Energy Policy 38 (2010) 1665–1671

Contents lists available at ScienceDirect

Energy Policy

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

Indicators of energy security in industrialised countries

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ARTICLE INFO

Article history:
Received 13 March 2009
Accepted 31 March 2009
Available online 14 May 2009

Keywords:
Energy security
Indicators
Energy imports

ABSTRACT

Energy security has become a popular catch phrase, both in the scientific arena as well as in the political discussion. Yet, in general the applied concepts of energy security are rather vague. This paper sheds some light on concepts and indicators of energy security. First, we conceptually discuss the issue of energy supply security and explain why it is not to handle by one science alone and what economics may contribute in order to structure the topic. After providing a brief survey of existing attempts to define or measure energy security we suggest an additional dimension along which indicators of energy security may be classified: ex-post and ex-ante indicators. Finally, we illustrate our concept on the basis of several simplified indicators. While ex-post indicators are mostly based on price developments, ex-ante indicators are to a greater extent aimed at illustrating potential problems. Our illustration suggests that it is worthwhile to take into account the market structure along with the political stability of exporting countries.

1. Introduction

The concept of 'security of energy supply', or in short form 'energy security', seems to be rather blurred. Nevertheless, many contributions recently addressed the issue of energy security, after geopolitical developments (e.g. war in Iraq in 2003, gas dispute between Russia and Ukraine in 2005/2006), equipment breakdowns (e.g. 2003 blackout in Northeast US), strikes (e.g. Venezuela in 2002/2003) and extreme weather events (e.g. hurricane Katrina in 2005) had negatively affected the supply of energy.

Most studies, however, address policies combating energy insecurity and mitigating externalities of energy supply disruptions without explicitly explaining the concept of energy (in-)security and how to measure the level of insecurity. The vagueness of energy (in-)security concepts prevents a consistent analysis of this issue.

According to the IEA (2007a, p. 12), energy insecurity "stems from the welfare impact of either the physical unavailability of energy, or prices that are not competitive or overly volatile." Reference to physical energy availability, energy prices and their volatility is made in most definitions. Bohi and Toman (1996, p. 1) point out that energy security "refers to the loss of economic welfare that may occur as a result of a change in the price or availability of energy." They identify potential energy security externalities which cause the loss of economic welfare and group them into three categories: those related to (1) volume of energy imports, (2) energy price variability and (3) national security and military expenditures. Consequently, their focus is less on the energy price itself, which is an indicator of scarcity or shortage, but on the variability of energy prices.

Indeed, prices or their volatility are an issue which causes much confusion. Let us take a look at different references to prices in defining energy security. In an earlier report the IEA (2001, p. 76) defines energy security "in terms of the physical availability of supplies to satisfy demand at a given price. The security problem therefore involves a quantity and a price risk." The 2001 European Commission Green Paper "Towards a European Strategy for the Security of Energy Supply" claims: "The European Union's long-term strategy for energy supply security must be geared to ensuring, for the well-being of its citizens and the proper functioning of the economy, the uninterrupted physical availability of energy products on the markets, at a price which is affordable for all consumers (private and industrial)" (European Commission, 2001, p. 3). In its report "Study on Energy Supply Security and Geopolitics" for the DG Energy and Transport of the European Commission, the Clingendael International Energy Programme (2004, p. 37) defines energy security "as the availability of energy at all times in various forms, in sufficient quantities, and at reasonable and/or affordable prices."

'Affordable' and 'reasonable' are rather vague terms. Whether affordable and reasonable prices are requiring unchanged price levels ("at given prices") as the IEA (2001) claims, is rather

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doi:10.1016/j.enpol.2009.03.061

questionable. From an economic perspective the claim of "competitive or not overly volatile" prices made by the IEA (2007a) has its appeal. Yet it remains unclear what 'overly volatile' means. The same holds for "reasonable prices". If this refers to competitive prices it is worth noting that they are unlikely to exist on all energy sub-markets, since these are not perfect markets. In the oil market, for instance, the OPEC cartel has market power, and in many countries gas prices are indexed to the oil price. Therefore, the concept of competitive prices remains diffuse. Moreover, a competitive price including a premium for a supplier cartel may not actually endanger energy security but merely lead to a slight energy price increase. However, market power may constitute an energy security problem, for example, if it is used to increase the price simply in order to inflict economic harm upon consumers—possibly at the cost of reduced revenues for the exporter himself. Thus, we share the view which is inherent in the definitions above, and which is supported by Bohi and Toman (1996): energy security exists if the energy sector does not cause (major) welfare-reducing frictions in the economy at national and global levels. Based on this general idea of energy security we will discuss indicators.

The paper is organised as follows: In Section 2, we will present an attempt to structure the discussion on measuring energy security. This will be followed by a survey of indicators measuring the level of energy security. Special attention is given to the IEA indicators of security of energy supply. In Section 3, we propose to distinguish between measuring energy security by ex-post indicators, i.e. after price formation in fuel markets, and by ex-ante indicators. Ex-post indicators are used to assess whether energy security existed in the past. In order to support politicians to decide about the appropriate policies to combat the hazard of energy supply disruptions and to promote energy security, we then discuss the ex-ante indicators. These indicators are used to estimate how energy (in-)security may evolve in the future. They complement the concept of ex-post indicators suggested before. We illustrate the proposed sets of indicators on the basis of data from OECD countries. Section 4 concludes.

2. Measuring the security of energy supply

Since the idea of energy supply security is not precisely defined, it seems even more challenging, if not premature, to attempt to measure it. Nevertheless, based on the definition we have adopted in the previous chapter (energy security exists if the energy sector does not cause major welfare-reducing frictions in the economy at national and global levels) we consider the topic sufficiently important to ask the question of how different aspects of energy supply security may be measured and especially, how economics may contribute to the issue.

2.1. Conceptual issues

In the public discussion the more alarming statements on energy insecurity seem to come from the political arena rather than from economists. A prominent example is the fact that the import of expensive energy implies a wealth transfer to certain states which might be inconsistent with the importer's policy priorities. Modern societies tend to rely on mobility which is often fuelled by resources almost 100% of which have to be imported. This is perceived as a restriction of policy space and as a risk, since the energy export/import relation might, in extreme cases, be used as a "political weapon". Although these arguments are used in a political context, they are all implicitly based on a situation in which one country could pose an economic threat to another country, namely, by deliberately inflicting economic harm. The economic dimension is thus of key importance to the problem of energy security. On the other hand, economics alone cannot deal with the problem comprehensively, since at least standard economics does not consider politically motivated changes of preferences or deviations from the principle of rationality, such as accepting own harm if this generates more harm to someone else. Having expressed this, we now turn back to standard economics and take a look at what it says about energy security as a problem.

Strictly speaking, many goods, markets and corresponding prices may change over time. The traditional role of politicians is to ensure that markets function. From an economic perspective, the call for politicians to act and solve an energy security problem may only be justified by the existence of market failure (e.g. an external effect). In what way are potential market failures related to energy security? One example—related to the level of imports—could be the direct effect of exporter's market power (i.e. increased imports raise prices). Another example would be an indirect effect via the impact of energy imports on a country's economy (e.g. through balance-of-payment effects). Market failure may also be caused by asymmetric information, or the classic externality related to most energy markets: the climate externality caused by the emission of greenhouse gases.

While asymmetric information is the subject of many scientific contributions, it is less directly related to energy security. Asymmetric information has, to our knowledge, not been quantified as a source of an energy security-related externality. However, several qualified studies quantify externalities, some of them with regard to the level of imports (see, e.g. Parry and Darmstadter, 2003 or Greene and Leiby, 2006). Quantifying the level of the externality is the most useful approach with respect to providing policy guidance since the externality, or the sum of externalities, may directly be translated into the magnitude of a tax that could be used to correct this market failure.

Energy price fluctuations are often mentioned as a source of economic frictions caused by the energy markets. Price shocks may prevent the economy from performing to its full potential, the reason being that the sudden change of relative prices of production input factors may lead to temporarily increased unemployment or the obsolescence of production capital (which would have been productive at lower prices). Other costs may result from the lack of insurance possibilities. While we agree that these are channels through which the energy sector causes frictions in the economy, we note that the actual market failures do not originate in the energy sector, but in the capital market, the insurance market and most notably the labour market. Although the economic theory takes the view that these market failures should be corrected in the markets where they originated, in real world economic policy making it may well be appropriate to decide that a certain degree of, say, labour market rigidity is accepted for social reasons, e.g. job protection.

For these political reasons and since the precise identification and absolute quantification remains a very difficult issue to date, there is a whole class of additional attempts contributing to measuring energy supply security. These may roughly be described as indicators covering specific aspects of the problem. As opposed to externalities they mostly do not provide any cardinal measures but are restricted to an ordinal scale, as well as a specific dimension of the issue. In order to interpret and use these indicators, it is important to be clear about their set of ad-hoc assumptions and the related shortcomings. Similarly, caution is demanded if these indicators are aggregated, since the usual problems of aggregation such as weighting, consistency or double-counting issues become relevant.

In this paper, we do not attempt to quantify the externality but to provide ordinal measures for different aspects of what is typically referred to as energy security. We therefore start with an