ELSEVIER

Energy Policy 35 (2007) 210–226

ENERGY POLICY

www.elsevier.com/locate/enpol

Security of energy supply: Comparing scenarios from a European perspective

Valeria Costantini[a,b,*], Francesco Gracceva[a,c], Anil Markandya[a], Giorgio Vicini[a]

[a]*FEEM, Foundation Eni Enrico Mattei, Corso Magenta 63, 20123 Milan, Italy*
[b]*Department of Economics, Roma Tre University, Via Ostiense 139, 00154 Rome, Italy*
[c]*ENEA, National Institute for New Technologies, Energy and Environment, Via Anguillarese 301, 00060 S.M. di Galeria, Rome, Italy*

Available online 20 December 2005

Abstract

This paper compares different results from a set of energy scenarios produced by international energy experts, in order to analyse projections on increasing European external energy dependence and vulnerability. Comparison among different scenarios constitutes the basis of a critical review of existing energy security policies, suggesting alternative or complementary future actions. According to the analysis, the main risks and negative impacts in the long term could be the increasing risk of collusion among exporters due to growing dependence of industrialized countries and insufficient diversification; and a risk of demand/supply imbalance, with consequent instability for exporting regions due to insufficient demand, and lack of infrastructures due to insufficient supply. Cooperation with exporting countries enhancing investments in production capacity, and with developing countries in order to reinforce negotiation capacity of energy-importing countries seem to be the most effective policies at international level.

JEL Classifications: O13; Q41; Q43

Keywords: Energy security; Energy scenarios; Energy markets

1. Introduction

Energy security is defined as the availability of a regular supply of energy at an affordable price (IEA, 2001a). The definition has physical, economic, social and environmental dimensions (European Commission (EC), 2000); and long- and short-term dimensions.

A *physical* disruption can occur when an energy source is exhausted or production is stopped, temporarily or permanently. *Economic* disruptions are caused by erratic fluctuations in the price of energy products on the world markets, which can be caused by a threat of a physical disruption of supplies. Recent energy market trends show that there is another cause for concern, linked to speculative price movements in anticipation of a potential disruption of supplies. The general perception by operators of a potential future disruption leads to panic buying even when supply and demand are apparently in balance. The result is sharp price rises, which directly affect business costs and the purchasing power of private consumers.

The instability of energy supplies may also cause serious *social* disruption. Today, oil is vital for the functioning of the economy, and any disruption of supply is likely to lead to social demands, and possible social conflict.

Lastly, there are many *environmental* concerns about damage to the ecosystems caused by the energy chain, whether accidentally (oil spills, nuclear accidents, methane leaks) or as a result of polluting emissions (urban pollution and greenhouse gas emissions).

While reference to affordability in the definition of energy security is aimed at drawing attention to the possible adverse welfare impacts of sudden large energy price increases, it is also relevant in the context of a lack of access to commercial energy especially for the lower-income groups of the population. Households choose

*Corresponding author. Department of Economics, Roma Tre University, Via Ostiense 139, 00154 Rome, Italy. Tel.:+39 06 5737 4215; fax.:+39 06 5737 4215.

E-mail address: v.costantini@uniroma3.it (V. Costantini).

0301-4215/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.enpol.2005.11.002

among energy options on the basis of fuel accessibility and affordability, the household's socio-economic characteristics and attitudes, and the attributes of the different fuels. Lack of access implies unsatisfied energy requirements or the use of traditional fuels, both of which result in reduced energy security. If commercial energy services and electricity are available, income is the main factor that appears to influence a household's choice of fuel (IAEA, 2005).[1]

Finally, the definition of energy security can be seen from a short-term perspective or a long-term perspective. In the short term, the concern is with the disruptive impacts of an unanticipated cut in supply or rise in price. In the long term, the concern is more with the availability of sufficient energy that allows stable and sustainable economic development.

Energy security has risen in importance on the international policy agenda during recent decades due to growing dependence of industrialized economies on imported energy consumption and the increased frequency of disruptions in supply. In this context, the current European domestic energy system is not sufficiently reliable or affordable to support sustained economic growth. OECD European countries are consuming more and more energy and importing more and more energy products. As a result, external energy dependence for all sectors of the economy is constantly increasing, especially for oil and natural gas. For the future, it is vitally important to be able to implement measures that will allow an orderly and effective response to the threat from energy insecurity. The adoption of an effective emergency oil stock system as provided by the IEA or the development of futures markets for energy products which allow consumers and producers to hedge against the possibility of disruptions, are all examples of political and market responses to energy insecurity.

For this purpose, we need reliable forecasts of future energy demand as well as quantitative assessments of future supply, together with a geopolitical analysis of distribution of resources. A number of researchers have tried to develop a set of security indicators (IEA, 2001a; Kendell, 1998; von Hirschhausen and Neumann, 2003). The measures of supply security can be grouped into two categories: dependence, and vulnerability, represented both in physical and economic terms. Physical measures describe the relative level of imports or the prospects for shortages and disruptions. Economic measures describe the cost of imports or the prospects for price shocks.

The type of dependence will vary according to energy type and according to the structure of the international market. Oil shows high dependence on market price volatility and on geopolitical instability of exporters. Gas, on the other hand, could be an insecure source of energy scarce supply if the importer depends significantly on a single gas pipeline.

The physical and economic dimension of dependence and vulnerability are strictly connected, because physical shortages or disruptions quickly manifest themselves as price increases. Nonetheless, economic dependence measures are probably less relevant to long-run thinking about energy security than are economic vulnerability measures, which are more representative of real effects of energy disruptions on the national system.

In this paper, dependence and vulnerability of the European energy system has been analyzed through a comparison of the results of energy scenarios produced by the International Energy Agency (IEA), the International Institute for Applied Systems Analysis with World Energy Council (IIASA-WEC), the Intergovernmental Panel on Climate Change (IPCC), the US Energy Department (EIA-DOE) and the European Union with its last available energy outlook (World Energy Technology and climate policy Outlook, WETO).

The forecasts from these scenarios vary widely, as we will see below. Pessimistic projections of increasing uncertainties on energy markets are not confirmed by all available scenarios, and there are substantial differences both on the supply and demand side. Considering those divergences, the aim of the analysis will be to examine the geopolitical factors emerging from those results. In the following sections a general overview on geopolitics of oil and natural gas will be provided together with a contextual report of divergent energy security measures coming from scenarios. A final assessment on key issues, risks and policies for the long term will be addressed both for oil and gas.

2. Comparing long-term scenarios for oil and gas reserves and resources

In order to describe a comprehensive framework of energy security, dependence and vulnerability data have to be gathered both on the supply and demand side. Resources availability projections are supported by long-term forecasts, while production and consumption figures come from both medium- and long-run models.

Considering the supply side, a preliminary condition for a long-term economic sustainability of the present oil-intensive energy system is the physical availability of fossil fuels (oil and natural gas). Here it is normal to make a distinction between: (a) reserves and resources,[2] since the more the energy system will have to count on resources the

[1]Two main indicators are identified by IAEA (2005). The first one is the percentage of households or population with no access to commercial energy options, or heavily dependent on 'traditional' non-commercial energy options, such as wood, crop wastes and animal dung. The second one is the share of income needed to satisfy minimum household commercial energy requirements according to household income group. In this case, defining minimum energy requirements is a very subjective task and may prove to be difficult and controversial.

[2]Reserves are defined as: (a) proved reserves, which have been discovered (but not produced) and are expected to be economically producible, and reserve growth, an increase in proved reserves that occurs over time as oil and gas fields are developed or technological improvements occur. Undiscovered resources are defined as what remains to be found through new field exploration, that is expected to become