Mitteilungen der Österreichischen Geographischen Gesellschaft,
152. Jg. (Jahresband), Wien 2010, S. 11–28

Themenschwerpunkt „Kernfragen der globalen Raumentwicklung“

In Search of a New Energy Paradigm: Energy Supply, Security of Supply and Demand and Climate Change Mitigation

Michael J. Bradshaw, Leicester*

with 4 Fig. and 1 Table in the text

Contents

Zusammenfassung

Auf der Suche nach einem neuen Energie-Paradigma: Energieversorgung, Versorgungssicherheit und Nachfrage, Dämpfung des Klimawandels

Schon vor der Katastrophe beim Macondo-Erdölfeld im Golf von Mexiko im April 2010 war zunehmend zu erkennen, dass der globale Energiebedarf immer schwerer und kostenaufwändiger zu decken sein wird. Dieser Beitrag befasst sich mit zwei zusammenhängenden Sachverhalten: dem Entstehen eines neuen Paradigmas zur Energiefrage und der Globalisierung des Energiebedarfs. Das neue Energie-Paradigma bezieht sich auf die Tatsache, dass die Frage der Versorgungssicherheit mit Energie heute in den weiteren Zusammenhang des Klimawandels und der Notwendigkeit den weltweiten Ausstoß von Treibhausgasen entscheidend zu reduzieren gestellt wird. Das

* Michael J. Bradshaw, Prof. PhD., Department of Geography, University of Leicester, University Road, Leicester, LE1 7RH, U.K.; E-mail: mjb41@le.ac.uk; *http://www.le.ac.uk/geography/staff/academic_bradshaw.html*

globale Energieversorgungssystem werde sich infolgedessen von fossilen Brennstoffen zu weniger karbonhaltigen Alternativen hin bewegen müssen, also zu erneuerbaren Energiequellen und zur Nuklearenergie. Unsere Analyse legt nahe, dass es immer noch unklar ist, wie dieser Übergang zu Alternativen mit weniger Karbongehalt erreicht werden soll. Sie zeigt auch auf, dass dieser Übergang die globale Energieversorgung vor neue Probleme stellen wird; dies besonders deshalb, weil eine Globalisierung des Energiebedarfs bedeutet, dass der Großteil des künftiges Bedarfszuwachses auf die Entwicklungsländer entfallen wird, angetrieben von wachsenden Volkswirtschaften wie jenen von China, Indien und Brasilien. Wenn der Süden bei einer Reduktion der Treibhausgase weiter wirtschaftlich wachsen soll, wird es der Kooperation zwischen dem Norden und dem Süden bedürfen. Der Norden wird Kapital und Technologie zur Verfügung stellen müssen, um dem Süden den sicheren Zugang zur Energie zu verschaffen, die dieser benötigt, um sein wirtschaftliches Wachstum aufrechtzuerhalten ohne dass auf fossile Brennstoffe und die mit ihnen verbundenen Kohlenemissionen zurückgegriffen werden muss. Das abschließende Kapitel befasst sich mit der Frage, was dieses „globale Energiedilemma" (die schwierige Vereinbarkeit von Versorgung mit sicherer und leistbarer Energie mit der Reduktion von Kohlenemissionen) für die Energiepolitik der Europäischen Union bedeutet.

Summary

Even before the disaster at the Macondo field in the Gulf of Mexico in April 2010, there was growing recognition that it was getting increasingly difficult and costly to meet the growing global demand for energy. This paper focuses on two related issues: the emergence of a new energy paradigm and the globalization of energy demand. The new energy paradigm refers to the fact that the contemporary concern for energy security is set within the wider context of climate change and the need to reduce significantly global emissions of greenhouse gases (GHG). As a consequence, the global energy system needs to move away from fossil fuels to lower carbon alternatives, namely renewable and nuclear energy. The analysis suggests that it is still unclear how this low carbon energy transition will be achieved. Further, it maintains that such a transition will pose new challenges to global energy security. This is particularly so because the globalization of energy demand means that the bulk of future energy demand growth will come from the 'developing world', driven by emerging economies such as China, India and Brazil. To enable the global South to continue to grow, while reducing GHG emissions will require cooperation between North and South. The North will need to provide capital and technology to enable the South to secure access to the energy needed to power economic growth, without increasing demand for fossil fuels and their associated carbon emissions. The final section considers what this 'global energy dilemma' (the need to provide secure and affordable access to energy services while reducing carbon emissions) means for European Union energy policy.

1 Introduction: Setting the scene

On April 20th 2010, while conducting drilling operations on the Macondo well in the Gulf of Mexico, the drilling rig Deepwater Horizon caught fire and exploded and subsequently sank, eleven workers on the platform were killed and 19 others injured. The failure of the blowout preventer resulted in the leakage of crude oil causing widespread environmental damage to the Gulf coast. The precise volume of oil leaked and the final cost of the clean up remain unknown, although the operator of the well, the International Oil Company (IOC) BP, has already set aside $ 32.2 billion and in the first quarter of 2010 recorded record losses of $ 17 billion due to the disaster (BBC News, 27 July 2010). The Deepwater Horizon was operating 40 miles southeast of the Louisiana coast in about 5,000 feet (1,500 metres) of water and the exploratory well completed was to a depth of 18,000 feet (5,486 metres) below the seabed (EPRINC 2010). Attempts to stem the leak were complicated by the fact that the wellhead is far beyond the operating depth of divers and can only be accessed by remotely controlled subsea robots. President Obama has held BP responsible for the disaster and BP have promised to make good all of the damage caused by the incident. While there has been public outcry in the United States, more informed observers recognise the disaster as the inevitable cost of the country's thirst for energy and its desire to source as much oil and gas from domestic sources as possible. In fact, just weeks before the loss of the Deepwater Horizon, President Obama had signed legislation allowing extensive oil and gas exploration in previously protected offshore areas, all in the name of 'energy independence.'

Stepping back from these events, the pursuit of oil (and gas) in increasingly difficult, costly and risky conditions is the story of the 'end of easy oil' and the pursuit of what Michael Klare (2010) calls 'extreme energy'. The International Energy Agency (IEA 2009, p. 42) predicts that, on the basis of current policies, by 2030 fossil fuels will still account for more than two-thirds of the world's primary energy and that oil production will have to increase from 85 million barrels per day in 2008 to 105 mb/d in 2030 (previous IEA estimates were much higher at 130 mb/d by 2030). However, there is a growing school of thought, associated with the notion of 'Peak Oil' (Campbell & Laherrère 1998, Deffeyes 2005, Hirsch et al. 2005) that the oil industry will soon hit its maximum rate of production and that thereafter levels may fall quite rapidly, never coming close to 100 mb/d (for a recent review of the evidence see Sorrel et al. 2010). Although this view is hotly contested, mainly by the oil industry, there is growing recognition that in the short-term we may face an energy crunch not because of a lack of oil reserves, but because the recent global economic recession has depressed investment in new oil and gas production and, as will be discussed below, new sources of demand in the emerging economies will place a strain on supplies, potentially forcing prices to new highs (for an alternate view see Morse 2009). In the longer term, it is now accepted that maintaining, let alone substantially increasing, global oil and gas production is going to be far more costly and take more time than was previously the case, particularly if the aftermath of the Deepwater Horizon disaster places further constraints and added costs on offshore oil and gas exploration and development. Even before the events in the Gulf of Mexico, there was already heightened concern about the security and affordability of future energy supplies.

For many, the current problems afflicting the oil and gas industry are proof positive of the need to move beyond the 'petroleum age' to a new energy future based on renewable and low(er) carbon sources of energy (LEGGETT 2006). The sustainability of the current energy system is not just called into question by concerns about the ability to maintain volumes of production, it is now widely accepted that the combustion of fossil fuels is the major source of anthropogenic carbon dioxide emissions. According to BAUMERT et al. (2005, p. 41): "61 percent of greenhouse gases (and almost 75 percent of all CO_2) stem from energy related activities, with the large majority coming from fossil fuel combustion." The United Nations' Intergovernmental Panel on Climate Change (IPCC 2007, pp. 2 and 5) states that: "Warming of the climate system is unequivocal" and that "Most of the observed increase in global average temperatures since the mid-20th Century is *very likely* (emphasis in the original) due to the observed increase in anthropogenic GHG concentrations." Thus, the current fossil fuel based global energy system is at the centre of the processes that are causing climate change; therefore, any attempt to mitigate climate change must address the energy system.

In their 2008 *World Energy Outlook*, the IEA (2008, p. 3) observed that the: "World's energy system is at a crossroads. Current global trends in energy supply and consumption are patently unstable – environmentally, economically, socially." As a consequence, according to the IEA (2008, p. 46): "the future of human prosperity depends on how successfully we tackle two central energy challenges facing us to today: security of supply of reliable and affordable energy; and effecting a rapid transformation to a low-carbon, efficient and environmentally benign system of energy supply." In the developed industrial economies, energy policy is no longer just focused on matching supply with demand, it is about promoting low(er) carbon sources of supply and reducing demand through the promotion of energy efficiency. Thus, as MÜLLER-KRAENNER (2007, p. 17) has observed, the world is confronted by a 'double energy crisis', maintaining and managing the current fossil fuel system to meet short and medium-term needs, on the one hand, and, on the other, developing a future low carbon system that will stabilize and then reduce GHG emissions to avoid catastrophic climate change. This is the essence of the 'global energy transition' from a high carbon fossil fuel system to a low carbon system based on renewable energy and low(er) carbon nuclear power and fossil fuel use with carbon capture and storage (CCS). But this global transition harbours many 'transitions' that will combine to bring about the new energy system that is required (elsewhere I have described the challenge of transition as the Global Energy Dilemma, see BRADSHAW 2010). Previous transitions where driven by the utilisation of new resources and new technologies that delivered increasingly efficient, both economically and thermodynamically, means of delivering energy services (SMIL 1994, PODOBNIK 2006). From the industrial revolution onwards oil followed coal and gas followed oil. Technological change and market forces drove from below the processes of transition as industry and consumers adopted the new fuels because they were more efficient and flexible. Today all of these fuels are still very much part of the global energy mix. However, the coming energy transition will be very different, it will involve the adoption of new sources of energy supply that are less efficient than fossil fuels, but are environmentally benign. Low(er) carbon energy will enviably be more costly and will require a top down approach and may require carbon taxes and trading schemes, renewable obligations and subsidies to encourage industry and consumers to eschew high carbon sources of energy services. In other words, it is highly unlikely that market forces alone will drive the transition; the state will need to intervene. The scale of this challenge is unprecedented, as NEWELL & PATERSON (2010, p. 1) note: "In response to climate change, we have the first instance of societies collectively seeking a dramatic transformation of the entire global economy."

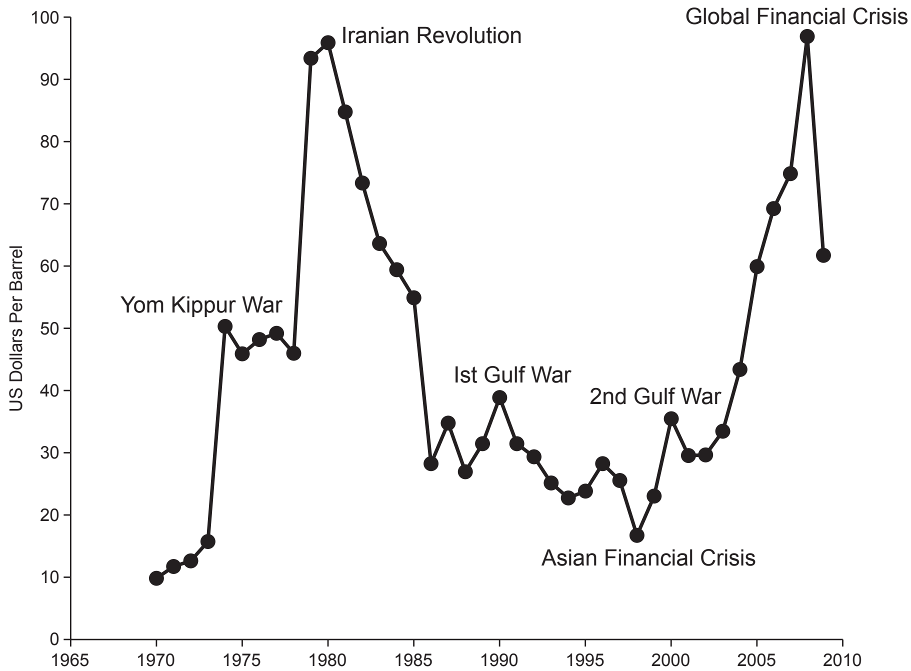
In the remainder of this essay I will focus on two issues that are at the heart of the global energy transitions that are currently underway: the emergence of a new energy paradigm and the globalization of energy demand. The focus of the discussion is more on the short-term challenges to the integrity of the fossil fuel system, rather than the development of the low carbon economy, but, as we shall see, they are intertwined with the climate change agenda. By way of a conclusion, the last section of the paper considers the implications of the discussion for European energy strategy.

2 A new energy paradigm

The contemporary concern for energy security dates back to the 1970s when the Organization of Petroleum Exporting Countries (OPEC) used control over oil production to punish the United States and it allies for siding with Israel in the Yom Kippur war.

The OPEC embargo proved short-lived and counterproductive as it tipped the global economy into recession, depressing demand for oil (see Fig. 1). However, the actions of OPEC prompted the western industrially developed economies, as represented by the Organization for Economic Development and Cooperation (OECD), into concerted action and the IEA was created in 1973–74. Its initial role being to co-ordinate measures in times of oil supply emergencies. In the aftermath of the resource crisis of the 1970s, the concept of energy security was to guarantee secure, reliable and affordable supplies of energy, with the emphasis very much on the interests of energy importing states. In response to high oil prices, the OECD nations promoted energy efficiency and sought out indigenous supplies of oil and gas. High oil prices and technological progress made it economic to develop oilfields offshore in the Gulf of Mexico, in the remote regions of Alaska and in the North Sea. Consequently, during the 1980s and 1990s energy security ceased to be a concern as there was plentiful supply and prices returned to pre-crisis levels, even the Iraqi invasion of Kuwait and the subsequent first Gulf War failed to trigger a period of sustained oil price increase and the Asian Financial crisis in the late 1990s further depressed prices. The oil industry responded by cutting investments and a spate of cost cutting mergers saw the emergence of the supermajors: BP-Amoco, Conoco-Phillips, Chevron-Texaco, Exxon-Mobil, Shell and Total-Fina-Elf. However, by the turn of the Century things in the global energy economy were starting to change.

The UN Conference on Environment and Development (Earth Summit) took place in Rio de Janeiro in June 1992 and firmly placed the issue of sustainable development



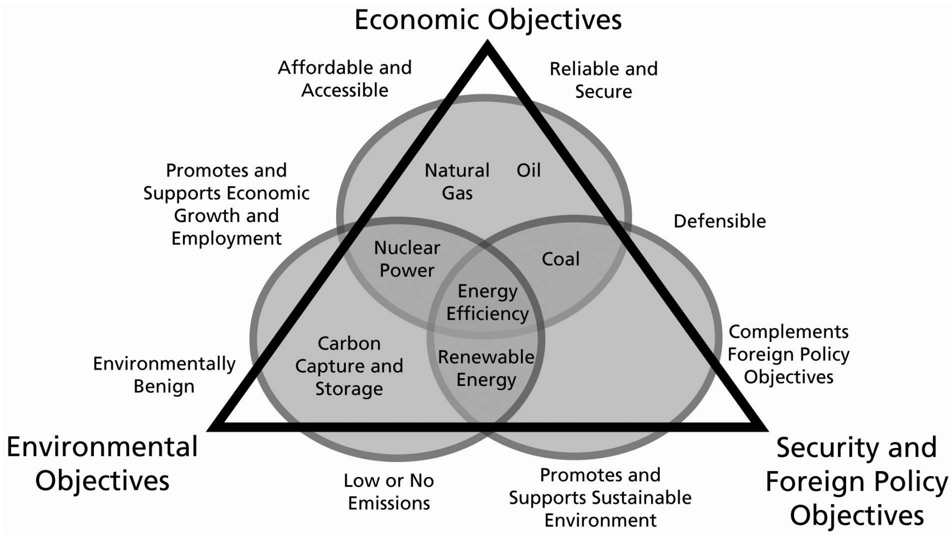
Source: BP 2010a, p. 16

Fig. 1: Average crude oil prices 1970–2010 (in $ 2009)

on the global policy agenda. Even before that, in 1988 the IPCC was first tasked with producing a comprehensive review of knowledge about climate change and its first assessment report was published in 1990. The second IPCC assessment was published in 1995 and provided the impetus for the adoption of the Kyoto Protocol in 1997, although it did not come into force until 2005. By the time the fourth IPCC assessment report was published in 2007 it was widely accepted, as noted above, that human actions were causing climate change and that drastic action was required to reduce our reliance on fossil fuels (GORE 2006). Somewhat fortuitously, this environmental awakening in the first decade of the 21st Century was paralleled by a rapid increase in energy prices (see Fig. 1), although the associated economic boom also increased global carbon emissions at a faster rate than predicted. This time the trigger was not military conflict, but a combination of the failure of global production to keep up with the rapid growth in demand, as well as the 'financialisation' of oil as a commodity (LABBAN 2010). Policy makers ascribed a host of 'above the ground' factors to explain the failure of production to keep up with demand. According to the United States Energy Information Agency (EIA 2010, p. 2), these "constraints refer to those nongeological factors that might affect supply, including: government policies that limit access to resources; conflict; terrorist activity; lack of technological advances or access to technology; price constraints on the economical development of resources; labour shortages; materials shortages, weather; environmental protection actions; and other short- and long-term geopolitical considerations." Among those geopolitical factors was the fact that the governments of the resource holding states were now firmly in control of their oil and gas reserves (Vivoda 2009). In some instances IOCs assets had been nationalized and they were then shut out of future investments. Elsewhere, the states favoured their own National Oil Companies (NOCs), who have entered into joint ventures with the IOCs and also the NOCs of energy importing countries, particularly China. As a consequence, the IOCs now find themselves having to develop the more remote and challenging oil and gas fields, where their financial and technological strengths enable them to bring resources to market that are beyond the reach of the NOCs. All of these actions, combined with growing concern about climate change mean that energy security is a much more complex notion than the idea of 'security of supply' that dominated the 1970s (IEA 2007, Chester 2009).

Today, the IEA defines energy security as: "the uninterrupted physical availability [of energy] at a price which is affordable, while respecting environment concerns." (IEA 2010) Recognising the changing situation, the mandate of the IEA has broadened to incorporate the "Three E's" of balanced energy policy making: energy security, economic development and environmental protection. Nonetheless, the energy-exporting states maintain that the IEA (and along with it the US and EU) is still too concerned with 'security of supply', and fails to acknowledge their need for 'security of demand.' States that have substantial oil and gas supplies want to be sure that there will be future demand for their production at an acceptable price before they will sanction investment in new fields and export infrastructure. Clearly, energy security means different things to different states depending where they are located in the global energy production network (Bradshaw 2009). In Europe, most recently there have been concerns about 'security of transit' as disputes between Russia and Belarus, Moldova and Ukraine have disrupted supplies of oil and gas from Russia (Pirani et al. 2009). More fundamentally, there are obvious contradictions and tensions in this rather simple notion of energy security. Is it possible to have secure energy supplies that are affordable and that, at the same time, are environmentally benign? Clearly what is required is a more sophisticated understanding of energy security, what I will call a 'new energy paradigm' (see also World Economic Forum 2006, Helm 2007 and Varrastro & Ladislaw 2007, Nuttall & Mantz 2008).

This new energy paradigm recognises that while the delivery of secure and affordable energy services is essential for economic development, the supply of those services must not compromise the environment, either through local disruption or by contributing to global ecosystem change. However, at the same time, because the energy production network is global in scope and no country is totally 'energy independent', energy security is also the realm of foreign policy, what one might call 'energy diplomacy.' Increasingly, energy security is also seen as a military security issue, both in the sense that secure supplies of energy are essential to prosecute war (the US military consumers more energy than many states) and also because military force may been needed to protect vital energy infrastructures (for example, against pirates in the Straits of Hormuz). Figure 2 illustrates the multi-dimensional nature of the new energy (security) paradigm, the three axes relate to the objectives of energy policy, that equate to the IEA's three E's. At the top is the economic objective whereby energy



Source: VERRASTRO & LADISLAW 2007, p. 102

Fig. 2: A new energy paradigm

supply is secure and affordable and therefore does not jeopardise economic growth; the second axis is an environmental objective that is low carbon and benign; and on third axis are security and foreign policy objectives that align energy diplomacy with foreign policy and wider security objectives. Various energy sources and technologies are then located within this economy-environment-security nexus.

The relative location of particular energy sources and technologies in this virtual space is open to debate. For example, I would question to the location of coal relative to oil. Coal is more ubiquitous than oil and many of the rapidly growing economies, such as China and India, have substantial coal resources. Yet, burning coal to generate electricity produces more CO_2 than oil and oil produces more than gas (oil is now seldom used for power generation). Thus, from an economic and energy security perspective, it makes more sense to burn more domestic coal than import more expensive and insecure oil and gas. This is precisely what China and India have been doing, but is also what the United States has done! China is also a major importer of coal, as its railway system cannot move sufficient coal from producing regions in the interior to the coastal where most of the demand is located. Whatever the precise locational coordinates of the various elements, this schematic is a useful heuristic device as it pulls together the key elements shaping energy policy today. The schematic also suggests that the current situation is more affordable and secure than the road to a low carbon future (WATSON 2009).

The last 40 years have seen a dramatic transformation of the global energy production network, but the changes that will need to take place over the next 40 years are nothing short of revolutionary. The transition to a low carbon energy system is a task equal to the industrial revolution of the 19th Century. At present, most policy

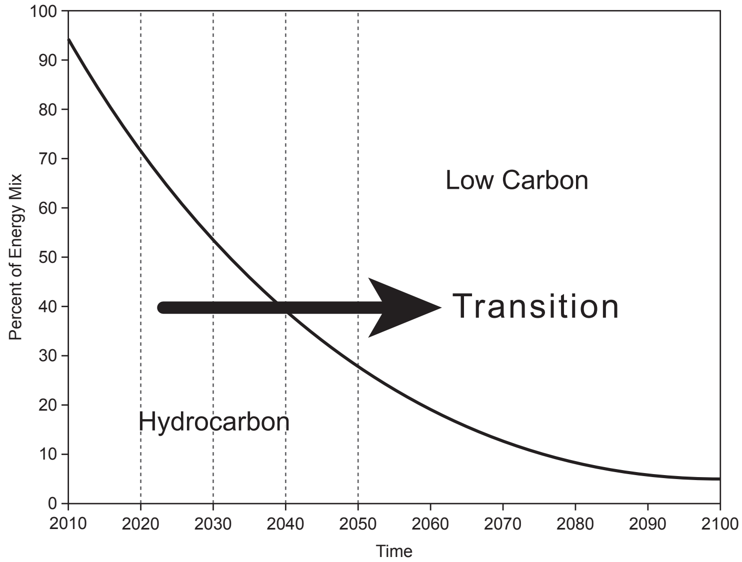


Fig. 3: The low carbon energy transition

statements, driven by the demands of climate science, have a clear sense of where we need to go. For example, by 2050 the developed economies need to have reduced their carbon emissions by 80 percent if we are to stand a chance of limiting global warming to 2°C. We are also told that the technologies already exist to bring about this transition, though many of them are not commercially proven. What is missing is a clear understanding of how that transition will be orchestrated. What role should the state play, what role should the private sector play, can the market deliver the needed changes? Where will the necessary investment come from? From an energy security perspective, there seems to be an underlying assumption that a future low carbon energy system will be more secure, but why should this be the case? Who will control the technologies and raw materials required to manufacture wind turbines and solar panels (Rowe 2009)? Rather the energy security challenges in the low carbon future will be different. Hence there is a need to formulate an understanding of energy security during transition (for recent book-length treatments of energy security see: Kalicki & Goldwyn 2005, Müller-Kraenner 2007, Chevalier 2009, Youngs 2009 and Pascual & Elkind 2010.)

Figure 3 provides a simple conceptualisation of the low carbon energy transition. The early stages of the transition, the period that we are about to embark on, are potentially the most complex. Over the next 10–20 years the world will continue to be dominated by the energy security concerns of the fossil fuel system; but, at the same time there will be new concerns generated by the growth of renewable and low(er) carbon energy sources. For example, there are already worries about access to the Lithium needed for rechargeable batteries and the rare earth metals required by wind turbines (Froggatt & Lahn 2010, pp. 20–21). As we enter the final decades of the petroleum age, renewable energy may generate an increasingly large share of the world's energy mix; but it is clear that the end of oil is unlikely to be a peaceful exit (Klare 2008). What will happen to those states whose economic prosperity is entirely dependent upon the export of oil and gas? The simple point is that transition, of any kind, is never a straightforward process and it demands that we develop new ways of thinking about energy security. To date, writing on energy security has not only been dominated by the fossil fuel system (and by oil more than gas), but it has also focused on the interests of established consumers in the developed world. Any new energy paradigm must not only recognise new sources of insecurity associated with the low carbon transition, but it must also recognise the rights and needs of new energy consumers in the developing world.

3 The globalisation of energy demand

In late 2009, Daniel Yergin, author of the Pulitzer Prize winning history of the oil industry *The Prize* (Yergin 2008) was asked to reflect on the changes that had taken place since the book as first published in 1991. Yergin (2009, p. 92) observed that one characteristic of the new age is that oil now has a split personality – it is both a physical commodity and a financial asset. He then went on to identify three other defining characteristics of the new age: the globalisation of demand for oil, the rise of climate change as a political factor shaping how we will use oil and the drive for new technologies that could dramatically affect future demand for all. The last two characteristics have been discussed above; it is the globalisation of energy demand that is the focus of this section. As Yergin (2009, p. 92) notes, globalization of supply is a familiar story, but "what is decisively new is the globalization of demand" (see Table 1).

In the commentary to their 2009 *Statistical Review of World Energy* (Rühl 2009, p. 2), BP noted that for the first time in 2008 non-OECD primary energy consumption exceeded OECD consumption. This is because energy demand in the developed industrial economies of the OECD is stagnant, while the emerging and developing economies of the non-OECD are experiencing a rapid growth in energy demand. In fact, the US consulting company IHS-CERA maintains that OECD oil demand actually peaked in 2005 (IHS 2010). The reasons for this are: socioeconomic and demographic changes, which among other things means that vehicle ownership has reached saturation point, a stronger governmental and consumer push for passenger vehicle fuel economy gains, and greater penetration of alternative fuels and vehicle technologies. Furthermore, the 2008–09 global economic crisis hit the OECD economies particularly hard, further depressing demand for energy. In fact, during 2009 the global economy contracted by 2 percent, with the OECD falling by 3.4 percent, but the non-OECD economies actually grew by 2.4 percent (Rühl 2010a, p. 1). Consequently, in 2009 global energy consumption globally fell by 1.1 percent, but in the OECD it fell by 5 percent, while non-OECD consumption grew by 2.7 percent, more than the rate of economic growth. The 5 percent fall in the OECD 30 countries means that in 2009 they

	1970	in %	1980	in %	1990	in %	2000	in %	2009	in %
North America	1805.1	36.4	2109.6	31.9	2316.0	28.6	2747.3	29.7	2664.4	23.9
S. & Cent. America	142.6	2.9	249.3	3.8	321.2	4.0	456.9	4.9	562.9	5.0
Europe & Eurasia	2133.9	43.0	2823.4	42.7	3186.4	39.4	2797.2	30.2	2770.0	24.8
Middle East	73.6	1.5	136.4	2.1	260.6	3.2	407.4	4.4	659.0	5.9
Africa	73.5	1.5	142.6	2.2	224.9	2.8	279.4	3.0	360.8	3.2
Asia Pacific	728.9	14.7	1157.3	17.5	1787.4	22.1	2571.4	27.8	4147.2	37.1
Total World	**4957.5**	**100.0**	**6618.6**	**100.0**	**8096.5**	**100.0**	**9259.6**	**100.0**	**11164.3**	**100.0**
OECD	3432.1	69.2	4123.2	62.3	4578.9	56.6	5352.4	57.8	5217.1	46.7
Non-OECD	1525.4	30.8	2495.5	37.7	3517.7	43.4	3907.2	42.2	5947.2	53.3

Source: BP 2010

Table 1: Changes in the geography of global primary energy consumption[1)] (million tons of oil equivalent)

consumed less energy than they did 10 years ago, even though their economies have grown by 18 percent since then (RÜHL 2010a, p. 1). This reflects a long-term trend of increasing energy intensity as more and more economic output is produced per unit of energy consumed. However, over the same decade the economies outside the OECD grew by 75 percent and their energy consumption grew by 57 percent (RÜHL 2010a, pp. 1–2). Geographically, energy consumption growth was concentrated in the Middle East and the Asia-Pacific regions. As Table 1 shows, the net result was that non-OECD's share of total primary energy consumption in 2009 increased to 53.3 percent.

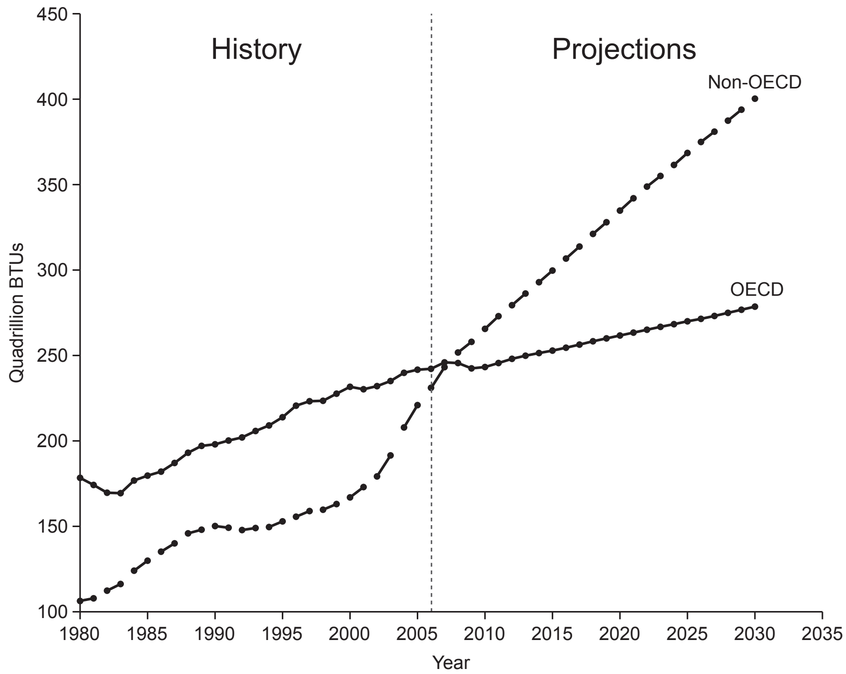
As the global economy climbs out of recession is it increasingly clear that the geography of global energy demand is experiencing a permanent shift away from the developed economies of the global north to the emerging and developing economies of the developing south. MITCHELL (2010) has offered an alternative analysis to the OECD/non-OECD divide that reveals the eastward shift of what he calls 'the oil deficit' (the balance between supply and demand) as a consequence of growing demand in the Asia-Pacific region. MITCHELL (2010, p. 10) notes that historically the Atlantic region has been the basis of the world oil market and "there is an active, free oil trade between countries, with a unified price structure based on commodity markets in London and New York." The Asia-Pacific, he maintains, is rather different, Asia is a price-follower and imports to China, India and Indonesia are mainly in the hands of state-owned or state-controlled companies. Overall, according to MITCHELL's analysis, the Atlantic region is far more self-sufficient than the Asia-Pacific; half of the Atlantic region's imports are from other countries in the region; and the Asia-Pacific region depends

1) Primary energy comprises commercially traded fuels only. Excluded, therefore, are fuels such as wood, peat and animal waste, which, though important in many countries, are unreliably documented in terms of consumption statistics. Also excluded are wind, geothermal and solar power generation.

far more on supplies from the Middle East than the Atlantic region does. Given what we have already said about the decline of OECD production (whose members are primarily in the Atlantic region) and the growth of demand in the Asia-Pacific region; it follows that the size of the Asia-Pacific oil deficit will continue to grow and will eventually outgrow the ability of the Middle East to supply it. MITCHELL (2010, p. 11) concludes: "By 2030 a quarter of the Asia-Pacific deficit will be met from outside the Middle East – essentially with West Africa – with some supplies from eastern Russia and Central Asia." Already NOCs from China are seeking access to new oil reserves in Sub-Saharan Africa and more recently Latin America. Increasingly, consumers in the Atlantic region will have to compete with consumers in the Asia-Pacific region for purchases of oil. Natural gas is a different matter, but there are also signs there of an integration of the Atlantic and Pacific basins to create a global gas market. The geo-political and economic implications of this global shift are clear, the global oil market is shifting from a system dominated by private companies and commodity markets to one where NOCs and state-to-state agreements will play an ever-increasing role, or put another way, the oil market will account for a diminishing share of the oil produced.

Projections produced by the IEA (2009a) and the EIA (2009, 2010) predict the rapid growth of future energy production in the non-OECD world and in the Middle East and Asia Pacific in particular. Figure 4 illustrates the reference case (business as usual) scenario in the EIA's *International Energy Outlook 2009* and clearly demonstrates the very different energy demand trajectories of the developed (OECD) and developing (non-OECD) worlds. According to their most recent *International Energy Outlook 2010* (EIA 2010, p. 1), their reference case suggests that world marketed commercial energy will increase by 49 percent from 2007 to 2035, but in the non-OECD the level of increase will be 84 percent, compared to an OECD increase of only 14 percent. The net result is that by 2035 the non-OECD will account for 62 percent of total global primary energy consumption (EIA 2010, p. 131). The IEA's *World Energy Outlook 2009* predicts much the same pattern with total primary energy demand increasing by 40 percent between 2007 and 2030, China and India are identified as the main drivers of growth. As noted above, the IEA predicts that global oil demand will reach 105 mb/d in 2030 and that all of the future growth in oil demand will come from the non-OECD with OECD oil demand falling. What is more worrisome is that they see demand for coal growing more strongly than any other resource. This is because growing Asian demand will be predominantly met by coal-fired power stations, and Asia will account for 97 percent of global incremental demand, and China alone will account for 61 percent of that growth (IEA 2009a, p. 89). As RÜHL (2010, p. 66) notes, as a consequence of surging demand in Asia, "Not only is more carbon being emitted throughout the world as economies grow and consume more energy, but the energy consumed itself is dirtier." It should be stressed that these projections are based on the reference case that assumes a continuation of existing government policies. It is highly likely that climate change concerns will seek to improve energy efficiency and curb fossil fuel consumption; however, such policies are likely to be more effective in the OECD states.

The implications of the globalisation of energy demand and the emergence of the Asia-Pacific as the centre future of growth for climate change mitigation are far reach-



Source: EIA 2009, p. 11

Fig. 4: World marketed energy consumption: OECD and Non-OECD, 1980–2030

ing. The moral and historical argument in relation to climate change policy runs that as the vast majority of the anthropogenic CO_2 currently in the atmosphere is a result of the industrialisation and economic growth of the developed world (IEA 2009b, p. 26), it follows that they should be the ones to shoulder the brunt of the costs of climate change. After all, they are also the ones most able to afford the measures necessary to mitigate future emissions. However, the analysis presented above shows that the majority of the future growth in energy related CO_2 emissions will originate in the non-OECD developing world (Non-Annex I countries that did not have emission reduction targets under the Kyoto Protocol). The EIA (2010a, p. 7) notes that in 2007 non-OECD CO_2 emissions exceeded the OECD by 17 percent (in that year China passed the US a the world's largest emitter of CO_2 from fuel combustion) and that by 2035 they are expected to be double the level of the OECD. The global economic crisis has offered a brief respite, as there was no growth in total CO_2 emissions in 2009, but paralleling the situation with energy demand growth, a 7 percent decline in the OECD countries and Russia, covered for 9 percent increase in China and a 6 percent increase in India (Olivier & Peters 2010, p. 3). The lack of a global agreement on climate change policy, which culminated in a failure to reach a binding international agreement at Copenhagen in late 2009, is a direct consequence of the shifting geographies of projected energy demand and CO_2 emissions. It is accepted that increased energy consumption goes hand in hand with economic growth, population increases and urbanisation (PIELKE 2010). Clearly, it is possible to improve the energy efficiency of economic growth and also to reduce its carbon intensity, but as RÜHL (2010b, p. 64) observes: "Energy intensity, the energy needed to produce one unit of GDP, in the developing world is three times as great as it is in the developed world." He goes on to conclude that: "Something will have to give over the next few decades: either energy efficiency will have to increase or growth in the emerging-market economies will slow down."

The developing economies do not want to see their rate of economic growth slow and thus see attempts by the OECD to get them to agree to reduce their CO_2 emissions as a threat to their future economic prosperity. Promises of financial assistance and technology transfer ring hollow as the G7 has failed to meet the promises made at the Gleneagles Summit in Scotland in 2005 to provide debt relief and assistance. The Copenhagen Accord calls for the developed countries to provide new and additional resources of US$ 30 billion for the period 2010–2012 and rising to US$100 billion by 2020 to assist the developing countries in mitigating CO_2 emissions. However, many OECD member states are facing large budget cuts and only time will tell if they can meet these new obligations. Although the Copenhagen Climate Change Negotiations failed to reach a binding agreement on emission reductions to replace the Kyoto Protocol that expires in 2012, to date 138 countries, including the 27 member EU, are likely to or have engaged with the Copenhagen Accord and together they account for 86.76 percent of global emissions (U.S. CLIMATE ACTION NETWORK 2010). The next meeting of the Committee of Parties (COP-16) will be in Cancun, Mexico in late 2010 and it is hoped that a binding post-Kyoto agreement can be reached. Any agreement will have to take account of the consequences of the globalisation of energy demand, but without such an agreement to provide a global governance framework, it will be very difficult to make meaningful progress towards a transition to a low carbon energy system (SOVACOOL & BROWN 2009). One positive factor is that because much of the future emissions are yet to come from the developing economy, where much of the generating capacity, energy infrastructure and passenger cars are yet to build, there is still an opportunity to invest in lower carbon and more efficient technologies. But that requires access to know-how and capital; hence the need for an agreement on north-south technology transfer and financial assistance, without which the developing economies may have no choice but to lock into current high carbon technologies making the reference case scenarios of the IEA and EIA the most likely future. If that happens, we face a future of increased competition and conflict over access to fossil fuels and the increased certainty of catastrophic climate change (DYER 2010, PASKAL 2010).

4 Conclusions: Implications for a European energy strategy

Despite the fact that two of the founding treaties of the European Union, Euratom and the European Coal and Steel Community, were concerned with the energy issues, energy security has traditionally been the responsibility of individual member states rather than the European Commission. Legislation relating to the functioning of the Single Market has given the EU some powers relating to energy markets and the Lisbon Treaty will give the EU more power to influence the energy policies of member states, but it still remains the case that when it comes to energy security national interests have precedent over Europe-wide solidarity. However, because the EU negotiates en mass on climate change, there is an obvious tension between the EU's desire to provide international leadership, on the one hand, and its inability to orchestrate a European Energy Strategy, on the other. Nonetheless, the EU has conducted two Strategic Energy Reviews and does have an 'EU Energy Security and Solidarity Action Plan.' At the centre of the EU's strategy are three interlocking energy objectives: sustainability, competitiveness and security of supply (these parallel the IEA's three E's) and three targets to be achieved by 2020: a 20 percent reduction in GHG emissions, achieved by increasing the share of renewables in energy consumption to 20 percent and a 20 percent improvement in energy efficiency. The Energy Security and Solidarity Action Plan focuses on five issues: infrastructure needs and the diversification of energy supplies, external energy relations, oil and gas stocks and crisis response mechanisms, energy efficiency and making the best use of the EU's indigenous energy resources.

The EU's concerns about security of supply have been triggered by the conflict between Russia and Ukraine that cut off gas supplies to European customers in 2006 and 2009. The EU's response has been to promote infrastructure development and market integration to make it easier to respond to such events in the future. At the same time, the EU is promoting alternative sources of gas supply through the expansion of Liquefied Natural Gas (LNG) and the development of a southern energy corridor based on the Nabucco pipeline. Events in Moscow [Moskva] and Kiev [Kiïv] have prompted some member states to strike bilateral agreements with Moscow and to support the Nordstream pipeline that will by-pass the Ukraine and Belarus. However, such a strategy does nothing to reduce reliance on gas imports from Russia. An alternative strategy has seen the development of energy relations with other suppliers of natural gas in the Middle East, North Africa, West Africa and the Caribbean. At present, depressed LNG prices mean that EU buyers are looking to substitute LNG purchases for imports of pipeline gas from Russia. Thus, current market conditions are enabling the EU to diversify its source of gas supply. Longer term the situation remains unclear and the EU needs to re-evaluate its energy security policies in light of the rapid development of unconventional gas supplies in North America. These have substantially increased US domestic gas production, resulting in a glut of gas on international markets. This has in turn forced conventional gas producers, such as Russia's Gazprom to postpone the development of expensive Arctic and offshore projects such as the Stokhman project in the Barents Sea. In the longer term, this could lead to a shortage in gas supplies in Europe if demand increases and domestic production continues to decline. There is no guarantee that the unconventional gas revolution will be transferred to Europe and North Sea production is in decline.

The EU's policy is to rely on market actors and the private sector to engage in energy trade and to develop the necessary infrastructure to deliver energy services. The European Commission believes that the creation of a single energy market will promote energy security; but there are many vested national and industrial interests that stand in the way of such market liberalisation. Even if there was progress on the creation of a single market, the second part of the analysis above suggests that many of the threats to EU energy security actually lie outside of its control and result from the globalisation of energy demand. Customers in the EU now face increased competition for imports of oil and gas from exporting nations in the Middle East and Africa and, as MITCHELL (2010) suggests, this competition is set to intensify in the future, hence the emphasis on energy security in the EU's international relations. The Russian Gas crises highlighted the inability of the EU to speak with one voice on energy matters and this has prompted the Commission to focus on the need for internal solidarity and to stress the interdependent nature of its relations with energy supplying states. Thus, while energy security is to be left to the market, energy diplomacy is identified as an area where the EU needs to coordinate the member states in an attempt to speak with one voice.

As currently constructed, the EU's energy strategy reflects the tensions and contradictions of our times. In large part, with its emphasis on security of supply, infrastructure coordination and market liberalisation, the EU is concerned with the energy security priorities of the fossil fuel energy system; the aim being to create the conditions under which market mechanisms can deliver secure and affordable supplies of energy. At the same time, energy strategy is increasingly driven by climate change policy with its emphasis on the reduction of emissions and the development of renewable energy. But, here it remains unclear what role the market and the state must play. Energy efficiency is the one policy area that both improves security of supply and reduces GHG emissions, but again it is unclear how consumers and producers can be convinced that they should make investments in this area. Success stories abound, but it seems that state intervention is still essential to changing consumer behaviour. Thus, we face a dilemma, the market is expected to deliver energy security, but the state is increasingly seen as necessary to orchestrate the transition to a low carbon economy. Two things are clear: one, that energy security is a much more complicated issue than it was in the 1970s, and two that the globalisation of demand means that the energy policies of the member states and the EU must constantly monitor and respond to changes in the global energy system.

5 References

BAUMERT K., HERZOG T., PERSHING, J. (2005), Navigating the Numbers: Greenhouse Gas Data and International Climate Policy. Washington D.C., World Resources Institute.

BBC NEWS (27 July 2010),'BP to set aside $ 32.2 billion to cover oil spill costs.' – *http://www.bbc.co.uk/news/business-10770252* (Accessed: 29.07.2010)

Bradshaw M.J. (2009), The Geopolitics of Global Energy Security. In: Geography Compass, 3, 5, pp. 1920–1937, 10.1111/j.1749-8198.2009.00280.x

Bradshaw M.J. (2010), Global energy dilemmas: a geographical perspective. In: The Geographical Journal, forthcoming, doi: 10.1111/j.1475-4959.2010.00375.x

British Petrol (BP) (ed.) (2010), BP Statistical Review of World Energy June 2010. London, BP.

Campbell C.J., Laherrère J.H. (1998), The End of Cheap Oil. In: Scientific American, March, pp. 78–83.

Chester L. (2009), Conceptualising energy security and making explicit its polysemic nature. In: Energy Policy, 38, 2, pp. 887–895.

Chevalier J.-M. (ed.) (2009), The New Energy Crisis: Climate, Economics and Geopolitics. Basingstoke, Palgrave Macmillan.

Deffeyes K.S. (2005), Hubbert's Peak: Impending World Oil Shortage. New Jersey, Princeton Univ. Press.

Dyer G. (2010), Climate Wars: The Fight for Survival as the World Overheats. Oxford, Oneworld.

Energy Policy Research Foundation Inc. (EPRINC) (ed.) (2010), The Blowout and the Deepwater Moratorium … putting the spill in perspective. Washington DC, EPRINC.

Energy Information Agency (EIA) (ed.) (2009), International Energy Outlook 2009. Washington D.C., EIA.

Energy Information Agency (EIA) (ed.) (2010), International Energy Outlook 2010: Highlights. Washington D.C., EIA. – *http://www.eia.doe.gov/oiaf/ieo/index.html*

Froggatt A., Lahn G. (2010), Sustainable Energy Security: Strategic risks and opportunities for business. Lloyds 360° Risk Insight White Paper, Climatewise, Lloyd's, and Chatham House.

Gore A. (2006), An inconvenient truth. London, Bloomsbury.

Helm D. (ed.) (2007), The New Energy Paradigm. Oxford, Oxford Univ. Press.

Hirsch R.L., Bezdek R., Wendling R. (2005), Peaking of World Oil Production: Impacts, Mitigation and Risk Management. Washington D.C., US Department of the Environment.

International Energy Agency (IEA) (ed.) (2007), Energy Security and Climate Policy: Assessing Interactions. Paris, IEA.

International Energy Agency (IEA) (ed.) (2008), World Energy Outlook 2008. Paris, IEA.

International Energy Agency (IEA) (ed.) (2009a), World Energy Outlook 2009. Paris, IEA.

International Energy Agency (IEA) (ed.) (2009b), CO_2 Emissions from Fuel Combustion: Highlights. Paris, IEA.

International Energy Agency (IEA) (ed.) (2010) – *http://www.iea.org/subjectqueries/keyresult.asp?KEYWORD_ID=4103* (Accessed: 08.07.2010)

IHS (ed.) (2010), IHS-CERA 'Oil Demand from Developed Economies has Peaked' – *http://press.ihs.com/article_display.cfm?article_id=4142* (Accessed 09.07.2010)

Inter-Governmental Panel on Climate Change (IPCC) (ed.) (2007), Climate Change 2007: Synthesis Report: Summary for Policy Makers. Geneva, IPCC.

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

Klare M.T. (2008), Rising Powers, Shrinking Planet: The New Geopolitics of Energy. New York, Metropolitan Books.

Klare M. (2010), The Relentless Pursuit of Extreme Energy: A New Oil Rush Endangers the Gulf of Mexico and the Planet. – *http://www.tomdispatch.com/post/175249/Michael_Klare_the_oil_rush_to_hell* (Accessed 29.06.2010)

Labban M. (2010), Oil in parallax: Scarcity, markets and the financialization of accumulation. In: Geoforum, 41, 4, pp. 541–552.

Leggett J. (2006), Half Gone: Oil, Gas, Hot Air and the Global Energy Crisis. London, Portobello Books.

MITCHELL J. (2010), New Oil Axis. In: The World Today, March, pp. 9–11.
MORSE E.L. (2009), Low and Behold: Making the Most of Cheap Oil. In: Foreign Affairs, 88, 5, pp. 36–52.
MÜLLER-KRAENNER S. (2007), Energy Security: Re-Measuring the World. London, Earthscan.
NEWELL P., PATERSON M. (2010), Climate Capitalism: Global Warming and the Transformation of the Global Economy. Cambridge, Cambridge Univ. Press.
NUTTALL W.J., MANZ D.L. (2008), A new energy security paradigm for the twenty-first century. In: Technological Forecasting & Social Change, 75, pp. 1247–1259.
OLIVIER J.G.J., PETERS J.A.H.W. (2010), No growth in total global CO_2 emission in 2009. Bilthoven, Netherlands Environmental Assessment Agency.
PASCUAL C., ELKIND J. (eds.) (2010), Energy Security: Economic, Politics, Strategies, and Implications. Washington DC, Brookings Institution Press.
PASKAL C. (2010), Global Warring: How Environmental, Economic and Political Crisis will Redraw the World Map. New York, Palgrave Macmillan.
PIELKE R.A. (2010), The Carbon Economy and Climate Mitigation: an editorial essay. In: WIREs Climate Change, DOI: 10.1002/wcc.23.
PIRANI S., STERN J., YAFIMAVA K. (2009), The Russo-Ukrainian gas dispute of January 2009: a comprehensive assessment (= OIES Natural Gas Working Paper, 27). Oxford, OIES Natural Gas.
PODOBNIK B. (2006), Global Energy Shifts: Fostering Sustainability in a Turbulent Age. Philadelphia, Temple Univ. Press.
ROWE M. (2009), Elements of the future. In: Geographical Magazine, 82, 7, pp. 50–54.
RÜHL C. (2009), BP Statistical Review of World Energy June 2009: What's inside? London, BP.
RÜHL C. (2010a), BP Statistical Review of World Energy June 2010: What's inside? London, BP.
RÜHL C. (2010b), Global Energy After the Crisis: Prospects and Priorities. In: Foreign Affairs, 89, 2, pp. 63–75.
SMIL V. (1994), Energy in World History. Boulder, Westview Press.
SORRELL S. et al. (2010), Global oil depletion: A Review of the evidence. In: Energy Policy, 38, pp. 5290–5295.
SOVACOOL B.K., BROWN M.A. (2009), Scaling the policy response to climate change. In: Policy and Society, 27, pp. 317–328.
U.S. CLIMATE ACTION NETWORK (ed.) (2010), 'Who's On Board with the Copenhagen Accord?' – *http://www.usclimatenetwork.org/policy/copenhagen-accord-commitments* (Accessed 09.07.2010)
VARRASTRO F., LADISLAW S. (2007), Providing Energy Security in an Independent World. In: The Washington Quarterly, 30, 4, pp. 95–104.
VIVODA V. (2009), Resource Nationalism, Bargaining and International Oil Companies: Challenges and Change in the New Millennium. In: New Political Economy, 14, 4, pp. 517–534.
WATSON J. (2009), Is the move toward energy security at odds with a low-carbon society? In: GIDDENS A., LATHAM S., LIDDLE R. (eds.), Building a low-carbon future: the politics of climate change, pp. 33–41. London, Policy Network,
WORLD ECONOMIC FORUM (ed.) (2006), A New Energy Security Paradigm. Geneva, World Economic Forum.
YERGIN D. (2008), The Prize: the epic cost for money and power. New York, Free Press.
YERGIN D. (2009), It's Still the One. In: Foreign Policy, September/October, pp. 88–95.
YOUNGS R. (2009), Energy Security: Europe's New Foreign Policy Challenge. London, Routledge.