Renewable and Sustainable Energy Reviews 76 (2017) 185–192

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

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

Review of and comparative assessment of energy security in Baltic States

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ARTICLE INFO

Keywords:
Review
Comparative assessment
Energy security
Multi-criteria analysis
Endogenous weighting
Baltic States

ABSTRACT

This paper analyses the trends in energy security across the three Baltic States, namely Estonia, Latvia and Lithuania. The period of 2008–2012 is covered in the analysis. The aggregate measures of energy security are devised by the means of multi-criteria decision making techniques. The choice of indicators of energy security is based on the priorities set out in the European Union energy policy. The proposed system relies on the objective weighting that requires no expert assessment. However, this approach is also supplemented by the restricted models, where certain bounds are defined for groups of criteria, describing energy security in economic, energy supply chain, and environmental dimensions. The results show that Latvia maintained the highest level of energy security irrespectively of the multi-criteria approach taken.

1. Introduction

Energy is a vital input for any economics system. Especially, the contemporary economies highly rely upon energy inputs due to application of advanced manufacturing practices and computerisation. The recent studies [7,29,31] emphasize the importance of tracking and improving energy security. However, the measurement of energy security is not a straightforward issue as there is uncertainty over the definition of the concept of energy security [1,27]. Suchlike uncertainty renders different approaches towards assessment of the energy security. First, research on the energy security can follow either quantitative or qualitative approach [1] with the former one focusing on the analysis of certain indicators and the latter one relying on geopolitical considerations.

It is due to Ang et al. [1] that the concept of the energy efficiency usually rests on the following (interrelated) components: energy availability, infrastructure, energy prices, environment, social effects, governance, and efficiency. Sovacool and Brown [33] and Sovacool and Mukherjee [32] identified the following dimensions: availability, affordability, technology development, sustainability, and regulation. Each of the components of the energy efficiency can be measured in terms of multiple criteria. However, the previous studies on energy security have been mainly focused on security of supply and energy storage, energy import dependency. Therefore, such important economic, social and environmental indicators of energy security as energy and carbon intensity of economy, contribution of energy products to trade balance were not taken in to account [8,13,17,36]. Markandya and Pemberton [26] developed a comprehensive framework to analyse energy security in an expected utility framework, where there is a risk of disruption of imported energy. Specifically, the importance of an energy tax was assessed considering it as an instrument for maximisation of the expected utility. Then, energy tax was modelled against the changes in risk aversion, probability of disruption, demand elasticity and cost of disruption [26]. However, application of the aforementioned framework is data intensive. Some additional indicators in assessment of energy security were addressed in [18]. Radovanović et al. [18] applied principal component analysis to assess the impact of individual indicators on energy security index. It was shown that energy intensity, GDP per capita and carbon intensity have the greatest impact. However, such important indicators of energy security addressing contribution of energy products to trade to balance were not addressed in this paper. Sovacool and Brown [33] and Sovacool and Mukherjee [32] proposed an integrated approach for assessment of energy security involving multiple indicators. However, the latter approach focuses on the dynamics in separate indicators and offers rather limited possibility for comparative assessment of multiple countries in term of energy security through quantitative analysis (aggregation of indicators).

Loschel et al. [24,25] suggested to assess energy security by considering additional dimensions along with conventional indicators of energy security related to energy supply. These indicators were classified into ex-post and ex-ante indicators. The concept was illustrated on the basis of several simplified indicators. However, the proposed ex-post and ex-ante indicators do not cover the most

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http://dx.doi.org/10.1016/j.rser.2017.03.037
Received 23 February 2016; Received in revised form 23 January 2017; Accepted 8 March 2017
1364-0321/

important issues of energy security addressed by recent EU energy policy documents.

The issue of energy security is even more important for small countries relying on energy imports. The three Baltic States, indeed, are landlocked in terms of energy infrastructure, due to historical reasons and energy security issues are of high importance [5]. The closure of Ignalina nuclear power plant in Lithuania at the end of 2009 marked an increase in energy dependence. Estonia had been relying on shale oil, yet the extent of its combustion is to be reduced thanks to environmental regulations under the European Union (EU) policies [23]. All in all, a plethora of factors has been shaping energy policy and security in the region recently. Accordingly, this paper focuses on the analysis of energy security across the three Baltic States. The three Baltic States – Estonia, Latvia, and Lithuania – have been covered in the literature on energy security to a certain extent; however, the studies mainly addressed traditional energy supply and energy import dependency approach. Augutis et al. [3,4] proposed and applied frameworks for assessment of energy security in Lithuania concentrating on energy import dependency indicators. Tvaronavičienė et al. [35] attempted to look into this issue by forecasting energy use and energy supply. Lehtveer et al. [23] proposed energy use projections for Estonia along with energy security-related considerations. However, there are still many questions to be addressed in regards to energy security in the Baltic States.

The main contribution of this paper is to address the following issues which have not been fully addressed in previous studies dealing with energy security in the Baltic States. First of all, the most important economic, social and environmental indicators of energy security need to be addressed in assessment of energy security thereby taking into account EU energy policy priorities and targets [9]. Energy and carbon intensity of economy, contribution of energy products to trade balance and other indicators covered in energy security analysis would help to analyse the main drivers and implications of energy security. Second, an international comparison is needed to identify the best practice and challenges in a relatively homogeneous region. Third, different multi-criteria techniques should be employed in order to verify the robustness of the results.

For integrated assessment of energy security multi-criteria decision adding tools can be successfully applied. Multiple-criteria decision making (MCDM) offers an array of techniques for an integrated assessment of energy sustainability. These can be grouped into different categories with respect to normalisation and weighting used [1]. As regards the normalisation, the common approaches are min-max (linear) normalisation, vector normalisation, standardization etc. the weighting can be facilitated via statistical procedures (like Principal Components Analysis), expert assessments (e.g., Analytical Hierarchy Process), data-driven optimisation (e.g., Data Envelopment Analysis), equal weighting, or weighting based on fuel/import shares. In principle, there are two groups of techniques for weight calculation, namely subjective techniques based on expert assessment and objective ones based on data-driven methodologies. Indeed, the issue of weight choice has been the focal point of the MCDM methodology [37]. Different methodologies based on optimisation models have been proposed [28,30]. A particular group of techniques is linked to the Data Envelopment Analysis (DEA) technique [21,22,34]. Traditionally, DEA assigns observation-specific weights to construct the best practice frontiers. In the context of MCDM, the DEA-linked techniques are modified to consider common weights for the latter purpose thus arriving at the usual setting of a single weight vector. What is more, the DEA-linked techniques adjust weights so that the initial data are scaled without imposing a specific rule of normalisation.

This novelty of this paper is related to an extended approach towards assessment of energy security with respect to the main priorities of the EU energy policy. The paper seeks to assess and compare the trends in energy security of Baltic States by applying an integrated indicator-based approach and conducting an international comparison based on several methods of multi-criteria analysis. Following Ang et al. [2] and EU energy policy analysis, we define the three sets of criteria, namely those related to economy, energy supply chain, and environment. In order to ensure the robustness of analysis, we apply the two data-driven techniques for weight calculation. This allows for a more objective setting, where the alternatives (i.e., countries) are ranked on a basis of the weights rendered by mathematical programming models rather than subjective assessments. We supplement the unconstrained analysis by introducing some (subjective) weight restrictions to check whether the results are sensitive to certain preferences in regards to priorities of economic, energy supply chain, and environmental indicators. The research covers the period of 2008–2012, which indeed, marked important changes in energy policy and infrastructure in the three Baltic States. The data come from EUROSTAT.

The paper proceeds as follows. Section 1 analyses EU energy policy on energy security and energy security issues in Baltic States; Section 2 presents the optimisation approaches for weighting and calculation of the composite indicators assessing energy security; Section 3 describes the data used. The results are discussed in Section 4.

2. Energy security in Baltic States

Reduction of energy dependency and increase in energy security are the priorities of EU cohesion policy and can also ensure harmonious development of EU member states. The European Commission encourages more intensive use of the Structural and Cohesion funds EU Structural Funds for ensuring reduction of energy dependency and ensuring green growth. The EU imports more than half of all the energy it consumes. Its import dependency is particularly high for crude oil (more than 90%) and natural gas (66%). The total import bill is more than €1 billion per day. Many EU member states are also heavily reliant on a single supplier, including some that rely entirely on Russia for their natural gas. This dependence leaves them vulnerable to supply disruptions, whether caused by political or commercial disputes, or infrastructure failure. The European Commission released its Energy Security Strategy in May 2014. The Strategy aims to ensure a stable and abundant supply of energy for European citizens and the economy. The main measures to EU ensure secure supplies of energy were defined: the EU should follow a market-based approach to guarantee secure supplies. Interventionist measures by governments should be avoided; countries should increase energy coordination with each other, including through the maximisation of interconnector capacity and the removal of restrictions to cross-border energy trade; short-term behavioural changes should be enacted to boost energy efficiency and lower demand and the EU's Gas Coordination Group should continuously monitor developments in the gas supply.

The most important EU policy document – strategy Europe 2020 also emphasizes security of energy supply because energy is crucial for economic growth. Europe 2020 is the EU's growth strategy for the coming decade. In a changing world, EU seeks to become a smart, sustainable and inclusive economy. These three mutually reinforcing priorities should help the EU and the Member States deliver high levels of employment, productivity and social cohesion. Concretely, the Union has set five ambitious objectives - on employment, innovation, education, social inclusion and climate/energy - to be reached by 2020. Each Member State has adopted its own national targets in each of these areas [14]. Concrete actions at EU and national levels underpin the strategy. The 2015 European Semester kicked off in 2014 November with the Annual Growth Survey, which outlined the new Commission's three-pillar jobs and growth strategy: boosting investment, accelerating structural reforms and pursuing responsible, growth-friendly fiscal consolidation. In February, the European Commission published a series of country reports in February, analysing Member States' economic policies. In May 2015, the Commission has published the country-specific recommendations for each Member State, along with