Energy Policy 37 (2009) 2008–2017

Contents lists available at ScienceDirect

Energy Policy

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

Households' willingness to pay for safeguarding security of natural gas supply in electricity generation

D. Damigos [a,*], C. Tourkolias [b], D. Diakoulaki [b]

[a] National Technical University of Athens, School of Mining and Metallurgical Engineering, National Technical University of Athens, Zografou 15780 Athens, Greece
[b] National Technical University of Athens, School of Chemical Engineering, National Technical University of Athens, Zografou 15780 Athens, Greece

ARTICLE INFO

Article history:
Received 3 December 2008
Accepted 30 January 2009
Available online 12 March 2009

Keywords:
Security of supply
Natural gas
Contingent valuation

ABSTRACT

Security of energy supply is a major issue for all EU Member States due to Europe's increasing dependence on imported fossil-fuel sources and the continuous rise in energy demand. The latter is of particular importance in electricity sector given the continuously increasing use of gas for electricity generation. In order to properly tackle with the problem, concerted actions are required by the EU Member States in several levels, i.e. legislative, political, etc. Nevertheless, these actions will come at an additional cost paid by the society either through increased electricity bills or through public financing for energy security investments. Thus, such policies should be justified on the basis of cost-benefit analysis. Towards this direction, it may be necessary to take into account non-market costs and benefits, i.e. the value that consumers place on interruptions avoided. In order to explore households' perceptions and willingness to pay for securing gas supply for electricity production, an empirical study was conducted by means of the contingent valuation method. The results indicate that consumers are willing to pay a premium on their electricity bills in order to internalize the external costs of electricity production, in terms of energy security, which are caused from imported fuels.

1. Introduction

Using a commonly accepted definition, security of supply is an uninterrupted flow of energy to meet the demand in an environmental sustainable manner and at a price level that does not disrupt the course of the economy. By its definition, security of energy supply is a complex issue, holding geopolitical, economic, environmental and social dimensions.

Security of energy supply has become a crucial issue at European level. The problematic aspects of European dependence on imported, in particular Russian, energy have fostered the need of actions in several levels, i.e. legislative, political, economic and technical. For example, Member States, under Directive 2004/67/EC, are obliged to adopt measures (i.e. gas storage facilities, use of alternative back-up fuels in industrial and power generation plants, etc.) with respect to ensuring adequate levels of security of gas supply (EC, 2004). Further, in 2007, EU Member States outlined an action plan on Europe's energy policy, the concerns of which are threefold: combating climate change, limiting the EU's external vulnerability to imported hydrocarbons and promoting growth and jobs, in order to provide secure and affordable energy to consumers. As far as security of gas supply is concerned, it is noted that EU needs to diversify energy sources, suppliers, transportation routes and methods and make better use of strategic storage possibilities, e.g. facilitate the construction of new liquid natural gas (LNG) terminals (EC, 2007).

Given the strong linkage between natural gas and electricity production, the issue of security of gas supply becomes quite important. At the same time, the liberalization of electricity markets creates new challenges for energy policies, given that the selection of technologies, fuel sources, suppliers, etc. is made on private economic grounds. If the markets fail to address the geopolitical risk of gas supply disruptions they should be supported through effective policy actions. It is evident, however, that security measures will come at an additional cost paid by the society, either directly (e.g. through electricity bills) or indirectly (e.g. through public financing for energy security investments). Thus, such actions should be justified on the basis of comprehensive cost-benefit analysis. To gain understanding of households' perceptions and willingness to pay (WTP) about the security of energy supply, an empirical study was conducted in Greece using the contingent valuation (CV) method. The hypothetical scenario of the analysis focuses on the security of natural gas supply in electricity generation. According to the authors' knowledge, this is the first attempt that has been made to elicit WTP estimates for safeguarding gas used in electricity production. The results presented in this paper reveal that consumers are willing to pay a premium on electricity bills in order to internalize the external

* Corresponding author. Tel.: +30 2107722214; fax: +30 2107722156.
E-mail address: damigos@metal.ntua.gr (D. Damigos).

0301-4215/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.enpol.2009.01.042

costs caused by the production of electricity from imported gas in terms of energy security.

2. Energy dependence in the EU

Between 1997 and 2006, EU27 energy consumption rose by 7%, while energy production fell by 9%. As a result, net imports rose by 29%. In 2006, gross inland energy consumption, in the EU27, was 1825 Mtoe (million tonnes of oil equivalent), 78.7% of which were produced from solid fuels (17.8%), oil (36.9%) and natural gas (24%) (Eurostat, 2008). In 2006, EU27 Member States imported 53.8% of their energy fuels, namely: solid fuels 41.1%, oil 83.6% and gas 60.8% (EC, 2008a). Russia was by far the main supplier of energy sources, since 33.5% of the EU27's oil imports, 42% of gas imports and 25.8% of hard coal imports were of Russian origin (EC, 2008a).

According to the Energy Baseline scenario (EC, 2008b), primary energy requirements of the EU will continue to grow (although at rates lower than in the past), while the production of fossil fuels will decline, and European dependence on imported energy will reach 70% in 2030 (EC, 2001). More specifically, reliance on imports of gas is expected to increase from 57% to 84% by 2030 and that of oil from 82% to 93% (EC, 2007), magnifying the importance of Russian and Middle Eastern resources.

Focusing on electricity sector, fossil fuels continue to dominate total electricity production, with a share of almost 55% in 2006 (Fig. 1), despite the recognized environmental issues (i.e. greenhouse gases emissions, health impacts due to air pollution, etc.) and the resource depletion.

However, coal and lignite accounted for 28.5% of EU27 electricity production in 2006, falling from 37.4% in 1990, and oil contribution also declined from about 8.5%, in 1990, to 4.2%, in 2006. In the same period, the share of electricity produced from gas has risen by a factor of 2.5 to around 21%. This growth is mainly attributed to the implementation of environmental legislation and liberalization of electricity markets. Further, low gas prices for much of the 1990s, rapid investment in gas transportation infrastructure and low capital costs associated with some gas-based technologies with high efficiencies also assisted its progress (EEA, 2007).

The increasing share of gas in power generation has certainly benefited the environment. On the other hand, however, the fact that 70% of the EU's gas imports are used for power generation has risen serious concerns (e.g. Reymond, 2008; Weisser, 2007). The International Energy Agency (IEA) notices that "the projected high dependence of power generation on imported gas might create a domino effect on the power sector in case of gas supply shortages" (IEA, 2004). According to the same agency, the situation will become more frustrating, given that the EU's import needs will be five or six times higher than its domestic gas production in the year 2030 (Larsson, 2008).

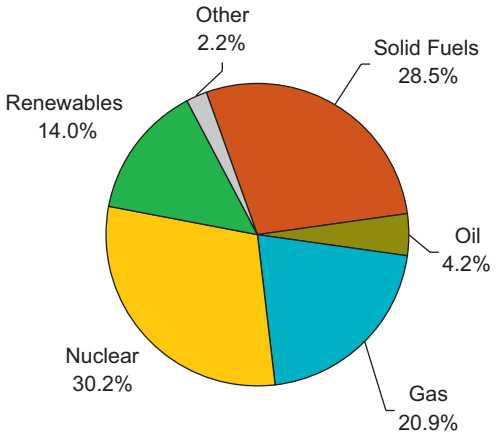

Fig. 1. Gross electricity generation share by source in 2006 for EU-27 (source: EC, 2008a).

3. Literature review

The contingent valuation method (CVM) is perhaps the most frequently and widely applied stated preference valuation technique because, firstly, it is the only method available for capturing non-use values, secondly, it produces estimates as good as estimates obtained by other direct or indirect valuation methods and, thirdly, the overall process has significantly improved as other relative scientific fields (e.g. sampling theory, estimation theory, data management, etc.) have shown considerable improvements (e.g. Coller and Harrison, 1995; Bateman and Willis, 1996; Bjornstad and Kahn, 1996; Carson et al., 1999). CVM has been in use for over 40 years and CVM studies have been conducted in over 50 countries by government agencies and international organizations (Carson et al., 1995; Carson, 2000). Due to the hypothetical character of the method and the fact that a social survey by means of questionnaire must take place, there is considerable controversy over whether it adequately measures people's WTP (for details see for example Bjornstad and Kahn, 1996; Ajzen et al., 2000; Westra, 2000; Goldar and Misra, 2001; Ajzen et al., 2004; Vatn, 2004).

CVM and other stated preference valuation methods (e.g. choice experiment, contingent ranking, etc.) have been used in the past in order to investigate consumers' willingness to pay for energy-related environmental issues (e.g. Braden et al., 1992; Batley et al., 2001; Bothe, 2003; Zarnikau, 2003; Nomura and Akai, 2004; Ek, 2005; Bergmann et al., 2006; Close et al., 2006; MacMillan et al., 2006; Borchers et al., 2007; Ladenburg and Dubgaard, 2007; Lienhoop and MacMillan, 2007; Whitehead, and Cherry, 2007; Wiser, 2007; Hansla et al., 2008; Longoa et al., 2008).

Stated preference studies have also been carried out to measure households' WTP for security of energy supply. These studies have generally focused on short-term security of supply in terms of reliable electricity (i.e. WTP for avoiding power outages in order to estimate the value of lost load—VOLL), rather than on reduction of import dependency, price volatility or long-term security of supply. For example, Willis and Garrod (1997) applied a contingent ranking method to derive lost utility values from a survey of industrial firms; Beenstock et al. (1998) estimated the cost of unsupplied electricity to Israeli households; Goett et al. (2000) examined small/medium commercial and industrial customers' choices among energy suppliers that offered different levels of reliability; Carlsson and Martinsson (2004) elicited Swedish households' willingness to pay to avoid power outages; Baarsma et al. (2005) investigated Dutch households' WTP to avoid the first hour of one outage; Longoa et al. (2008) estimated UK residents' WTP for energy programs with different characteristics (among them the short-term security of energy supply) that promote the production of renewable energy; Li et al. (2009) conducted a CV study in order to estimate how much would US households be willing to pay annually to support increased energy research and development (R&D) activities designed to replace fossil fuels, in order to reduce future dependence on foreign oil and emissions of CO_2.