Energy Policy 38 (2010) 887–895

Contents lists available at ScienceDirect

Energy Policy

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

Conceptualising energy security and making explicit its polysemic nature☆

Lynne Chester*

The John Curtin Institute of Public Policy, Curtin University, GPO Box U1987, Perth WA 6845, Australia

ARTICLE INFO

Article history:
Received 15 July 2009
Accepted 19 October 2009
Available online 11 November 2009

Keywords:
Energy regime
Energy security
Security of supply

ABSTRACT

Twenty-first century access to energy sources depends on a complex system of global markets, vast cross-border infrastructure networks, a small group of primary energy suppliers, and interdependencies with financial markets and technology. This is the context in which energy security has risen high on the policy agenda of governments around the world and the term 'energy security' has quietly slipped into the energy lexicon. The limited discourse about the nature of the term or its underlying assumptions has been totally eclipsed by an almost overwhelming focus on securing supplies of primary energy sources and geopolitics. An examination of explicit and inferred definitions finds that the concept of energy security is inherently slippery because it is polysemic in nature, capable of holding multiple dimensions and taking on different specificities depending on the country (or continent), timeframe or energy source to which it is applied. This 'slipperiness' poses analytical, prediction and policy difficulties but if explicitly recognised through definitional clarity, new levels of understanding will enrich the policy debate to deal with obstacles impacting on the constantly evolving nature of energy security.

1. Introduction

The term 'energy security' is ubiquitous to contemporary discussion about energy issues and climate change. The term is commonly found embedded in discussion framed around a handful of notions which denote unimpeded access or no planned interruptions to sources of energy, not relying on a limited number of energy sources, not being tied to a particular geographic region for energy sources, abundant energy resources, an energy supply which can withstand external shocks, and/or some form of energy self-sufficiency.

The term's blithe appearance throughout a wide range of reports and documents issued over the last decade or so by government and supranational organisations (such as the European Commission), and academic discourse, has been rarely accompanied by discussion or explanation of the notions which underpin its meaning. Of the limited discussion that has ensued, it has been more peripheral than centre stage and often the meaning attributed has been more implicit than explicitly stated. The term has quietly slipped into the energy lexicon and assumed a relatively prominent position. The limited discourse about its nature or any underlying assumptions has been totally eclipsed by an almost overwhelming focus in the literature on securing supplies of primary energy sources and geopolitics.

This has led to sporadic references about the term energy security being abstract, elusive, vague, inherently difficult and blurred (For example: Alhajji, 2006; Isbell, 2007; Löschel, Moslener et al., 2009; Wright, 2005). Two recent contributions have gone some way to develop a deeper understanding of the term but notably the comments of both have been eclipsed by the context of wider energy-related discussions (Chevalier, 2006; Kruyt, van Vuuren et al., 2009).

This article is intended as a contribution to redressing this gap in the literature about the conceptualisation of energy security. The article is structured in six sections. The following section considers the world's energy regime in which the term's usage has evolved in the period since the Second World War. A third section considers definitions of energy security, explicit and inferred, increasingly apparent in recent decades from which a number of aspects about the term are discerned and subsequently discussed before considering the market paradigms underpinning energy security definitions, and the implications for the policy role and actions of government. A concluding section draws together the salient points and posits some implications should definitional clarity remain 'the exception rather than the rule'.

2. The energy regime post World War 2

Usage of the term energy security has evolved with the transformation of the world's energy regime. This transformation is marked by, *inter alia*, the growing dominance of non-renewable fossil fuels, the liberalisation of energy markets, the development

☆ An earlier version of this paper formed part of a presentation to the November 2008 2nd IAEE Asian Conference held in Perth, Australia.

* Tel.: +61 8 9266 1707; fax: +61 8 9266 3658.
E-mail address: l.chester@curtin.edu.au

0301-4215/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.enpol.2009.10.039

of nuclear energy, the escalating energy demands of developing nations, and the impacts of political instability and large-scale natural events.

2.1. Increasing reliance on oil

Many countries, particularly those comprising the Organisation for Economic Co-operation and Development (OECD), became strongly reliant on Middle East oil as an energy source following the Second World War. This fossil fuel was integral to the world's post-war economic growth trajectory particularly through the transport sector and currently accounts for 34% of world energy use (IEA, 2008a). Oil was relatively abundant and cheap until the oil price shocks of the 1970s precipitated by the Organisation of Petroleum Exporting Countries' restriction on production. The shortfall in global energy supplies led to the formation of the International Energy Agency (IEA) with member countries required to hold oil stocks for sharing in an oil supply emergency. It also led to a view of energy security as synonymous with the need to reduce dependence on oil consumption (Martin and Harrje, 2005; UNDP, 2000).

2.2. The 1970s economic crisis and the liberalisation of energy markets

The rapidly accelerating oil prices of the 1970s occurred during a period of rampant inflation, persistently high levels of unemployment, growing government expenditures accompanied by comparatively declining revenues, a sharp downturn in profit rates, falling productivity, and a strong trend towards the internationalisation of production (Castells, 1989; Dunford, 1990, 2000; Moseley, 1988). This was a period of unprecedented economic phenomena and accepted economic management strategies did not restore the growth path of the 1950s and 1960s leading to strident criticism of government intervention and regulation.

By the 1980s the need for greater competition and less government involvement was strongly advocated for network sectors (especially electricity, gas and telecommunications) which had been traditionally dominated by government monopolies. Considerable restructuring of energy markets around the world has subsequently occurred and, in electricity's case at an astonishing pace (Chester, 2007: pp. 16–26). Competition has been injected through the breaking-up of vertically integrated monopolies, new forms of pricing and access regulation of monopoly networks, and the creation of new trading markets. This restructuring has not only been promoted by individual country governments but actively encouraged by the OECD, the World Bank, the International Monetary Fund, and international trading agreements such as the General Agreement on Tariffs and Trade and the subsequent General Agreement on Trade in Services.

2.3. Nuclear energy

The immediate decades following the Second World War also saw the rapid development of nuclear energy's use for electricity generation. Twenty-five countries by the late 1970s, including the United States, United Kingdom, France, Germany and Russia, had embarked on nuclear-based electricity generation. Two accidents in 1979 and 1986 (Three Mile Island in the United States and Chernobyl in the former Soviet Union) significantly weakened public acceptability for this energy source. Very high capital costs consistently exceeding budget, construction times increasing to over a decade, decommissioning and radioactive waste disposal taking many times the plant life, reactor safety and concern about its potential application for weapons purposes have all contributed to a significant slowing in nuclear energy's growth (Greenpeace International, 2007; Thomas, 2008). By 2006, nuclear energy accounted for around 15% of the world's electricity generation compared to 41% from coal and a further 20% from gas (Nuclear Energy Agency, 2003). The current climate change debate has seen some resurgence in the promotion of nuclear energy as a low-emitter of greenhouse gases relative to other primary fuels for electricity generation.

2.4. Fluctuating fortunes for coal and natural gas

The emergence of nuclear energy further reduced the role of coal. Oil had become the main fuel for transport by 1930 and replaced coal as industry's primary energy source from the late 1950s as prices fell with the development of pipeline and supertanker infrastructure (McNeill, 2001). Similar infrastructure development for natural gas led to lower prices and the expansion of this particular primary energy source which now accounts for almost a quarter of the world's energy consumption. The consumption of natural gas has doubled since 1980 as infrastructure to overcome its transportation became increasingly available. The world's known natural gas reserves are as large as oil but shipping constraints hindered development. These have been removed with the late twentieth century emergence of a global market for liquefied natural gas (LNG). Development of LNG has meant the wider availability of this energy source although natural gas resources are concentrated in a handful of countries. The former Soviet Union and the Middle East hold nearly 75% of known world reserves (IEA, 2008b; Yergin, 2005).

2.5. The energy appetite of large developing countries

The late twentieth century also witnessed the emergence of China and India as key energy consumers and major energy importers. In 1980 these two countries accounted for less than 8% of the world's energy consumption. By 2005 their share was 18% and it is projected that, over the next 25 years, their combined energy use will more than double to reach 25% of world consumption (IEA ,2008a; 2008b).

Swift growth in China's coal consumption over the past few years has seen a sharp increase in coal's share of world energy use. The cost of coal is now comparatively low as global oil and gas prices have, in recent years, escalated and remain high, compared to their levels in the 1990s (IEA, 2008b; UNDP, 2004).

2.6. Political instability and extreme natural events

Given the levels of energy import dependence around the world, the possibility of serious energy supply interruptions has been heightened with political instability in supplier countries and the increasing frequency of disruption to gas supplies from Russia to Europe. Risks to the energy supply chain infrastructure have also come to the fore with the 11 September 2001 terrorist attacks in the United States, and extreme natural events such as Hurricane Katrina in 2005 and the 2009 floods and bushfires in north-eastern and south-eastern Australia, respectively.

A rapid escalation in oil prices, the disruption of gas supplies to Europe during freezing winter temperatures, electricity blackouts following hurricanes or other severe natural disasters, all tend to focus public and media attention on energy supply issues and the measures initiated by governments to overcome short-term supply disruptions. This also was the focus of energy security strategies following the oil disruptions of the 1970s. But today's energy supply systems are far more complex than a few decades ago and it is this complexity which has attributed far more to the term 'energy security' than dependency on a particular primary energy source.

2.7. The energy regime of the twentieth-first century

Twentieth-first century access to energy sources depends on open global markets and a vast infrastructure network of offshore platforms, pipelines, tankers, refineries, storage, generation capacity, and transmission and distribution systems. Cross-border pipelines and strategic transport channels feature strongly, China and India are major energy importers, there is a growing reliance on an ever-smaller group of oil and gas suppliers as the interdependence between industrialised countries and energy exporters has deepened, financial markets and energy markets are closely linked, and technology has created interdependencies between electricity and oil refining as well as natural gas processing. This complexity brings heightened risks of major supply disruption through political conflict or war, technical system failures, accidents, sabotage, extreme weather events or financial market turmoil (Birol, 2006; UNDP, 2004; Yergin, 2005).

Vast networks of complex energy supply systems from upstream to downstream, energy markets as exemplars of liberalisation, the domination by fossil fuels of a growing global energy dependence, the incapacity of most countries to be energy self-sufficient, around 80% of greenhouse gas emissions generated by total world energy consumption which is projected to rise by 50% in the 25 year period to 2030 without fundamental policy changes or major supply constraints (IEA, 2008b), and global attention focused on addressing the environmental consequences of unchecked use of fossil fuels. This is the political, economic and social context in which usage of the term energy security has evolved. It is also the context in which energy security has been placed high on the policy agenda of the developed and developing world, and supranational organisations such as the European Commission (EC), the World Economic Forum, the OECD, the North Atlantic Treaty Organisation (NATO), the Asia Pacific Economic Cooperation (APEC) and the G8. The European Union, the United Kingdom and Japan, to name a few, have spent considerable resources developing energy security strategies.

3. Conceptualisations of energy security

The energy security literature is marked by a very dominant focus on securing supplies of two primary energy sources, oil and gas (For example, see: IEA, 2008b, Isbell, 2007; Müller-Kraenner, 2008, UNDP, 2004, Wesley, 2007). Yet electricity now ranks second only to oil in terms of final energy consumption and is the world's most dominant form of energy supply to the economy making it critical to energy security (IEA, 2008a; Chang and Liang Lee, 2008).

The literature is also notably marked by 'vapid abstractions' from a "foreign-policy cottage industry that obsesses about the need for nations and their diplomats to worry about and attempt to manage petroleum markets" (van Doren, 2006: p. 186). This preponderance with geopolitics infers that the international or global realm is the only legitimate or relevant space for discourse about energy security (For example, see: Grant, 2008; Houssin, 2007; Kalicki and Goldwyn, 2005; Marquina, 2008; Moran and Russell, 2009; Naughten, 2008; Toichi, 2003; Yergin, 2005; Wesley, 2007; Youngs, 2007).

3.1. Market-centric definitions

Bohi and Toman (1993: p. 1094) state that "energy security can be defined in various ways" although their focus is limited to "economic issues related to the behaviour of markets". Subsequently they define energy insecurity "as the loss of economic welfare that may occur as a result of a change in the price or availability of energy" (Bohi and Toman, 1996: p. 1). Some years earlier, the IEA defined energy security as an "adequate supply of energy at a reasonable cost" (IEA, 1985: p. 29) and later posited that "energy security is simply another way of avoiding market distortions" (IEA, 1995: p. 23) because 'smoothly functioning international energy markets' will deliver "a secure – adequate, affordable and reliable – supply of energy" (IEA, 2002: p. 3).

This IEA definition of energy security in market terms has been consistently restated and most recently expressed as "energy security always consists of both a physical unavailability component and a price component, (but) the relative importance of these depends on market structure" (IEA, 2007a: p. 32). A similar approach is mirrored by Stern (2007), the UK Government (DBERR, 2007a; DTI, 2006, 2007) and Bielecki (2002: p. 237) who suggests that the concept is centred on notions of supply 'reliability' and 'adequacy' at 'reasonable' market-determined prices.

The logic which underpins these 'market-centric' definitions goes something like this: as a consequence of the 'liberalisation' of energy markets, energy security (and insecurity) is a market outcome, determined by the operation of the market and thus can only be defined in market terms—particularly supply (physical availability) and price. Continuity of physical supply—often described in terms of availability, reliability, relative shortage or complete disruption—across the total supply chain assumes a singular, unparalleled importance within this definition of the concept.

> A security of supply risk refers to a shortage in energy supply, either a relative shortage, i.e. a mismatch in supply and demand inducing price increases, or a partial or complete disruption of energy supplies (Scheepers, Seebregts et al., 2006: p. 13).

Therefore the purpose of energy security strategies is to overcome "situations when energy markets do not function properly … (and) should be mostly aimed at 'making markets work'" (Noël, 2008). Competitive markets and 'independent' regulation are considered the "most effective way of delivering secure and reliable energy supplies" (DBERR, 2007a: p. 8). A corollary of this view comes strongly to the fore in the UK Government's energy approach. The 'right' level of security (i.e. continuity of supply) "depends on the balance between the costs and the benefits of increasing security … (and) is left to the market as suppliers are better placed than government or the regulator to understand the value that their different customers place on security of supply" (ibid: p. 17).

3.2. Quantitative measurement

A further corollary of the market-centric conceptualisation of energy security has been successive endeavours at its 'operationalisation'. The first step was the 'translation' of the market-centric definition into short-term (operational) and long-term (adequacy) threats to supply disruptions based on sources of energy supplies, and subsequent transit, storage and delivery (IEA, 1995; Stern, 2002). The second step was quantification of these risks. "To be analytically helpful, a measure of supply security needs to be quantifiable" (DBERR, 2007b: p. 2), "can be used as a measure to indicate a desired state" (Scheepers, Seebregts et al., 2006: p. 13) and can "measure risks and policy effectiveness" (Tönjes and de Jong, 2007). Even more recently it has been contended that quantitative indicators are necessary to understand the "energy security consequences of different development pathways" (Kruyt, van Vuuren et al., 2009: p. 1).

Quantitative measurement of energy security risks has gathered pace since the early part of this decade. Since 2002 the UK Government has published security-of-supply indicators which range across three categories of supply and demand forecasts, market signals (e.g. forward prices for gas and electricity) and market response (planned major new investments (JESS 2002; 2006). The Clingendael International Energy Programme has developed, in relation to the European Union, a Crisis Capability Index (for short-term supply interruption) and a Supply/Demand Index (Scheepers, Seebregts et al. 2006, 2007). The IEA (2004, 2007a) has also proposed energy security measurement 'tools' of physical availability (geopolitical energy security and pipe-based import dependence) and the price component (power system reliability and market power).

Another example of this quest for quantification has been an extension of the Shannon–Wiener index, an established non-parametric measure of ecological diversity (Stirling, 1998). Modifications of this index have been used to construct indicators of energy source diversity, import dependency, primary energy demand and political stability (APERC, 2007; Jansen, van Arkel and Boots, 2004; Neumann, 2007).

Other quantitative indicators to emerge have been an oil vulnerability index (Gupta, 2008), indicators of oil import dependency, Middle East oil import dependency and a non-carbon based fuel portfolio (APERC, 2007), "a mathematical expression of a penalty notice, reflecting the societal damage" (Bollen, 2008: p. 21) from energy insecurity, and classification of energy security by ex-post (price development) and ex-ante (potential problem) indicators (Löschel, Moslener et al., 2009). Notably, a recent study went to a far more microlevel and tested the energy security of deregulated electricity markets by establishing quantitative indicators for adequacy of generation capacity, reliability and reasonable price (Chang and Liang Lee, 2008).

3.3. Broader definitions encompassing qualitative aspects

The progressive endeavours to quantify energy security raise two significant points. First, as demonstrated by Kruyt, van Vuuren et al. (2009), the adoption by policymakers of energy security indicators is virtually non-existent apart from some marginal use in relation to oil and, as mentioned earlier, by the UK Government.[1]

Secondly, broader definitions of energy security are observable which embrace dimensions other than market supply and market price. For example, the European Commission's Green Paper *Towards a European strategy for the security of energy supply* stated:

> 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 *market*, at a price which is *affordable* for all consumers (private and industrial), while respecting environmental concerns and looking towards *sustainable* development … Security of supply does not seek to maximise energy self-sufficiency or to minimise dependence, but aims to reduce the risks linked to such dependence (EC, 2000: pp. 1–2, emphasis added).

The hazards posed to each of these dimensions of energy security are identified, by the Green Paper, as physical, economic, social and environmental risks. Moreover, it is recognised that these risks will not be ameliorated or prevented without government intervention—through policy and/or regulatory action—given the complex institutional arrangements which guarantee the existence and functioning of contemporary energy markets.

A similar view is expressed in the European Parliament's response to this Green Paper which highlights notions of adequate capacity to meet demand, and availability through source diversification and many suppliers. The Parliament's response stresses Europe's high oil import dependence, proposes a reduction in transport's demand for oil but contends that dependence on imports of energy fuels "is neither necessarily a bad thing nor economically inefficient provided the sources are diverse, not one supplier is dominant and we can produce sufficient goods and services to pay for them" (European Parliament, 2001: p. 17).

The dimensions of availability, affordability, adequate capacity and sustainability are echoed by the APERC (2007) and annual issues of the *World Energy Assessment* which defines energy security as "the availability of energy at all times in various forms, in *sufficient quantities* and at *affordable* prices without unacceptable or irreversible impact on the environment" (UNDP, 2004: p. 42, emphasis added).[2] These latter assessments distinguish between short and long term energy supply interruptions, and stress the need for diversification of local and imported energy sources to keep pace with expected growth in demand (For example: UNDP, 2000: p. 113).

The APERC's energy security definition of

> the ability of an economy to guarantee the availability of energy resource supply in a sustainable and timely manner with the energy price being at a level that will not adversely affect the economic performance of the economy (2007: p. 6)

places the concept firmly within the context of the broader economy. Similarly, Chevalier (2006: p. 2) suggests that the "standard definition … is a flow of energy supply to meet demand in a manner and at a price level that does not disrupt the course of the economy in an environmental sustainable manner". Both these latter definitions also clearly infer the desirability for government action should economic performance be jeopardised by insufficient, unsustainable and unaffordable market provision of energy.

Table 1 summarises the dimensions of energy security prioritised by the narrower market-centric and broader multi-dimensional definitions as well as the endeavours to quantitatively measure energy security.

4. Multiple aspects of energy security

A number of fundamental aspects about the term energy security are discernible from the discussion thus far.

First, an inherent feature of energy security is about the management of risk—the risk of interrupted, unavailable energy supplies; the risk of insufficient capacity to meet demand; the risk of unaffordable energy prices; the risk of reliance on unsustainable sources of energy. These risks may be caused by energy

[1] Although the UK Government's indicators are not mentioned, Kruyt, van Vuuren et al. (2009) do provide an unparalleled summary of the range of simple and aggregated indicators of energy security that have been devised in recent years.

[2] Sustainability and acceptability (to the environment) are found to be used synonymously in a number of publications discussing energy security.

Table 1
Dimensions prioritised in energy security definitions and quantitative measures.

Dimensions of energy security	Market-centric definitions	Quantitative measurement	Broader definitions
Absolute:			
Availability	✓	✓	✓
Adequacy of capacity		✓	✓
Relative:			
Affordability			✓
Sustainability			✓

market instabilities, technical failures or physical security threats (IEA, 2007b).

A second point concerns the extent to which the definition of energy security may be framed to reflect a country's (or continent's) energy use 'mix', the abundance of local resources and reliance on imports. This is illustrated by the EC's 2006 Green Paper *A European strategy for sustainable, competitive and secure energy*. The document places a far stronger emphasis on the physical security of supply (network infrastructure, stock, diversification of supplies) than the Green Paper of six years earlier. The objective of supply security, now separated from sustainability, is targeted at "tackling the EU's rising dependence on imported energy" (EC, 2006: p. 18) projected to rise to around 70% of energy requirements in the next 20 to 30 years. This dependence is to be 'tackled' by a number of policy measures such as reducing demand, diversification of the energy mix and supply sources, stimulating investment in adequate capacity, emergency preparedness, and improved energy access for business and citizens. The clear priority of energy security is to minimise the EU's import vulnerability, supply shortfalls and potential supply uncertainty given the high dependence on one single gas supplier (EC, 2007).

Third, the term 'energy security' clearly reflects a concept (an abstract idea) with some form of strategic intent. This view is exemplified by the following definition developed by the Centre for European Policy Studies: "security of supply consists of a variety of *approaches* aimed at insuring against supply risks. Security of supply becomes a cost-effective risk-management strategy of governments, firms and consumers" (Egenhofer and Legge, 2001: p. 3, emphasis added). The latter point about responsibility or carriage of the strategy is contestable and goes beyond the purposes of the current discussion. The salient point is that energy security is a concept with strategic intent.[3] Energy security is not a policy. Specific policy measures are implemented by governments to achieve the objective(s) of energy security, *however defined*, and these policy measures have increasingly included reliance on competitive markets, the creation of new regulatory regimes to support those markets, and 'geopolitical approaches' (Youngs, 2007).

Fourth, the concept of energy security has a temporal dimension. The risks or threats to physical supply differ across short, medium and long term horizons. Short-term risks include extreme weather conditions, accidents, terrorism attacks, or technical failure. The main issue of concern is the *reliability* and *continuity* of available technological and commercial mechanisms which convert primary energy sources for end-use by consumers. Long-term risks concern the adequacy of supply to meet demand and the adequacy of infrastructure to deliver supply to markets which will, in turn, depend on levels of investment and contracting, the development of technology and the availability of primary energy sources (Egenhofer, Gialoglu et al., 2004). Therefore the meaning attributed to energy security will differ across time because the probability, likelihood and consequences of different risks or threats to supply will vary over time.

A fifth aspect concerns the differences between energy markets. There are significant differences between the oil, gas, nuclear and electricity energy markets such as the rigidity of transport infrastructure, the difficulties of storage, and the regional nature of markets (IEA, 1995). Consequently, to apply the concept of energy security to the gas market will result in a different meaning than if applied to the oil market or the electricity market. These security-of-supply differences across energy markets were recognised by the IEA's 1995 gas study, affirmed by the UK Government's decision to develop separate sets of security-of-supply indicators for each energy market and reinforced by the electricity-centric indicators developed as part of Chang and Liang Lee's (2008) recent study of energy security and deregulated electricity markets.

A further aspect concerns the 'eye of the beholder', a point noticeably made by Alhajji (2006), Birol (2006), and the World Economic Forum (2006). Different perspectives of energy security will be held by producers, large and small consumers, developing and developed countries, companies operating within a network, policymakers and other energy stakeholders.

Box 1 summarises these many aspects of the term 'energy security' and particularly in terms of its contemporary usage.

5. Market paradigms underpinning conceptualisations of energy security

A final aspect about energy security is possibly the most significant given the implications for the policy role and actions of governments. As we have seen, a definition of energy security may contain both absolute and relative notions. Availability and adequacy of capacity are capable of absolute measurement. Affordability, or the 'reasonableness' of prices, are relative notions with meanings subject to considerable variation. Supranational organisations, governments, policy advisers and commentators generally favour a definition of energy security centred on the absolute notions of market supply and market price. Broader definitions, such as those used by the European Commission, encompass absolute and relative notions. All definitions envisage the market playing a central role in ensuring, enhancing or attaining energy security. However, what is the market paradigm underpinning these definitions?

Two competing market paradigms are evident within contemporary economic thought: the pure Walrasian market which optimally allocates products in a perfectly informed, atomistic world; or the market which is a social, political and historical construct (Chang, 2002; Coriat and Weinstein, 2005). Each paradigm defines the interrelationship between market and state, and thus the role to be played by policy to deal with matters such as energy security.

[3] The IEA (2002) and Jenny (2007) contend that energy security is an evolving concept because it now 'includes' a range of energy sources other than oil, a wide range of risks along the supply chain, and price as well as supply availability. This, I would contend, amounts to a concretisation of the concept and it is the contention of this article that the *application* – or usage – of the concept has evolved over time to reflect multiple aspects.

Box 1–Multiple aspects of the term 'energy security'.

§ Energy security is about the management of risk(s).
§ Energy security can refer to energy use 'mix', abundance of local resources, and/or the reliance on imports.
§ Energy security is a concept, not a policy, with strategic intent.
§ Policies are implemented to improve energy security.
§ Energy security can hold a temporal dimension.
§ Energy security will differ between across energy markets.
§ Energy security will differ between energy market stakeholders.

The narrower market-centric definition of energy security clearly is based on the pure Walrasian market with its self-equilibrating properties. Markets are assumed to clear automatically via price adjustments i.e. prices respond to changes in demand or supply, finding equilibrium at the price at which the quantity supplied equals the quantity demanded. These oscillations, according to this paradigm, underpin a systemic stability across markets for all goods and services and ensure an optimal allocation of resources between competing needs. Yet this self-equilibrating nature of the market rests on numerous assumptions such as identical consumers behaving rationally because they are perfectly informed about all the available alternatives, zero transaction costs, no trading at disequilibrium prices, and infinitely rapid velocities of prices and quantities (Blaug, 2002: pp. 40–41).

Notwithstanding any perceived incompatibility of these assumptions with economic reality, this paradigm maintains that the market should be left 'unfettered' from state interventions to ensure its 'efficient' workings are allowed to determine output and price. The market-centric definition of energy security is couched in these market terms of output (supply) and price and "energy security policies should be mostly aimed at 'making markets work' and letting them work when they do" (Noël, 2008). This approach strongly advocates a limited role for governments and policy. Energy markets should be allowed to operate 'freely'. Competitively determined output and prices should be the energy security objectives of governments. Adequacy of capacity, affordability and sustainability will naturally follow as by-products of an 'unfettered' market but the sacrosanct objectives of competitive output and prices will be jeopardised if governments intervene in the pursuit of lower-order objectives.

Not surprisingly, a different view is held by the alternative market paradigm which situates the market as one of a multiplicity of formal and informal institutions comprising capitalism. "All institutions, including the market … are defined in relation to the structure of the rights and obligations of the relevant actors" (Chang, 2007: p. 7) which in the case of the market includes the institutional arrangements that determine and/or regulate market participants, and the objects and process of market exchange. As these 'rights and obligations' are deemed to be the result of politics, the market – like all institutions – is considered to be a political construct. Property rights, and the entitlements bestowed on market participants are not free of politics, nor are the determination of interest rates and wages which impact on every sector of the economy, along with numerous state actions to 'protect' market participants. Far from being 'natural', "markets are the fruit of complex social and historical developments" (Coriat and Weinstein, 2005: p. 1) with politics, and thus the state, being integral to their creation and functioning.

Consequently, the institutionalist paradigm assigns a far more active role to the state in relation to the market. Market outcomes result from a myriad of institutional arrangements and processes all of which are influenced by the state and politics. Accordingly, a view of market outcomes solely in terms of output and price provides a partial and thus inaccurate view, of reality. The corollary of this paradigm is that energy markets need to be considered through a multi-dimensional lens which goes beyond the absolute market notions of output and price to include notions such as adequacy of capacity to meet demand, affordability and sustainability. This approach is more consistent with the definition of energy security adopted by, for example, the European Commission and reflected in the policy positions of EU member states.

6. Implications of energy security's multi-dimensional nature and specificities

Within a literature skewed heavily towards viewing energy security through the prism of geopolitics and the supply of oil, the apparent or inferred definitions of energy security have been found to fall into one of two broad categories. The first category centres on market supply and energy availability at market price. The second category is broader taking into account more dimensions.

Within each of these definitional categories, the foregoing discussion has also shown that multiple meanings can be attributed to the term energy security. Its meaning may be used to convey absolute and relative notions denoting dimensions of availability, adequacy of capacity, affordability and/or sustainability (Refer Table 1). Those favouring the narrower market-centric definition place an almost exclusive priority on the absolute dimension of availability i.e. physical supply (although notions around 'adequate capacity' may be mentioned) and affordability is eschewed, not only due to its inherent relativity but because it is generally assumed that market price reflects energy availability and thus the cost of security of supply (Behrens and Egenhofer, 2008). Possibly the narrowest market-centric definition of energy security is that posited by Noël (2008) as energy availability "to those willing to pay the market price".

The adoption by government of a narrow market-based or broader multi-dimensional definition of energy security provides an unequivocal signal of its intended role vis-à-vis the market in the pursuit of energy security objectives. Energy market outcomes are either viewed purely in absolute market terms or more broadly. If the former, governments may well focus on reducing market obstacles and imperfections through regulation. If the latter, governments may well intervene to 'adjust' market outcomes. For example, with respect to market price and the affordability of energy prices, government may provide subsidies for low income groups such as the UK Government's fuel poverty programme (DBERR, 2001); with respect to sustainability, governments may seek to discourage the use of high-emission fossil fuels through mechanisms such as the EU cap-and-trade scheme.

The discussion has also shown that energy security is a concept not a policy. Policies may be directed at implementing a strategic intent to alleviate energy *in*security which often is framed in terms of: (1) the management of perceived risk(s)—to avoid supply disruption, insufficient capacity, unaffordability, and reliance on unsustainable energy sources, and/or (2) a country's energy use mix and reliance on local resources or imports. Application of the concept of energy security has evolved to have relevance across the world's energy regime of a vast complex network of energy supply systems from upstream to downstream.

The time horizon adds a further layer of complexity to the meaning of energy security because whatever dimensions are used to define the term, the risks or threats to those dimensions will differ in the short term from the medium and long term. Finally, the heterogeneity between energy markets means that the application of the concept will result in different meanings for different energy sources and different stakeholders.

These findings lead to the contention that the concept of energy security is inherently slippery because it is polysemic in nature. The concept has many possible meanings. Energy security may be delineated through multiple dimensions and it takes on different specificities depending on the country (or continent), timeframe or energy source to which it is applied.

This slipperiness, and the inherent prediction and policy difficulties that this poses, has been noted in the context of surging oil prices and the governance of liberalised gas markets (Isbell, 2007; Wright, 2005). Brennan (2007: p. 3) also alluded to these difficulties, in the context of electricity, when suggesting "rather than adopt one at the risk of excluding others, it is useful to have as a reference point as many of these different meanings as is reasonable".

One possible approach to assess a country's (or continent's) energy security over the short and long term, encompassing Brennan's notion of a 'multiple meaning reference point', is to use a four-dimensional grid of availability, adequacy of capacity, affordability and sustainability fully cognisant that the level of disaggregation would need to be at each energy source.[4] This approach conceptualises the issue of energy security broadly yet explicitly recognises the temporal aspect and energy market heterogeneity. Such an approach does not presuppose that one dimension is the sole or primary determinant of energy security. Such an approach does, however, infer that all four dimensions contribute – to some degree – to energy security. Such an approach also recognises many of the polysemic layers in which energy security is swathed. It also responds to the call "for more holistic conceptualisations of energy security" (Chang and Liang Lee, 2008: p. 100) despite the complexity posed for analysis and allows for the application of multiple indicators 'leading to a broader understanding' (Kruyt, van Vuuren et al., 2009: p. 1).

But the polysemic qualities of energy security pose further implications. First, these qualities demonstrate the impracticality of seeking a common definition of energy security for which some have yearned (Alhajji, 2006; Cabalu, Alfonso et al., 2008). Conceptualisation of energy security at a global level compared to regional, national, global, producer or consumer levels may contain similar notions of availability, adequacy, affordability and sustainability but the specificities of each will understandably differ at any point in time. All hold equal validity but each will express the concept of energy security in terms of their respective sphere. No one sphere can appropriate energy security as its own despite the global sphere dominating the literature because the issue of energy security does not start or stop at national borders or only hold significance for a particular group of countries given the world's energy appetite, the location of energy sources (primary and end use) and the operation of sub-national energy markets.

Second, energy security is akin to a 'wicked' problem which is not amenable to traditional linear, analytical approaches or resolution by the systematic application of technical expertise (Chester, 2009; Goodin, Rein and Moran, 2006; Rittel and Webber, 1973) [5]. Consequently strategies and specific policies to deal with energy security require new ways of thinking and pose substantive challenges to governance structures, skills bases and organisational capacities.

Moreover, the multiplicity of meanings that can be attributed to energy security establishes that there can be no 'one-size-fits-all' solution. For example, the policy measures designed to reduce a country's energy import dependence will differ considerably from the policy measures aimed at improving energy affordability. Both can be denoted as dimensions of energy security but each requires considerably different policy formulation, policy instruments and implementation given the vast difference in the nature and scale of impact sought.

The temporal dimension of energy security also signals the impossibility of an absolute or clear end-state solution. The meaning of energy security differs over the short, medium and long term because the probability, likelihood and consequences of different risks or threats to supply will vary over time. Thus we will never reach an end-state of energy security as such. An analogous situation is the process of competition. Firms continually seek to create and maintain the best conditions for their profitability. To do this, firms will continually seek out and exploit differences in technology, production, distribution, access to information and consumption trends. It is an ongoing never-ending process. Likewise policymakers and governments will take actions seeking to address short and long term obstacles deemed to be impacting on energy security. But the factors influencing energy security, *however it is defined*, are constantly changing. Hence, an end-state of energy security is never reached because its nature is continually evolving.

As stated at the outset, the purpose of this article is to address a lacuna in the literature, namely discussion about the conceptualisation of energy security. This is not a plea for some form of standardised conceptualisation, the folly of which is evident given energy security's polysemic qualities expounded in this article that have emerged from the evolving political, economic and social context of the contemporary energy regime. There is, however, a plea inherent to this article for robust debate and discussion about the use of the term. Those who engage with the discourse, including policymakers, should openly present the suppositions, assertions, or premises which inform and shape their use of the concept. Definitional clarity will enrich debate about policies to deal with obstacles impacting on the constantly evolving nature of energy security, as it applies to a range of spheres other than the global, as well as reach new levels of understanding about this polysemic concept.

References

Alhajji, A.F., 2006. The meaning of energy security. USAEE Blog, Posted 22 August. Retrieved 12 November 2008 from 〈http://blog.usaee.org/?q=node/8#top〉.

Asia Pacific Energy Research Centre (APERC), 2007. A quest for Energy Security in the 21st Century: Resources and Constraints. APEC, Tokyo.

[4] This approach has been adopted to analyse Australia's energy security (Chester, 2008).

[5] Wicked problems have multiple characteristics which may include being difficult to define, having many interdependencies, being multi-causal, leading to unforeseen consequences, evolving as steps are being taken to address it, having no clear solution, being socially complex, being the responsibility of more than one institution, involve changing behaviour and/or being seemingly intractable (Australian Public Service Commission, 2007).

Australian Public Service Commission, 2007. Tackling Wicked Problems: A Public Policy Perspective. Australian Public Service Commission, Australian Government, Canberra.

Behrens, A., Egenhofer, C., 2008. Energy policy for Europe: identifying the European added-value. CEPS Task Force Report, 6 March. Centre for European Policy Studies, Brussels. Retrieved 26 April 2008 from 〈http://shop.ceps.eu/BookDetail.php?item_id=1623〉.

Bielecki, J., 2002. Energy security: is the wolf at the door? The Quarterly Review of Economics and Finance 42, 235–250.

Birol, F., 2006. Policy forum: the future of energy markets—world energy prospects and challenges. The Australian Economic Review 39 (2), 190–195.

Blaug, M., 2002. Ugly currents in economics. In: Mäki, U. (Ed.), Fact and Fiction in Economics: Models, Realism, and Social Construction. Cambridge University Press, Cambridge, UK, pp. 35–56.

Bohi, D.R., Toman, M.A., 1993. Energy security: externalities and policies. Energy Policy 21 (11), 1093–1109.

Bohi, D.R., Toman, M.A., 1996. The Economics of Energy Security. Kluwer Academic Publishers, Boston.

Bollen, J., 2008. Energy security, air pollution, and climate change: an integrated cost-benefit approach. Netherland Environmental Assessment Agency, Bilthoven, April. Retrieved 14 December 2008 from 〈http://www.rivm.nl/bibliotheek/rapporten/500116004.pdf〉.

Brennan, T.J., 2007. Electricity markets and energy security: friends or foes? Discussion Paper RFF DP 07–46. Resources for the Future, Washington, October. Available at:〈http://www.rff.org/RFF/Documents/RFF-DP-07-46.pdf〉.

Cabalu, H., Alfonso, C., Manuhutu, C., 2008. Regional cooperation in energy security in the ASEAN+3. In: Cabalu, H., Marinova, D. (Eds.), Second International Association for Energy Economics (IAEE) Asian Conference: Energy Security and Economic Development under Environmental Constraints in the Asia-Pacific Region. Refereed papers. Curtin University of Technology, Perth, November, 75–96. Retrieved 18 February 2009 from 〈http://www.business.curtin.edu.au/business/research/conferences/2nd-iaee-asian-conference/refereed-conference-papers〉.

Castells, M., 1989. The Informational City: Information Technology, Economic Restructuring, and the Urban-Regional Process. Blackwell, Oxford.

Chang, H.-J., 2002. Breaking the mould: an institutionalist political economy alternative to the neo-liberal theory of the market and the state. Cambridge Journal of Economics 26 (5), 539–559.

Chang, H.-J., 2007. Institutional change and economic development: an introduction. In: Chang, H.-J. (Ed.), Institutional Change and Economic Development. United Nations University Press, New York, pp. 1–14.

Chang, Y., Liang Lee, J., 2008. Electricity market deregulation and energy security: a study of the UK and Singapore electricity markets. International Journal of Global Energy Issues 29 (1/2), 109–132.

Chester, L., 2007. What are the outcomes and who benefits from the restructuring of the Australian electricity sector? Unpublished Ph.D. Thesis, University of New South Wales. Available at: 〈http://www.library.unsw.edu.au/~thesis/adt-NUN/public/adt-NUN20071017.113919/〉.

Chester, L., 2008. The (default) strategy determining the security of Australia's energy supply. In: Cabalu, H., Marinova, D. (Eds.), Second International Association for Energy Economics (IAEE) Asian Conference: Energy Security and Economic Development under Environmental Constraints in the Asia-Pacific Region, Refereed papers. Curtin University of Technology, Perth: November, pp. 97–122. Available at: 〈http://www.business.curtin.edu.au/business/research/conferences/2nd-iaee-asian-conference/refereed-conference-papers〉.

Chester, L., 2009. Does the polysemic nature of energy security make it a 'wicked' problem? In: Proceedings of the International Conference on Energy, Environment, Sustainable Development: EESD09, 24–26 June 2009, 54. World Academy of Science, Engineering and Technology, Paris, pp. 159–171.

Chevalier, J.-M., 2006. Security of energy supply for the European Union. European Review of Energy Markets, September 1(3), 1–20. Retrieved 14 December from 〈http://www.rivm.nl/bibliotheek/rapporten/500116004.pdf〉.

Coriat, B., Weinstein, O., 2005. The social construction of markets. Issues in Regulation Theory, No. 53, September.

Department for Business, Enterprise & Regulatory Reform (DBERR), 2001. The UK Fuel Poverty Strategy. DBERR, London (November).

Department for Business, Enterprise & Regulatory Reform (DBERR), (2007). Energy Markets Outlook. DBERR, London (October).

Department for Business, Enterprise & Regulatory Reform (DBERR), 2007. 'Expected energy unserved: a quantitative measure of security of supply. URN 07/1522, Contribution to the Energy Markets Outlook Report. DBERR, London (October).

Department of Trade and Industry (DTI), 2006. The energy challenge: energy Review Report 2006. DTI, London (July).

Department of Trade and Industry (DTI), 2007. Meeting the energy challenge: a white paper on energy. DTI, London (May).

Dunford, M., 1990. 'Theories of regulation'. Environment and Planning D: Society and Space. 8(3), 297–321.

Dunford, M., 2000. Globalization and theories of regulation. In: Palan, R. (Ed.), Global Political Economy: Contemporary Theories. Routledge, London, pp. 143–167.

Egenhofer, C., Gialoglu, K., Luciani, G., Boots, M., Scheepers, M., Costantini, V., Gracceva, F., Markandya, A., Vicini, G., 2004. Market-based options for security of energy supply. INDES Working Paper No. 1, March. Retrieved 30 May 2008 from 〈http://shop.ceps.eu/BookDetail.php?item_id=1114〉.

Egenhofer, C., Legge, T., 2001. Security of energy supply: a question for policy or the markets? Report of a CEPS Working Party. Centre for European Policy Studies, Brussels, November.

European Commission (EC), 2000. Green paper: towards a European strategy for the security of energy supply. Commission of the European Communities, COM/2000/0769 Final, Brussels. Retrieved 12 August 2008 from 〈http://europa.eu/scadplus/leg/en/lvb/l27037.htm〉.

European Commission (EC), 2006. Green paper: a European strategy for sustainable, competitive and secure energy. COM(2006) 105 Final, Brussels, 8 March. Retrieved 12 August 2008 from 〈http://europa.eu/scadplus/leg/en/lvb/l27062.htm〉.

European Commission (EC), 2007. Communication from the Commission to the European Council and the European Parliament: an energy policy for Europe. COM (2007) 1 Final, Brussels, 10 January. Retrieved 12 August 2008 from 〈http://europa.eu/scadplus/leg/en/lvb/l27067.htm〉.

European Parliament, 2001. Report on the Commission Green Paper: towards a European strategy for the security of energy supply. (COM (2000) 769-C5–0145/2001—2001/2071(COS)), Committee on Industry, External Trade, Research and Energy. Giles Chichester, Rapporteur, 17 October. Retrieved 13 October 2008, from 〈http://www.europarl.europa.eu/activities/plenary/reports/sidesSearch.do#〉.

Goodin, R.E., Rein, M., Moran, M., 2006. The public and its policies. In: Moran, M., Rein, M., Goodin, R.E. (Eds.), The Oxford Handbook of Public Policy. Oxford University Press, Oxford, pp. 3–35.

Grant, I., 2008. Energy, security and geopolitics: could someone please tell us what we mean? Paper presented to the Second IAEE Asian Conference, Perth, Australia, 5–7 November. Retrieved 18 February 2008 from 〈http://www.business.curtin.edu.au/business/research/conferences/2nd-iaee-asian-conference/other-conference-papers〉.

Greenpeace International, 2007. The Economics of Nuclear Power. Greenpeace International, Amsterdam.

Gupta, E., 2008. Oil vulnerability index of oil importing countries. Energy Policy 36 (3) (March).

Houssin, D., 2007. Security of energy supplies in a global market. Speech by IEA Director Office of Oil Markets and Emergency Preparedness to 2nd Energy Forum, Prague, 4–6 November.

International Energy Agency (IEA), 1985. Energy Technology Policy. OECD/IEA, Paris.

International Energy Agency (IEA), 1995. The IEA Natural Gas Security Study. OECD/IEA, Paris.

International Energy Agency (IEA), 2002. Energy Security. OECD/IEA, Paris.

International Energy Agency (IEA), 2004. Energy Security and Climate Change Policy Interactions: An Assessment Framework, OECD/IEA, Paris (December).

International Energy Agency (IEA), 2007a. Energy Security and Climate Policy: Assessing Interactions. OECD/IEA, Paris (March).

International Energy Agency (IEA), 2007b. Contribution of Renewables to Energy Security: IEA Information Paper. OECD/IEA, Paris (April).

International Energy Agency (IEA), 2008a. Key World Energy Statistics 2008. OECD/IEA, Paris.

International Energy Agency (IEA), 2008b. World Energy Outlook 2008. OECD/IEA, Paris (November).

Isbell, P., 2007. Security of supply. Oxford Economic Forum, November 71, 3–6.

Jansen, J.C., van Arkel, W.G., Boots, M.G., 2004. Designing indicators of long term security. ECN-C—04–007. Energy Research Centre of the Netherlands. Petten: January. Retrieved 14 December 2008 from 〈http://www.ecn.nl/publications/Default.aspx?pu=bs&yr=2004〉.

Jenny, F., 2007. Energy security: a market oriented approach. Presentation to OECD Forum on Innovation, Growth and Equity, Paris, 14–15 May. Retrieved 14 December 2008 from 〈http://www.oecd.org/document/56/0,3343,en_21571361_37578380_38248376_1_1_1_1,00.html〉.

Joint Energy Security of Supply Working Group (JESS) (2002), First Report, June, London, Department of Trade and Industry.

Joint Energy Security of Supply Working Group (JESS) (2006), Long-term security of energy supply, December, London, Department of Trade and Industry December.

Kalicki, J.H., Goldwyn, D.L. (Eds.), 2005. Energy and Security: Toward a New Foreign Policy Strategy. Woodrow Wilson Press, Washington.

Kruyt, B., van Vuuren, D.P., de Vries, H.J.M., Groenenberg, H., 2009. Indicators for energy security. Energy Policy 37(6), 2166–2181.

Löschel, A., Moslener, U., Rübbelke, D.T.G., 2009. Indicators of energy security in industrialised countries. Energy Policy, in press.

Marquina, A. (Ed.), 2008. Energy security: Visions from Asia and Europe. Palgrave Macmillan, Houndsmill, Basingstoke.

Martin, W.F., Harrje, E.M., 2005. The International Energy Agency. In: Kalicki., J.H., Goldwyn, D.L. (Eds.), Energy and Security: Toward a New Foreign Policy Strategy. Woodrow Wilson Press, Washington, pp. 97–116.

McNeill, J.R., 2001. Something New Under the Sun: An Environmental History of the Twentieth-Century World. W.W. Norton & Company, New York.

Moran, D., Russell, J.A. (Eds.), 2009. Energy Security and Global Politics: The Militarization of Resource Management. Routledge, Abingdon, Oxon.

Moseley, F., 1988. Introduction. International Journal of Political Economy 18 (2), 3–9.

Müller-Kraenner, S., 2008. Energy Security: Re-measuring the World. Earthscan, London.

Naughten, B., 2008. Asia's rising complex energy interdependence. International Journal of Global Energy Issues 29 (4), 400–433.

Neumann, A., 2007. How to measure security of supply? Posted 9 September. Retrieved 29 June 2008 from 〈http://www.energypolicyblog.com/?p=55〉.

Noël, P., 2008. Is energy security a political, military or market problem? An online Q & A in The Financial Times, 10 January. Retrieved on 16 August 2008 from 〈http://www.ft.com/cms/s/2/fd6ef84a-bf85-11dc-8052-0000779fd2ac.html〉.
Nuclear Energy Agency, 2003. Nuclear Energy Today. OECD/NEA, Paris.
Rittel, H.W.J., Webber, M.M., 1973. Dilemmas in a general theory of planning. Policy Sciences 4 (2), 155–169.
Scheepers, M., Seebregts, A., de Jong, J., Maters, H., 2006. EU Standards for Energy Security of Supply. ECN-C-06-039/CIEP. ECN Clingendael International Energy Programme, The Hague, June.
Scheepers, M., Seebregts, A., de Jong, J., Maters, H., 2007. EU standards for energy security of supply: updates on the crisis capability index and the supply/demand index quantification for EU-27. ECN-C-06-039/CIEP. ECN Clingendael International Energy Programme, The Hague, April.
Stern, J., 2002. Security of European natural gas supplies: the impact of import dependence and liberalization. Chatham House Report, July. Retrieved 2 July 2008 from 〈http://www.chathamhouse.org.uk/publications/papers/view/-/id/58/〉.
Stern, J., 2007. European gas security: what does it mean and what are the most important issues. Presentation to CESSA Conference, 14 December 2007, Cambridge. Retrieved 6 July 2008 from 〈http://www.energypolicyblog.com/?p=110〉.
Stirling, A., 1998. On the economics and analysis of diversity. SPRU Electronic Working Paper Series, Paper No. 28, December. Retrieved 23 July 2008 from 〈http://www.sussex.ac.uk/Units/spru/publications/imprint/sewps/sewp28/sewp28.pdf〉.
Thomas, S., 2008. Can nuclear power plants be built in Britain without public subsidies and guarantees? Public Services International Research Unit, University of Greenwich, London: March.
Toichi, T., 2003. Energy security in Asia and Japanese policy. Asia-Pacific Review 10 (1), 44–51.
Tönjes, C., de Jong, J., 2007. Perspectives on security of supply in European natural gas markets. Working Paper. Clingendael International Energy Program, The Hague, August.
United Nations Development Program (UNDP), 2000. World Energy Assessment: Energy and the Challenge of Sustainability. UNDP, New York.
United Nations Development Program (UNDP), 2004. World Energy Assessment: Overview 2004 Update. UNDP, New York.
van Doren, P., 2006. 'Energy & security: toward a new foreign policy strategy. In: Kalicki, Jan H., Goldwyn, David L. (Eds.) - Book Review'. The Energy Journal 27, 2006, pp. 182–187.
Wesley, M. (Ed.), 2007. Energy Security in Asia. Routledge, London.
World Economic Forum, 2006. The new energy security paradigm. Energy Vision Update, Spring, World Economic Forum, Geneva: Retrieved 14 December 2008 from 〈http://www.weforum.org/pdf/Energy.pdf〉.
Wright, P., 2005. Liberalisation and the security of gas supplies in the UK. Energy Policy 33 (17), 2272–2290.
Yergin, D., 2005. Energy security and markets. In: Kalicki, J.H., Goldwyn, D.L. (Eds.), Energy and Security: Toward a New Foreign Policy Strategy. Woodrow Wilson Press, Washington, pp. 51–64.
Youngs, R., 2007. Europe's external energy policy: between geopolitics and the market. CEPS Working Document No. 278/November. Centre for European Policy Studies, Brussels. Retrieved on 14 April 2008 from 〈http://shop.ceps.eu/BookDetail.php?item_id=1560〉.