, Cambridge, 325–383.

Christie, Edward Hunter (2009): Energy vulnerability and EU-Russia Energy Relations. *Journal of Contemporary European Research,* Vol. 5, No. 2. 274–292.

Cohen, Gail – Joutz, Frederick – Loungani, Prakash (2011): *Measuring energy security: trends in the diversification of oil and natural gas supplies.* Source: www.imf.org/external/pubs/ft/wp/2011/wp1139.pdf

Európai Bizottság (2000): *Towards a European Strategy for the Security of Energy Supply.* Green Paper, Communication from the Commission to the European parliament, The Council, The European Economic and Social Committee and the Committee of the Regions, European Commission, Brüsszel.

Flaherty, Chris – Leal Filho, Walter (2013): Energy security as a subset of national security. *Global Energy Policy and Security,* Vol. 16, 11–25.

Gupta, Eshita (2008): Oil vulnerability index of oil-importing countries. *Energy Policy,* Vol. 36, No. 3. 1195–1211.

IEA (2015): *Key World Energy Statistics.* Source: www.iea.org/publications/freepublications/publication/KeyWorld_Statistics_2015.pdf

IEA (2016): *What is energy security?* Source: www.iea.org/topics/energysecurity/subtopics/whatisenergysecurity/

Jewell, Jessica – Cherp, Aleh – Riahi, Keywan (2012): *Energy security indicators for use in integrated assessment models.* LIMITS – Low climate impact scenarios and the implication of required tight emission control system. International Institute for Applied Systems Analysis, CEU. Source: www.feem-project.net/limits/docs/limits_d4-1_iiasa.pdf

Mansson, Andre – Johansson, Bengt – Nilsson, Lars J. (2014): Assessing energy security: An overview of commonly used methodologies. *Energy,* Vol. 73, 1–14.

Molis, Arunas (2011): Building methodology, assessing the risks: the case of energy security in the Baltic States. *Baltic Journal of Economics,* Vol. 11, No. 2. 59–80.

Rowies, Daan (2015): *MENA oil exporters' resilience to oil price shocks.* Source: www.delcredereducroire.be/newsletter/en/risk-monthly/53862/menaoil-exporting-countries-resilience-to-oil-price-shock

Vivoda, Vlado (2010): Evaluating energy security in the Asia-Pacific Region: a novel methodological approach. *Energy Policy,* Vol. 38, No. 9. 5258–5263.

Winzer, Christian (2012): Conceptualizing energy security. *Energy Policy,* Vol. 46, 36–48.