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Methodology for quantitatively assessing the energy security of Malaysia and other southeast Asian countries

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HIGHLIGHTS

- Thirty-five indicators representing 13 elements grouped into five aspects of energy security.
- Normalization process of converting indicator results into a standard unit.
- Synthesis of results into indexes for elements, aspects and overall energy security.
- Designed to suit data availability of Malaysia and other Southeast Asian countries.
- Suitable for multi-year and multi-country application.

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ABSTRACT

This paper presents a methodology for quantitatively assessing energy security. The methodology is tailored to suit the limited data availability of Malaysia and other Southeast Asian countries. In this methodology, energy security is conceptualized as having 5 core aspects which sub-divide into 13 elements. A total of 35 indicators have been identified as measurements of these 13 elements. The methodology details the means by which the indicator results are converted into a common unit i.e. a normalization process into a 0-to-1 scale. Also detailed are the weights used in the weighted-average process by which normalized indicators are synthesized into composite scores representing the 13 elements, the 5 core aspects, and 1 overall energy security index.

1. Introduction

1.1. The need for a tool of quantitative assessment

Energy security is a complex field of research that extends beyond a range of core issues, such as availability and affordability, to include a number of other related issues such as economic, environmental, technological, risk management, social and geopolitical. It is not clear how many issues are there and how they relate to each other. This complexity leads to any discussion on energy security often becoming subjective and unbalanced towards one related issue or another, thereby losing focus on the core. For example, so much emphasis on energy independence can lead one to neglect other issues such as resource sustainability and affordability, and to forget that it is possible to be energy secure without being energy independent.

Moreover, there is not always a clear measurement to indicate whether or not the situation has improved with respect to any one issue. For example, year-on-year increases in electricity prices are often used to indicate increasing unaffordability of energy, but an indicator of affordability should also take into account increases in income. At the same time, the issue of affordability includes the cost to the government, the nation as a whole, as well as to households and industries. This means that the issue of affordability will have several indicators dedicated to it and it will be a problem to interpret these indicators together, as it will be when we consider all together the various issues that make up energy security.

Hence there is a need to identify the core issues (or core aspects, as they shall also be referred to) and to identify how other issues are related to them. There is also a need to introduce a method (or tool) to quantitatively assess these issues and to synthesize the findings into a single figure representing the level of energy security. Such a tool can provide an objective assessment that is as useful to the discussions of decision makers and analysts in the field of energy security as the method that calculates the gross domestic product (GDP) is to discussants in the field of economics. That is, while economists may hold varying opinions on the economy, they constantly refer to the GDP and its component figures such as government spending, investments and net imports in their

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discussions. At the same time, decision makers find the GDP useful in assessing whether or not their decisions will result in a net improvement to the economy and they often refer to the GDP in their communications. Likewise, the field of energy security requires a tool of quantitative assessment that produces an index that summarizes the assessment (at the national level) in a single figure so as to facilitate discussion and analysis.

1.2. Existing methods of measuring energy security

There is to-date a number of different means of measuring energy security. The Supply/Demand Index developed by Scheepers et al. (2006) is based on the structure of the country's energy demand and supply. Hughes and Shupe (2011) employ a decision matrix that ranks a country's sources of energy alternatives according to four criteria. von Hippel et al. (2011) measure energy security along different scenarios using indicators identified with six aspects of energy security.

Other methods are mostly concerned with the elements of import dependency and diversity of supplies. The International Energy Agency (IEA, 2007a) and Nicolas Lefèvre (2010) focus on resource concentration as a driver of longer-term energy security using two indicators: one is for the price component of energy security (competitiveness and volatility), based on diversity of fuel exporters and fuel-types. The second is for the volume component of energy security (availability and stability), based on dependency on pipeline gas imports (a variation of import source diversity). The indicator for the price component also forms the ex-ante indicator of Löschel et al. (2010).

The Asia Pacific Energy Research Centre (APERC, 2007) uses five indicators of energy security which measure net import dependency, net oil import dependency, Middle East import dependency (also a variation of import source diversity), diversity of primary energy types and non-carbon based fuel portfolio (a variation of fuel-type diversity).

Jansen et al. (2004) and Frondel et al. (2009) base their supply risk measurements on diversity of fuel types and import sources. Diversity of import sources also features as the basis of the method of Cohen et al. (2011).

Import diversity, diversity of supplies and their variations do not adequately capture the multi-dimensionality of energy security. There are more comprehensive methods developed by institutions in the developed countries (DECC, 2011; Institute for 21st Century Energy, 2010; METI, 2010). However, these are unsuitable for application to Southeast Asian (SEA) countries as they require data which are not regularly published, if at all collected. For example, statistics of the transport sector and households are very limited in Malaysia. As such, indicators such as average fuel consumption per kilometer driven or electricity consumed per square meter of commercial space, while valuable and insightful, are not applicable. Likewise, indicators based on energy consumption and expenditure of the poorest 20% of populations are applied by Thierry Lefèvre (2006). Methods that rely on such indicators are not practical for application to a plurality of SEA countries, and to a number of different years.

Moreover, some indicators from these comprehensive methods are of limited value for assessing the energy security of SEA countries. For example, indicators of technological development, typically based on expenditures on research and development of energy technologies, are not suited for application to Malaysia and most other SEA countries as these are technology adopters rather than technology developers.

Likewise, global political–military security issues are taken as external variables by SEA countries which do not have the diplomatic or military influence to affect them. Therefore, inclusion of such issues needs careful consideration as to how they can benefit any assessment of energy security of SEA countries.

As such, there is a requirement to refine the available tools to suit the needs and limitations of Malaysia and other SEA countries.

2. Objectives

We seek to develop a tool to quantitatively assess energy security that is practical for application to the case of Malaysia and other SEA countries (allowing for the exceptions of Myanmar, Laos and Cambodia for which data are too scare for any but the simplest methodologies). The tool shall consist of a set of indicators that cover the core aspects of energy security. These core aspects will be developed in Section 3.1. Further, the tool should be practical for application on an annual basis so as to allow trending of results over time, as well as multi-country comparison.

The tool will be further developed by expressing each indicator on a 0-to-1 scale. This is to allow multiple indicators to be synthesized into composite scores – one for each core aspect and one for overall energy security (the Energy Security Index or ESI).

3. Methodology

3.1. Development of the core aspects of energy security

For this tool, the concept of energy security is developed by gathering the concepts from other works, eliminating the duplicate aspects (or dimensions, as they are often called) and selecting for inclusion only those aspects that can be applied to Malaysia and other SEA countries, given their data availability. It is intended for aspects that are excluded due to irregular availability of data that are to be analyzed separately and those that do not lend themselves to measurement are to be left to discussion.

Winzer (2012) reviewed the literature on security of energy supply and found that “the common concept behind all energy security definitions is the absence of, protection from or adaptability to threats that are caused by or have an impact on the energy supply chain.” Individual authors limit their concept of energy security along one or several dimensions due to the difficulty of measuring all of those threats at once. One dimension focuses on the sources of those threats (technical, human and natural). Another dimension focuses on the scope of the impact of those threats. These are measured in terms of continuity of commodity supplies, service supply, the economy and the environment and society. Many authors further limit their concept of energy security by distinguishing between secure and insecure levels of continuity based on the speed, size, duration, singularity and sureness of the threat.

Winzer further proposed certain limitations to distinguish between the concept of energy security and the concepts of environmental sustainability and economic efficiency. These limitations are meant to address a problem commonly found in energy security measurement which is that double-counting arises from the attachment of additional meanings to the term ‘energy security’ that are largely contained in other policy goals. According to Winzer, the impact of the environment on the energy supply chain belongs to the concept of energy security, while the impact of the energy supply chain on the environment belongs to the concept of environmental sustainability. Likewise, the impact of the economy on the energy supply chain belongs to the concept of energy security, while the impact of the energy supply chain on the economy belongs to the concept of economic welfare. These limitations bring the definition of energy security closer to that of Scheepers et al. (2006) which leads to a consideration of the short-term and long-term risks affecting the energy supply chain.