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Energy: Revival of a burning matter

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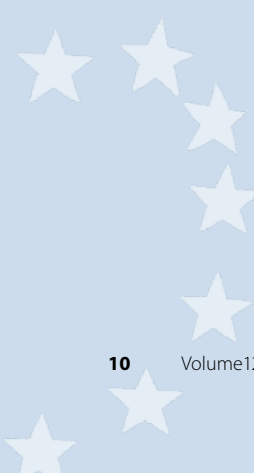
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ABSTRACT

The main purpose of this paper is to preview the other contributions to this volume of the EIB Papers. In this context, it offers a few additional perspectives. One highlights why energy issues have re-emerged as a matter of policy interest. Another concerns the difference between the macroeconomic impact of the oil price shocks of the 1970s and that of the recent rise in international energy prices. A third perspective – set against concerns about the security of energy supply for Europe – pertains to the wide variation in energy import dependency across EU countries. Lastly, the paper comments on the energy efficiency ambitions of the European Union.

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Energy – revival of a burning matter

1. A sense of *déjà vu*

Insinuating – as the title of this overview paper does – that energy matters are subject to ebbs and flows seems to be odd. Leaving aside the role of energy in the production of goods and services, its profound importance is obvious when we imagine how its absence would derail daily life in modern societies. Take the case of electricity (Bodanis 2006). A local, short-term electricity blackout is unlikely to be more than a nuisance – although perhaps a memorable one when people get stuck in elevators, miss decisive moments of major sports events on TV, and so on. Inconvenience rises if blackouts are widespread – nation-wide, for instance – and last hours, severely disrupting rail and air traffic and inner-city road transport, communication, air conditioning, heating, hospital services, that is: everything powered by electricity. Although cars and mobile phones continue to work for a while, once tanks and batteries are empty, this lifeline goes, too, because neither refuelling cars nor recharging batteries works without electricity. When blackouts go on for a few days, refrigerated food will perish and fresh food supplies will not be available – not even from the bakery next door. And even if they did, people run out of cash at some point, cannot get fresh money – neither from automatic teller machines nor the friendly clerk of their local bank because neither can process transactions without electricity, and for the same reason credit cards turn into what they are made of – just a piece of plastic. For modern, energy-reliant societies, a blackout striking for a week or more would truly be nightmarish, with public safety crumbling, no police or ambulance to call, and hospitals of no value. All in all, for modern societies, energy is vastly more valuable than what its share in gross domestic product suggests,¹ and although a secure supply of energy is the more vital the more ‘modern’ a society is, its importance does not rise and fall over time.

One reason why it is nonetheless apt to speak of a revival of energy matters is that the degree to which societies can be, or feel, certain of their energy supplies varies over time – in particular in energy-importing countries. In this respect, there has been a sea change since the beginning of the new millennium for a number of reasons. The import dependency of EU countries has increased since the mid-1980s and is projected to rise further due to dwindling oil and gas production in EU countries. In addition, prospects for international energy companies to be involved in developing oil and gas resources of energy-exporting countries are not as good as they appeared some twenty years ago. What is more, there is growing anxiety, rightly or wrongly, that energy-rich countries might not be as reliable as they used to be – because of political instability in these countries or their neighbours, politically motivated supply disruptions, or both. Last but not least, the rise in international oil prices, notably since end-2003, combined with emerging economies’ growing demand for energy back the notion that a secure supply of energy at affordable prices cannot be taken for granted.

A simple way to illustrate the renewed interest in energy is to examine the attention it has received in the financial press. According to the print-edition archives of *The Economist*, the number of articles in that newspaper containing the word ‘energy’ averaged 290 a year in



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¹ In the European Union, for instance, the energy sector accounts for around 3 percent of GDP.

1997-2000, but increased by around 50 percent to 430 in 2001-07.² The reporting in *The Economist* also nicely captures how energy issues, or their assessment, changed over time. In 1999, the newspaper famously ran an article with the title “The next shock? The price of oil has fallen by half in the past two years to just over \$10 a barrel. It may fall further – and the effects will not be as good as you might hope”, and the article considered the possibility of oil prices plunging to \$5 a barrel (*The Economist* 1999). As the world found out pretty soon thereafter, it escaped the shock of falling prices, but experienced rising ones instead, leading the newspaper in 2006 to ask how high oil prices can go and to express “Nostalgia for calmer days” (*The Economist* 2006a).

Interest in energy matters has re-emerged for reasons similar to those prevailing in the 1970s, but there is more than history repeating itself.

Global warming is the other main reason why energy is a hot topic again, with energy production and consumption arguably being the main source of man-made greenhouse gas emissions. At the risk of simplifying a little and taking an advanced-country perspective, one might say that climate-change concerns have replaced fears of the 1970s and 1980s about acid rain and other environmental and health damages caused by emissions of sulphur dioxide and nitrogen oxides. One reason why fears of the 1970s and 1980s rescinded is that advanced countries succeeded in substantially cutting emissions of sulphur dioxide and nitrogen oxides. This being said, mankind’s possible contribution to global warming is not a new concern either, but the uncertainty surrounding it seems to be much lower now than it was ten to twenty years ago.

Reviewing the coverage of global warming in *The Economist*, we find that the number of articles mentioning it went up by some 20 percent from an average of 58 a year in 1997-2000 to 70 in 2001-07. Perhaps more telling is how the tone of articles on global warming has changed. In the run-up to finalising the Kyoto Protocol in December 1997, the newspaper though recognising the danger of global warming recommended “For Kyoto, a modest proposal”, stressing that “If you want a cool planet, keep a cool head” (*The Economist* 1997). Indeed, this advice was in the tradition of earlier commentary suggesting to “Stay cool” and noting “penguins and people can afford to relax for many years yet” (*The Economist* 1995). More recently, the flavour of articles has become less relaxed, with “The sound of distant howling – Signs of climate change are hard to be sure. But the latest look alarming” (*The Economist* 2005), “The heat is on – The uncertainty surrounding climate change argues for action, not inaction. America should lead the way” (*The Economist* 2006b), and “The melting tongue of ice – global warming gives our correspondent the shivers” (*Economist.com* 2007). In sum, although only illustrative, the transformation in the coverage of global warming by a newspaper known for the rigour of its analyses and its sceptical view of global warming indicates that the climate-change challenge is real and closely linked to the use of energy.

To conclude, for a variety of reasons, interest in energy matters has re-emerged since the turn of the millennium. To some extent, it is *déjà vu* as today’s interest is driven by factors known from the 1970s, notably environmental challenges related to energy production and consumption and concerns about the security of energy supply. What is more, as in the 1970s, improvements to energy efficiency are perceived to be key for tackling both problems. Yet, there are differences too. Environmental challenges were largely regional and local in character while they now have a global dimension. As for security of supply, oil was the focus in the 1970s while today worries about a reliable supply of natural gas seem to be of importance as well – at least from a European perspective. Another conspicuous fact is

² To be a little more precise, both figures are annualised averages because the archives contain articles since June 1997 and the data for 2007 cover only the first five months of the year. Obviously, the figures are inflated (in both sub-periods) as they include articles on other ‘energy’ issues, such as how astrophysicists study dark energy in the universe.

that the energy price shock of the 1970s adversely affected the economic performance of energy-importing countries. By contrast, despite the recent surge in energy prices, the world economy continues to steam ahead without noticeable inflationary pressure. The reason for this is one of the themes reviewed in this paper (Section 2). But our main purpose is to offer a guided tour of the contributions to this volume of the *EIB Papers*. In this context, we will examine how energy import dependency varies across EU countries (Section 3) and we will elaborate on the role of energy efficiency in reducing energy consumption (Section 4). Section 5 concludes.

2. Energy and the macroeconomy – now and then

To start with some facts, Figure 1 shows developments in the real price of crude oil since the beginning of the 1970s. Following a few ups and downs during the first years of the new millennium, prices have been on an upward trend since end-2003. In real terms, today's oil prices are three times higher than five years ago and five times higher than seven years ago. Such a steep rise in oil prices is without doubt reminiscent of the oil shocks of 1973-74 and 1979-80. Indeed, although the real price of oil has not yet reached its peak of 1980, it is well above the level prevailing after the first oil shock and firmly in the range of the second one.

Despite the recent surge in energy prices, the world economy continues to steam ahead without noticeable inflationary pressure – in contrast to the 1970s.

Figure 1. Inflation-adjusted oil price in USD per barrel, 1970-2006

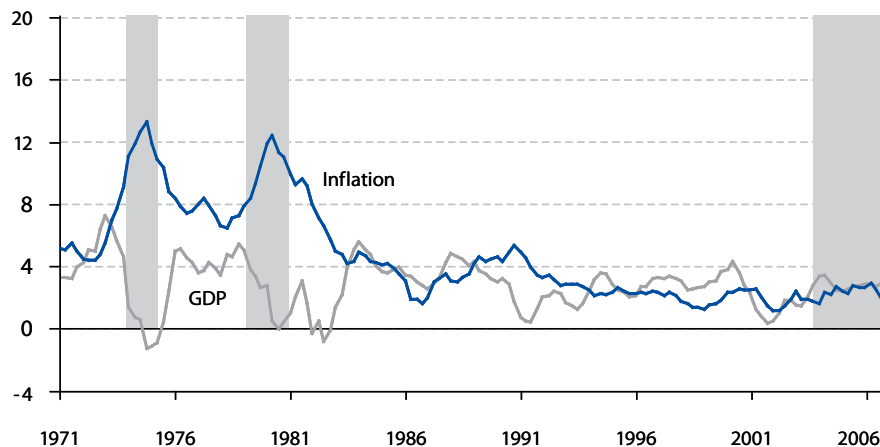


Source: IMF, International Financial Statistics.

Notes: The shaded areas mark the periods of the oil shocks in the 1970s and early 1980s and the period since November 2003. Data are in 2005 prices.

Given the similarity between the size of the price shocks of the 1970s and the recent surge in oil prices, a hypothetical macroeconomic forecast made in 2000 on the assumption that oil prices increased as much as they did, would probably have projected a severe slowdown in economic activity and a rise in inflation. As Figure 2 shows for OECD countries, such a forecast would have been widely off the mark. To recall, the oil price shocks of the 1970s coincided with a steep rise in inflation. In contrast to the pre-1970 experience, faster inflation was not accompanied by higher economic growth. On the contrary, economic activity in most advanced economies plummeted, and with the concurrence of economic stagnation and inflation, the term stagflation was born. This time, the experience with rapidly rising oil prices seems to have been a happier one. Inflation and economic growth in OECD countries averaged, respectively, 2.5 percent and 3.0 percent a year in 2004-06. For the world as a whole, the comparable figures are 3.7 percent and 5.2 percent.

Figure 2. Real GDP growth and inflation (in %) in G-7 countries, 1971-2006



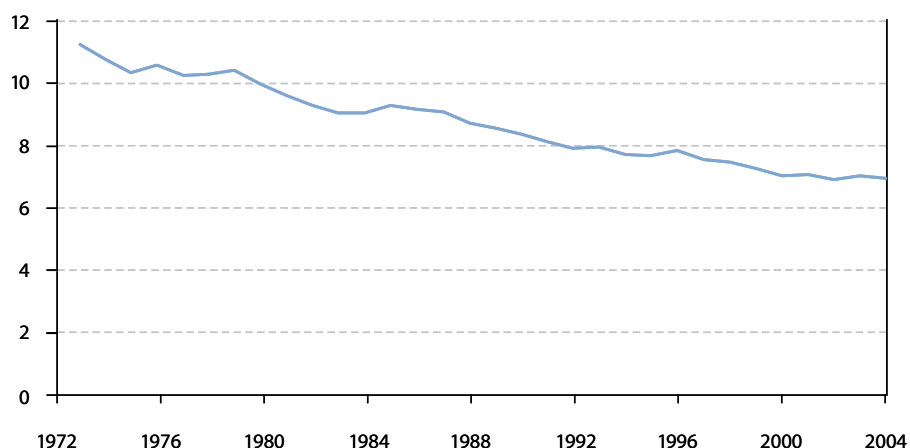
Source: OECD, Main Economic Indicators.

Notes: The shaded areas mark the periods of the oil shocks in the 1970s and early 1980s and the period since November 2003.

Advanced economies are less energy intensive than some thirty years ago, implying that any increase in the cost of energy hurts them less than it used to.

There are four main reasons why the recent surge in energy prices has not spoiled the macroeconomic performance of the world economy. To begin with, advanced economies are much less energy intensive than they used to be thirty years ago, that is, they need far less energy per unit of output produced. As Figure 3 shows for the EU-15, energy intensity fell by 37 percent in 1973-2004. That said, the process has been uneven and there was almost no change in the mid-1990s and the early years of the new millennium. Figure 4 indicates that the downtrend in the oil intensity of industrial countries has been more pronounced (a decline of 50 percent), with the use of oil in these countries largely confined to the transport sector and the chemical industry, where it is an important non-energy input. In sum, because of lower energy intensity, any increase in the cost of energy hurts advanced countries less than it used to.³

Figure 3. Energy intensity of EU-15 countries in megajoule per euro of GDP

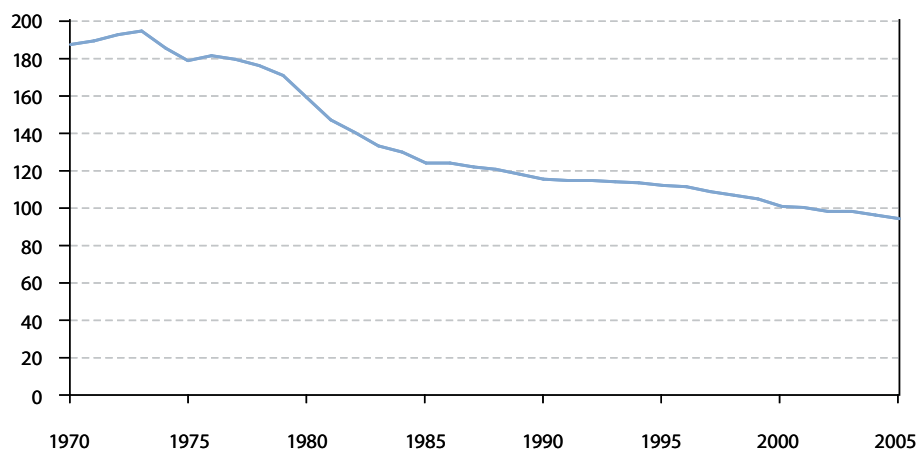


Source: EUROSTAT and own calculations.

Notes: GDP in 1995 prices.

³ Considering the importance of energy sketched in the introduction, one could detect a dichotomy: although modern economies are increasingly vulnerable to being without energy, they are better at weathering an increase in its cost.

Figure 4. Oil intensity of OECD countries (index 2000=100)



Source: US Department of Energy database and OECD WEO database.

Second, in contrast to the 1970s, economies in this day and age can absorb energy price shocks without too much impact on real economic activity and inflation. This is largely because labour and product market conditions today tend to foil workers' and firms' efforts in energy-importing countries to claw back the international transfer of income associated with a hike in the price of primary energy and other raw materials (Carlin and Soskice 2006). A variety of factors have contributed to this change. Substantial labour and product market deregulation in many developed countries is one of them. Another is fierce foreign competition – coming with external trade liberalisation – which is keeping a lid on wages and prices. And then, there is the globalisation of financial markets, making all types of capital more mobile and thereby limiting the bargaining power of labour. Finally, while labour markets were very tight at the time of the first oil shock, unemployment in many countries continues to be high today, curbing wage demands and thus inflationary pressures.

The underlying structure of most advanced economies is also more flexible, helping them to adjust to an increase in energy prices.

Third, macroeconomic policies of today benefit from the lessons learned in the context of the first oil shock and are free of the constraints that characterised the macroeconomic situation around the time of the second one. In response to the first shock, and hoping the oil price hike would be transitory, policy makers tried to stem the rise in unemployment with expansionary aggregate demand policy. In the event, this policy proved to be futile not only because oil prices remained high, but also because demand policy is inherently of little use to offset an adverse supply shock. The legacy of this policy was high inflation and unemployment when the second oil shock hit. This time around, the policy response was different. To suppress the inflationary effect of yet higher oil prices and, indeed, to initiate a process of disinflation, monetary policy was tightened in many countries, eventually anchoring inflation expectations at low levels. The recent oil price rise has happened in different circumstances. Cognisant of the limits of demand policy and thanks to the success in stabilising inflation expectations, macroeconomic policies have been free to play their role in promoting non-inflationary economic growth.

Fourth, an oil price shock can have different causes and there is evidence that its macroeconomic impact depends, in part, on what triggers the shock. Kilian (2006), for instance, distinguishes four types of shocks – two caused by supply-side disturbances and two caused by demand-side disturbances – and examines their short-term and long-term impact on GDP and inflation in oil-importing countries. The first type of supply shock is triggered by political events in OPEC countries, such as the Iranian revolution, the Gulf war, and so on. All other things being equal, this type of shock

– characteristic for the oil price hike of the late 1970s – is estimated to result in a sustained reduction in real GDP growth. The second type of supply shock includes all other disturbances to the supply of oil, such as a cut in production by OPEC in response to oil market developments. Disturbances of this nature are estimated to dampen economic activity over the short term, but leave long-term growth unaffected. The first type of demand shock reflects disturbances that are specific to the oil market, a build-up in precautionary oil stocks for instance. Similar to supply shocks set off by political events, this type of demand shock – characteristic for the oil price hike in the mid-1970s – is estimated to adversely affect economic activity not only in the short run, but also in the long run. Finally, the second type of demand shock captures changes in aggregate demand – the worldwide economic boom since 2003 being a case in point. Oil price increases associated with shocks of this nature are found to boost economic activity in the short run even though they do not affect long-run economic growth. In sum, difference in the type of shocks help explain why the oil price spikes of the 1970s (oil-market specific demand disturbances and political supply shocks) slowed economic growth and why the recent rise in oil prices (aggregate demand shock) have done no harm.

The spare capacity that contributed to low oil prices in the period 1986-99 was not the outcome of rational investment decisions and is thus unlikely to re-emerge.

To take stock, over the last 30 years or so, real oil prices have seen sizeable ups and downs, but the economic repercussions of the first and the second oil price shocks were very different from those of the recent surge in oil prices. But what drives oil prices in the long run? This question, which is of broader importance given the impact of oil prices on the cost of other primary energy resources and energy services, is at the heart of the contribution by **Bassam Fattouh**. He reviews three main approaches to analysing long-run oil price behaviour: the economics of exhaustible resources, the supply-demand framework, and the informal approach. While the first approach suggests that oil prices must exhibit an upward trend, the other two do not offer such clear-cut predictions. All three approaches are frequently used to project long-term oil price developments and various actors – governments, central banks, international oil companies, and so on – rely on these projections for planning energy policy, evaluating investment decisions, and analysing the impact of various supply and demand shocks on the oil market. Acknowledging the usefulness of all three approaches for a better understanding of oil markets, Fattouh also stresses that using them to predict oil prices and to push for policies based on these predictions defeats their purpose and is bound to result in errors. Besides this overall conclusion, Fattouh emphasises that the spare capacity that contributed to low oil prices in the last one and a half decades of the previous century was not the outcome of rational investment decisions and is thus unlikely to re-emerge.

In these circumstances, oil prices will remain fairly sensitive to oil market disturbances – real or imagined. This takes us to concerns about energy security since stable and affordable prices are typically considered an important feature of energy security.

3. Energy security and import dependency: EU member states are not equal

Concerns about energy security have at least two aspects: the threat of abrupt supply disruptions and the fear of excessive prices and price volatility. Obviously, there is a link in that actual or expected supply disruptions affect prices and their volatility. This is the background against which **Machiël Mulder, Arie ten Cate, and Gijsbert Zwart** explore the welfare effects of policies aimed at enhancing the security of energy supply. In setting the stage, they distinguish between a political and an economic perspective. From a political perspective, ensuring security of supply often means that a stable supply of energy needs to be guaranteed at ‘affordable’ prices, regardless of circumstances.

From an economic perspective, less ambitious though more reasonable considerations guide the debate. A key economic question is whether or not markets succeed in achieving an efficient balancing of supply and demand in the short run and an efficient level of investment in the long run. Taking the economic perspective, the authors assess two policies directed at the security of energy supply: investments in strategic petroleum reserves and a cap on the production of gas from the largest Dutch gas field. Their main conclusion is that both policies are unlikely to be welfare enhancing, but they might be in specific circumstances. More generally, considering the economic costs and benefits of such policies, the authors argue that it would often be wiser to accept the consequences of supply disturbances than to avoid them. Governments should thus proceed carefully in taking such policies.

From an economic perspective, the key security-of-supply issue is whether or not markets succeed in achieving an efficient balancing of supply and demand in the short run and an efficient level of investment in the long run.

Energy price risks also feature prominently in the paper of **Shimon Awerbuch** and **Spencer Yang**. They apply portfolio-theory optimisation concepts from the field of finance to develop and evaluate optimal EU electricity generating mixes. They consider portfolio theory highly suited to the problem of planning and evaluating electricity portfolios and strategies on the grounds that energy planning is similar to investing in financial securities where financial portfolios are widely used by investors to manage risk and to maximise performance under a variety of unpredictable outcomes. Awerbuch and Yang find that compared to the EU electricity mix currently projected for 2020, optimal mixes generally include greater shares of wind, nuclear, and other non-fossil technologies, which often cost more on a stand-alone engineering basis. Optimal mixes are also found to enhance energy security and reduce CO₂ emissions. As perhaps the single most important lesson of the portfolio optimisation analysis the authors consider the fact that adding a fuel-less technology (such as wind energy) to a risky generating mix lowers expected portfolio cost at any level of risk, even if the fuel-less technology costs more when assessed on a stand-alone basis.

The contribution of **Franz Hubert** turns the spotlight on the extension of the Eurasian gas transport network. In the past, gas transport through that network was interrupted occasionally when Russia and other members of the supply chain for Russian gas (Ukraine and Belarus) failed to reach agreement on gas prices and transit fees. These very rare, very short, but highly publicised events gave the impression that due to conflicts along the transit routes, Russian gas is unreliable and expensive. The game-theoretic model Hubert develops in his paper suggests the opposite might be true. As there are currently no international institutions that could enforce multilateral contracts and because the members of the supply chain for Russian gas failed to develop a stable long-term cooperation, the pipeline system is expanded and diversified beyond what is in the interest of Russia, Ukraine, and Belarus as a group. Investment is partly driven by strategic considerations to increase bargaining power *vis-à-vis* transit countries, rather than consumers. A key conclusion emerging from this analysis is that Europe's energy consumers might benefit, both in terms of prices and energy security, from a diversified transport system with substantial spare capacities. At the same time, energy dependency will grow because the fraction of Russian gas in the energy mix becomes larger.

Dependency on gas imports from Russia and the energy-security challenges arising from it are issues also addressed by **Dieter Helm**. Emphasising that Russia has tended to avoid dealing with the EU as a whole and, instead, has entered into bilateral deals with individual countries, he argues for a new European energy policy that diversifies away from Russian gas and improves Europe's bargaining power. Such a policy would have a number of elements, including a credible target for the level of gas import dependency on Russia, schemes that reward investments (such as LNG terminals) for enhancing supply security, and steps to improve gas interconnections within Europe and to further

develop interconnections between Europe on the one hand, and the Caspian area and North Africa on the other. Helm also reminds us that Europe's energy security has an internal dimension, too, and that, in fact, improvements to internal energy security would strengthen the EU's bargaining power *vis à vis* foreign energy suppliers. Steps towards enhanced internal security of supply include further internal EU energy market reforms and investments aimed at better interconnecting and integrating Europe's physical networks.

From a political perspective, the energy risk landscape has changed fundamentally in recent years, with a re-politicisation of energy and geopolitical rivalry over access to energy-rich regions characterising the scene.

The last paper focussing on the security of energy supply is that of **Coby van der Linde**, who introduces us to the art of managing energy security risks. The key theme running through her paper is that the energy risk landscape has changed fundamentally over the last decade or so, requiring a re-evaluation of risk assessment and management tools and strategies. Many of these tools currently used in most energy-importing countries – risk spreading through financial markets, holding of strategic reserves, environmental risk management, diversification of both energy supply and sources of supply, and so on – were developed after the 1973-74 oil crisis and adapted to the market-oriented conditions prevailing in the 1980s and 1990s. Since then, following two decades of a largely market-based system of energy supplies, a re-politicisation of energy is taking place; investment options serve national interests rather than the international market; new players – such as Brazil, India, and China – are becoming increasingly important; geopolitical rivalry over control of and access to energy-rich regions characterise the scene; and geopolitical tensions show that energy security will become firmly integrated in the foreign and security policies of a nation. Although traditional risk assessment and management tools continue to be useful in these circumstances, van der Linde argues that a new set of international rules is needed in order to prevent geopolitical clashes over energy security.

The energy-security perspective of all papers introduced so far is European, if not global, and the common thread is Europe's dependency on fossil fuel imports from a narrow set of countries, many of them perceived as politically unstable or unreliable. Against this background, the security of energy supply has moved to the top of the EU policy agenda. In fact, given the EU's dependence on energy imports, there have been calls for a common EU policy *vis à vis* energy-supplying countries, Russia in particular. It is fair to say that the willingness to coordinate security of supply policies among EU member states, or even delegate such policies to the EU level, differs across member states. The history of bilateral relationships between individual members, on the one hand, and energy-supplying countries on the other hand partly explains why the support for a common security of supply policy might not be equally strong in all member states. At the same time, differences across member states in the degree of import dependency probably play a role too. But how unequal are EU member states in this respect and why are they unequal?

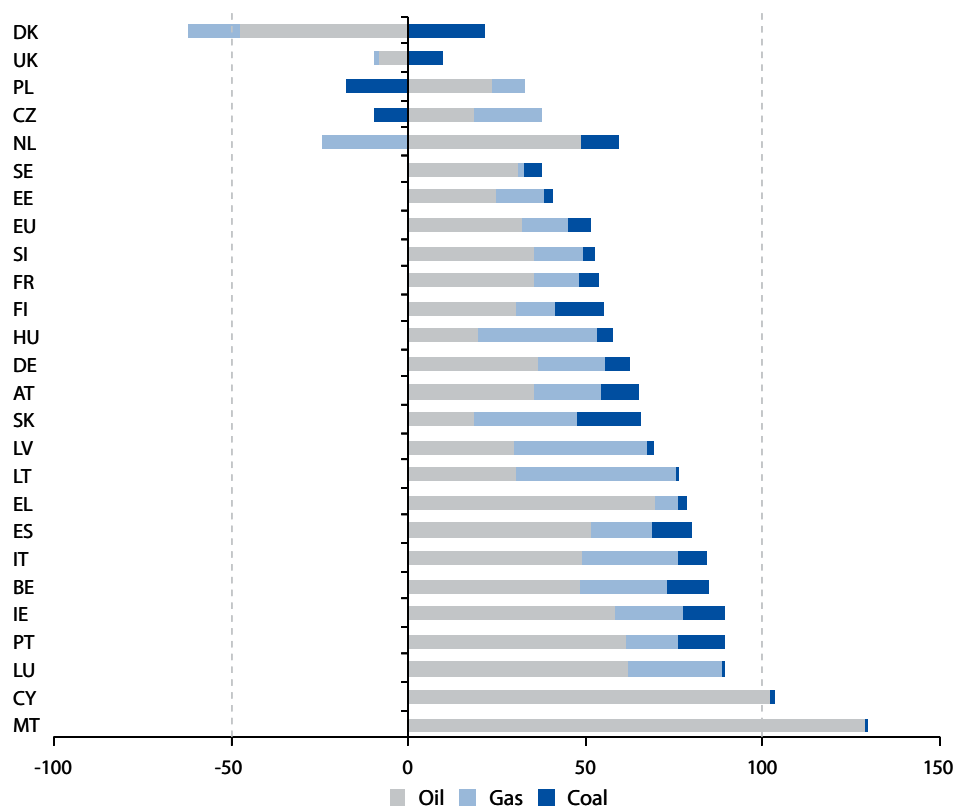
EU energy import dependency is projected to increase considerably in the years to come, largely because of an anticipated drop in EU production of primary energy. More specifically, the EU import dependency ratio – that is the ratio of net imports to total consumption⁴ – is projected to increase from 53 percent in 2006 to 65 percent by 2030 (European Commission 2006b). This uptrend is most pronounced in the case of natural gas, with dependence on natural gas imports foreseen to rise from 54 percent to 84 percent by 2030.

Not all EU members are equally dependent on fossil fuel imports, however. In fact, there is a great deal of dispersion around the EU average. Figure 5 plots the share of net imports for each fossil fuel in relation to total consumption. As can be seen, the ratio of total fossil fuels imports to total

⁴ Total consumption is gross inland consumption defined as follows: primary production + recovered products + net imports + variations of stocks – bunkers (=quantities supplied to sea-going ships). All data refer to EU-25.

consumption ranges from around –40 percent for Denmark, which is thus a net exporter, to more than 80 percent in countries such as Belgium, Ireland, Italy, and Portugal.

Figure 5. EU countries' import share of coal, oil, and gas in total consumption (in %), 2005



Source: Eurostat.

As described in more detail in Box 1, there are essentially two reasons why import dependency differs across EU countries. One is variation in the domestic production of fossil fuels. The other is variation in the use of nuclear energy and renewables.⁵ Distinguishing between (i) least import-dependent EU countries, (ii) medium import-dependent EU countries, and (iii) most import-dependent EU countries, the following picture emerges. There seems to be a North-South divide, with northern countries being relatively well-endowed with fossil fuel resources and/or relying to a large degree on renewables and/or nuclear. In virtually all countries of the first group, domestic production of fossil fuels covers more than half of total consumption; the exception is Sweden, with no fossil fuel production to speak of but an exceptionally large contribution of renewables and nuclear. Countries in the second group rely on nuclear energy and/or renewables to a degree that is close to or way above the EU average; Latvia and Austria are the exceptions as they have no nuclear energy but an unusually high share of renewables (about one quarter) in total energy consumption. Finally, although some of the most import-dependent EU countries have significant domestic fossil fuel production (Greece), nuclear energy (Belgium), or renewables (Portugal), in none of them are domestic sources of energy large enough to prevent a high degree of import dependency; interestingly enough, this group of countries comprises all EU Mediterranean countries, except for France.

⁵ Reflecting common practice, nuclear is treated as a domestic source of primary energy irrespective of whether uranium is imported or not. The EU imports almost its entire natural uranium requirement, supplied by a diverse set of countries. By contrast, around 70 percent of enriched uranium originates in the EU, with most of the remainder imported from Russia.

Energy-import dependency varies considerably across EU countries, and there seems to be a North-South divide.

Box 1. Why energy import dependency varies across EU countries

To examine why energy import dependency varies across EU countries, we have sorted them according to the degree of their import dependency and classified them in three groups – as shown in the following table.

EU countries grouped by energy import-dependency ratio (IDR)

| | |
|--|--|
| <u>Least</u> import dependent: IDR < 40 percent | Denmark, United Kingdom, Poland, Czech Republic, The Netherlands, Estonia, Sweden. |
| <u>Medium</u> import dependent: 50 percent < IDR < 80 percent | Slovenia, France, Finland, Lithuania, Hungary, Germany, Slovak Republic, Austria, Latvia. |
| <u>Most</u> import dependent : IDR > 80 percent | Greece, Spain, Portugal, Italy, Ireland, Belgium, Luxembourg, Cyprus, Malta. |

Source: Own classification based on Eurostat data for 2004.

Although the demarcation line between groups of countries is somewhat arbitrary, classifying countries in this way helps to bring out clearly the relative importance of domestic fossil fuel production, on the one hand, and nuclear energy and renewables, on the other hand, in explaining differences in energy import dependency. A simple visual inspection of the three equally-scaled charts on the next page shows the differences across country groups, but some of the finer points are worth highlighting.

Least import-dependent EU countries

All countries in this group are from central-northern-eastern Europe. Domestic production of fossil fuels covers a considerable share (more than 50 percent) of gross inland consumption in all of these countries – with the notable exception of Sweden. In the case of Denmark and the United Kingdom, there is significant production of both oil and gas. In Poland, the Czech Republic, and Estonia, it is coal that largely explains the relatively modest dependence on fossil fuel imports. By contrast, in the Netherlands, it is natural gas. Noteworthy, Sweden produces virtually no fossil fuels, and its relatively low import dependency is due to an exceptionally large contribution of renewables (30 percent of consumption) and nuclear (35 percent). Renewables also make a notable contribution in Denmark (14 percent) and Estonia (10 percent) while nuclear plays some role in the Czech Republic (16 percent) and the United Kingdom (10 percent).

Medium import-dependent EU countries

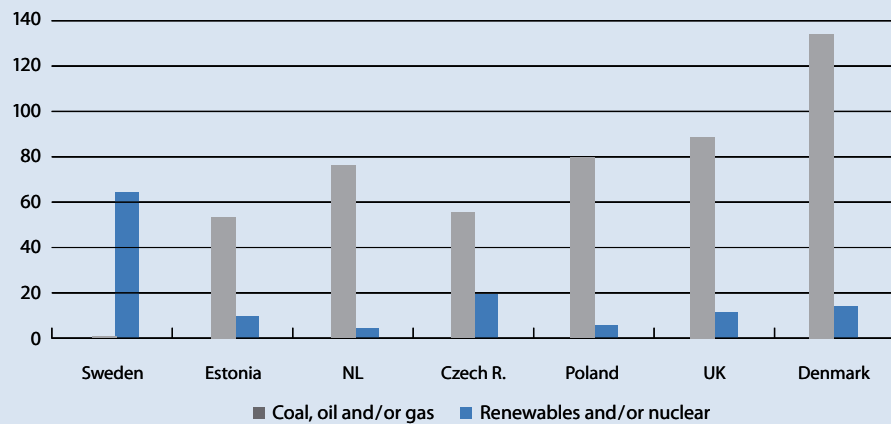
With the exception of Germany, Slovenia, and Hungary, no country in this group extracts fossil fuels sufficient to account for more than 10 percent of its total consumption. In the case of Germany and Slovenia, domestic fossil fuel production largely comprises coal mining (around 16 percent of consumption) whereas in Hungary, there is a fairly balanced mix of coal, oil, and natural gas production (24 percent) that contributes to limiting import dependency. Except for Latvia and Austria, which have no nuclear power plants, all countries rely on nuclear energy to a degree that is close to or way above the EU average (around 14 percent of total consumption), with France (41 percent) and Slovakia (26 percent) relying the most on this source of energy. The reason why Latvia and Austria are in the group of medium import-dependent countries is due to an unusually high share of renewables (about one quarter) in total energy consumption. There are three more countries where the contribution of renewables is considerably above the EU average of 6½ percent: Finland (22 percent), Slovenia (11 percent), and Lithuania (9 percent).

Most import-dependent EU countries

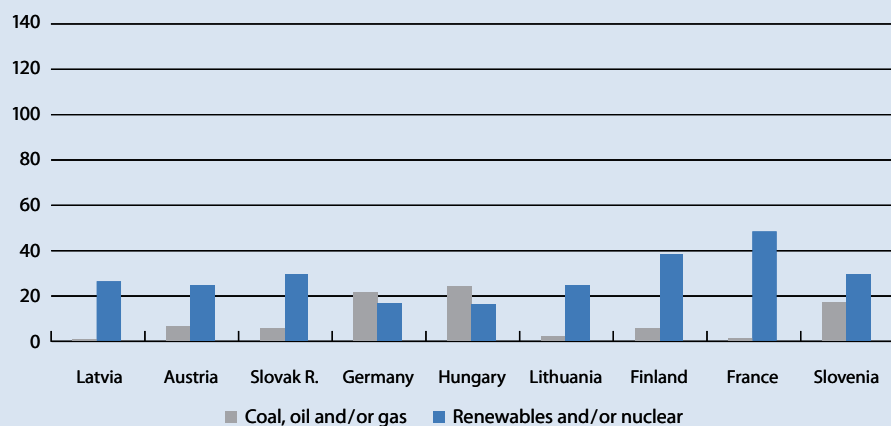
Not surprisingly, the domestic extraction of fossil fuels contributes close to nothing to total consumption in these countries, with the exception of coal in Greece (27 percent), oil and natural gas in Italy (9½ percent), and coal and gas in Ireland (9 percent). Nuclear is a source of energy only in Belgium (21 percent) and Spain (11½ percent), and the share of renewables exceeds the EU average only in Portugal (12½ percent) and Spain (7½ percent).

Ratio of domestic energy production to total energy consumption (in %), 2004

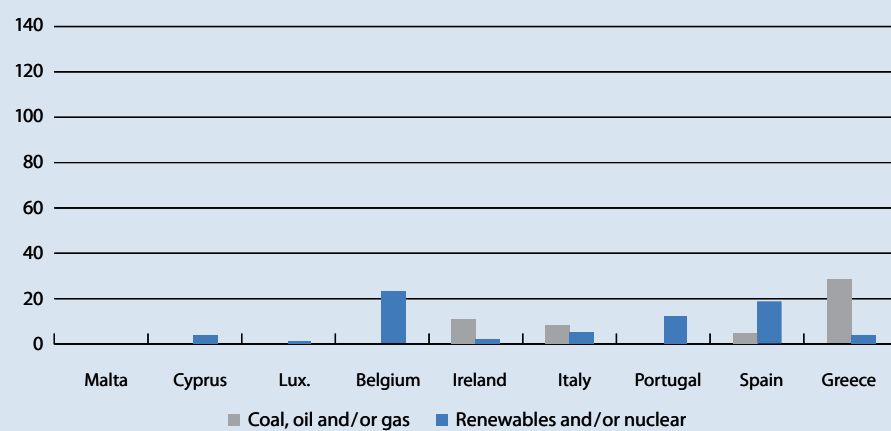
Least import-dependent EU countries



Medium import-dependent EU countries



Most import-dependent EU countries



Source: Own classification based on Eurostat data for 2004.

An important caveat to make is that we have presented a snapshot of today's situation. With EU fossil fuel extraction liable to fall in the decades to come and without a major shift towards renewables and nuclear, energy import dependency will increase and intra-EU disparities will narrow.

EU countries also differ widely in terms of their dependency on natural gas imports from Russia – an issue featuring prominently in the current energy security debate. Eurostat data suggest that there are at least five countries in the EU – Slovakia, Finland, Lithuania, Latvia, and Estonia – which presently import all their gas from Russia. The Czech Republic, Poland, and Slovenia follow with 74 percent, 62 percent, and 60 percent, respectively.⁶ Norway is a very important supplier for the United Kingdom as nearly 72 percent of British gas imports come from there. Algeria has strong positions in Portugal and Spain, accounting for around 63 percent and 51 percent of gas imports. Overall, the gas market is relatively segmented, with Russia supplying countries in central and eastern Europe, Norway supplying largely northern and western Europe, and Algeria delivering gas to southern Europe. Thus, reliance on Russian gas is far from uniform across EU member states, possibly weakening the will to forge a common policy. What is more, even if a common stance were beneficial for the EU as a whole, it might not necessarily be for individual members that see benefits in continuing long-established bilateral relationships with Russia.

4. The quest for sustainable energy systems

An energy system can be considered sustainable if it has good prospects to endure indefinitely and is benign to people and ecosystems in the sense of having low impacts and posing low risks.

Pondering about sustainable energy systems obviously needs a sensible working definition of energy system sustainability. **Marc Jaccard** – whose contribution focuses on the quest for sustainable energy systems like no other in this volume – offers the following: to be sustainable, an energy system must, first, have good prospects for enduring indefinitely in terms of the type and level of energy services it provides and, second, it must be benign to people and ecosystems in the sense of having low impacts and posing low risks. Using three criteria (cost, extreme event risk, and geopolitical risk) and taking a global, long-term perspective, he explores the respective role of energy efficiency, fossil fuels, renewable energy, and nuclear power in a sustainable energy system. He finds both nuclear power and energy efficiency constrained in their potential over the 21st century to deal with the rapidly rising demand for energy services, leaving renewables and zero-emission fossil fuels, especially coal in the latter case, to compete for dominance of the global energy system. As for this competition, he reasons that while the market share of renewables will grow significantly, they are unlikely to unseat fossil fuels, even as these are required to reduce substantially their greenhouse gas emissions. Jaccard also puts forward unmistakable policy recommendations: policies for clean energy should not be biased against or in favour of any particular form of energy and should not require a minimum production of renewable energy or nuclear power or a minimum amount of energy efficiency, or set a target for abolishing fossil fuels. Instead, policies should focus explicitly on specific environmental objectives; in the case of the climate-change risk, this means levying a tax on greenhouse gas emissions or setting a regulated emissions cap that is consistent with the environmental imperatives that scientists are arguing for. For completeness, we note that similar policy recommendations transpire from the contribution of **Dieter Helm**, who discusses not only security-of-supply issues but also climate-change challenges.

It is perhaps useful to elaborate on the limited role that Jaccard ascribes to enhanced energy efficiency in a sustainable energy future for the 21st century. For one thing, his perspective is truly

⁶ Poland's reliance on gas coming through pipelines of its eastern neighbours is even higher given that 28 percent of its gas is supplied by countries of the former Soviet Union other than Russia. The Czech Republic gets 26 percent of its gas imports from Norway, while Slovenia receives 40 percent from Algeria.

global and takes into account the rapidly rising energy demand resulting from global population growth and the aspiration of people in less developed countries to eventually enjoy some of the energy services taken for granted in rich countries. For another, he makes the point that energy efficiency is a double-edged sword as it lowers the operating cost of energy services, which can result in a rebound in the demand for the service – such as demand for additional decorative and security lighting possibly triggered by the use of efficient light bulbs – or demand for new energy services – such as backyard patio heaters in wealthier northern countries. This being said, his scenario envisions global primary energy use by the end of this century to be some 14 percent lower than it would be if energy intensity declined at a business-as-usual pace. All in all, in his scenario for a sustainable energy system, the energy intensity of the global economy would decline at an average rate of about 1 percent per year through the century.

Energy efficiency is a double-edged sword as it lowers the operating cost of energy services, which can result in increasing and new demand for energy services.

Let us, then, consider gains in energy efficiency and reductions in energy intensity from a European perspective.⁷ We already know from Figure 3 that the energy intensity of the EU economy has fallen by almost 40 percent since the beginning of the 1970s, implying an average drop of 1½ percent a year. The two oil price hikes of the 1970s have arguably induced a more efficient use of energy – both for productive and consumptive purposes. At the same time, they have lowered the profitability of energy-intensive industries relative to that of less energy-intensive industries, thereby boosting the latter at the expense of the former. In addition, reflecting concerns about the price and availability of imported energy resources and the environment, regulatory changes have mandated an increase in energy efficiency. One should also not forget that since the beginning of the industrial revolution, autonomous technological progress has been contributing to higher energy efficiency, and it is reasonable to assume that this has continued since the 1970s. Last but not least, the increasing integration of developing countries into the world economy has triggered a shift of industry from North to South, thereby reducing the energy intensity of more advanced countries.

Looking ahead, the EU has set itself the objective of accelerating the decline in energy intensity of the EU economy. In March 2007, the European Council agreed on an “Energy Policy for Europe”, the key objective of which is to reduce, by 2020, EU member states’ greenhouse gas emissions by at least 20 percent compared to 1990. To achieve this objective, the Council endorsed the proposal of the European Commission to raise the share of renewable energy resources in the EU energy mix to 20 percent and to reduce EU energy consumption by 20 percent relative to baseline projections. The energy savings target and measures to achieve it are spelled out in the Commission’s “Action Plan for Energy Efficiency”, which observes “it is still technically and economically feasible [for member states] to save at least 20 percent of total primary energy by 2020 on top of what would be achieved by price effects and structural changes in the economy, natural replacement of technology and measures already in place” (European Commission 2006a, p. 5).⁸

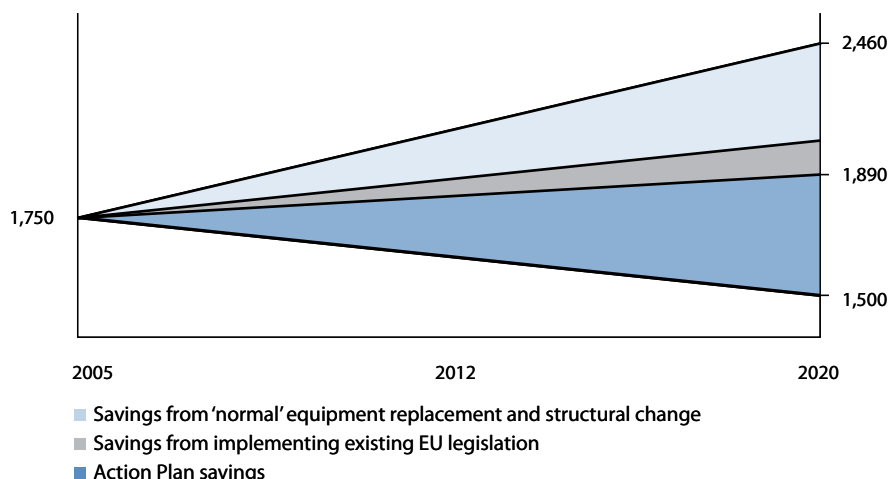
Figure 6 shows a stylised presentation of alternative EU energy consumption paths for the period 2005-2020, including the path underlying the 20 percent energy savings target. The steepest upward-sloping line shows how energy consumption would increase if consumption were to grow in line with projected GDP growth (2.3 percent a year). Energy consumption would be around 2,460 million tonnes of oil equivalent (Mtoe) in 2020.

7 All other things equal, the energy intensity of an economy falls with an increase in energy efficiency. But energy intensity might drop for other reasons too, notably changes in the structure of economic activity such as a rising share of less energy-intensive services at the expense of energy-intensive industry.

8 The Commission estimates that this would result in annual fuel cost savings of around €50 billion by 2012, increasing to around €100 billion by 2020 (for a crude oil border price of \$48 per barrel). The decline in carbon emissions resulting from the targeted energy savings are estimated at 780 million tonnes of CO₂.

The next line indicates the combined effect of changes in the structure of EU economies and autonomous changes such as normal replacement of obsolete energy-producing/using equipment with more energy efficient one. By extension, the area (light blue) between these two lines indicates the energy savings caused by these structural changes.

Figure 6. Trends in EU primary energy consumption (in Mtoe) under alternative assumptions



Source: European Commission (2006a).

Notes: Stylised presentation; Mtoe = million tonnes of oil equivalent; EU-25.

The third line from the top shows the effect of fully implementing policies already legislated at EU level. This consumption path corresponds to the baseline scenario the Commission used for its annual estimate on future developments in energy (European Commission 2006a). In this baseline scenario, EU energy consumption grows at an annual average rate of ½ percent, resulting in a total of 1,890 Mtoe in 2020. Energy consumption growth at this rate combined with GDP growth of 2.3 percent implies an annual decline in energy intensity of around 1.7 percent, that is, 0.2 percentage points more than what was achieved in 1973-2004. The grey area in Figure 6 pictures the energy savings resulting from fully implementing policies already legislated at EU level.

EU countries have committed themselves to an energy-savings target that is truly ambitious by historical standards.

The downward-sloping line illustrates the consumption path associated with the Action Plan and the dark blue area indicates the additional energy savings resulting from its implementation. In 2020, total energy consumption would amount to about 1,500 Mtoe, that is, 20 percent less than baseline consumption of 1,890 Mtoe and 14 percent less than consumption in 2005. Relative to 2005, total energy consumption of 1,500 Mtoe would imply an annual average decline in the energy intensity of the EU economy of around 3.2 percent – a truly ambitious goal compared to the drop in energy intensity observed over the last three decades.

To achieve this ambition, the Commission considers it essential that ‘best available technologies’ be used. Specific additional measures envisaged under the Action Plan include an accelerated use of fuel-efficient vehicles; better use of public transport; tough standards and better labelling on appliances; improvements to the efficiency of heat and electricity generation, transmission, and distribution; and rapid improvements to the energy performance of existing and new buildings. While acknowledging that these measures will not be for free, the Commission maintains that fuel cost savings will more than offset additional cost.

In this context, some of the hoped-for gains in energy efficiency are occasionally described to be as easy to collect as the proverbial twenty-euro note lying on the sidewalk. According to this view, it

is a combination of lack of awareness (that there is indeed money on the sidewalk), market failures, and market barriers that prevent energy consumers from realising profitable energy savings. This takes us to the contribution of **Joachim Schleich**, who reviews barriers to profitable investments in energy efficiency and examines the relevance of such barriers in the German higher education sector.

His analysis tries to answer three questions. First, do individuals and organisations really ‘leave money on the floor’ by neglecting cost-effective measures to improve energy efficiency? Second, what is the nature of the barriers to energy efficiency, that is, the mechanisms which inhibit a decision or behaviour that appears to be both energy efficient and profitable under existing (and expected) economic conditions? Third, do these barriers impede an efficient resource allocation? And, if so, can these barriers be overcome by adequate policy intervention? Considering a variety of possible barriers – such as excessive risk aversion, imperfect information, lack of access to capital, and split incentives – he stresses that policy making needs to distinguish between barriers that would obstruct economic efficiency (and thus warrant policy intervention) and those that do not. Although he does not say so explicitly, it is fair to conclude that technology-based, engineering-economic modelling on which the Commission’s Action Plan rests is bound to over-estimate the economically efficient potential for energy savings. Schleich also emphasises that economically relevant barriers are more likely to be found in organisations where the share of energy costs in total production costs is low – such as in the services sectors and public administrations. As for the German higher education sector, he finds that there are indeed mechanisms that inhibit the adoption of profitable energy-efficient measures. A case in point are split-incentives barriers that could be removed or reduced efficiently through measures such as global budgeting at the level of universities and devolved budgeting at the level of departments.

To wrap up our discussion of energy efficiency and its role in a sustainable energy system, most energy specialists would agree that there is scope for economically viable investments in energy efficiency, but how big the scope is remains controversial. Jaccard (2006, p.96) has put his doubts in terms of the proverbial money lying on the sidewalk:

“Yes, it looks like there is twenty dollars in nickels and dimes scattered along the sidewalk and in the muck of the ditch. On closer inspection, some apparent coins are just pieces of worthless metal, some are difficult to find, some will take effort to clean, and in climbing into the ditch to gather coins I risk falling and injuring myself. I might profit from the effort to recover the twenty dollars, but I might not. I might even suffer substantial losses. I need to consider this carefully before deciding how much, if any, of the apparent twenty dollars in coins I should try to recover because the costs of trying could exceed the benefits.”

Let us then turn to the role of renewable energy in a sustainable energy system. In **Mark Jaccard’s** vision of a sustainable energy future, they will gain considerable market share without replacing (near) zero-emission fossil fuels as the dominant source of primary energy. To illustrate, in his scenario for 2100, renewables are foreseen to have increased by a factor of eight and to supply primary energy equal to mankind’s current total energy consumption. But what will or should drive the expansion of renewables? Many economists – Jaccard and Helm, for instance – argue that a key role should be given to policies that aim at internalising the environmental cost of fossil fuels. In practice, policies of this type – such as the Emissions Trading Scheme of the European Union – are still at an early stage and other policies to promote renewables have so far taken the lead. **Dominique Finon** analyses two of them.

There certainly is scope for economically viable investments in energy efficiency, but how big it is remains controversial.

When choosing between alternative policies to directly promote renewables, one needs to consider possible trade-offs – between cost effectiveness and environmental effectiveness, for instance.

Focussing on renewable electricity, he discusses the pros and cons of feed-in tariffs and of tradable green certificate systems. To simplify a little: the former guarantees a price for renewable electricity and leaves it to the market how much renewable electricity to produce, whereas the latter fixes the amount of renewable electricity and lets the market determine its price. With perfect information and zero transaction cost both instruments would lead to the same amount and price of renewable electricity. If these conditions are not met, however, results are likely to differ. In these circumstances, argues Finon, economic reasoning does not provide an unambiguous answer to the question which of the two instruments is best for promoting renewable electricity. This is because there is a range of criteria for assessing the pros and cons of alternative policies, and while one instrument might be strong when measured against one criterion, it might be weak when measured against others. There are then possible trade-offs to consider – such as a trade-off between good performance of an instrument in terms of cost-effectiveness and possibly less-than-satisfactory performance with respect to environmental effectiveness. Finon stresses that such trade-offs become more relevant when moving from the principles of a particular instrument to its practical application. Although he finds that, in principle, each of the two instruments could be designed so that its weaknesses are mitigated without compromising its strength too much, experience in various countries seems to suggest that, in practice, feed-in tariffs are easier to adapt to real-world situations than tradable green certificate systems – a conclusion that Finon finds to hold when considering a common European approach to promoting renewable electricity.

Renewables also take centre stage in the paper of **Kolev** and **Riess**. Acknowledging the need for policies to price in the environmental cost of energy and distinguishing between mature-technology renewables and new-technology renewables, they examine the rationale for specifically promoting new renewables. They affirm that it is intellectually easy to think of market failures that could hinder new renewables to establish themselves in the market, but they find it much harder to ascertain the practical relevance of such failures and to decide on the proper type, size, and duration of policy measures. In this context, they stress that so-called experience curves – typically seen as underpinning policies in favour of new renewables – do not inform about possible market failures and using them to gauge the scope of policies in favour of new renewables could cost society dearly. Leaving these issues aside and taking the rationale for promoting new renewables for granted, Kolev and Riess then look at policies in favour of new renewables and investments in new-renewable energy projects from a cost-benefit perspective. In contrast to conventional wisdom, a cost-benefit perspective suggests that new renewables need to do better than just become competitive with mature renewable technologies. Moreover, in contrast to conventional wisdom, a cost-benefit perspective suggests that environmental aspects are largely irrelevant for a rational decision on new renewables when equally clean mature renewables are available.

A common thread of all papers introduced so far is the awareness that the creation of sustainable energy systems will not happen without appropriate economic policies. There is also agreement that market failures provide the main rationale for such policies. And then, implicitly or explicitly all papers emphasise that policies need to set a reliable, long-term framework that encourages sustainable energy investments. The impasse energy-sector investors face in the absence of such a framework is the focus of the contribution by **Juan Alario**. Concentrating on Europe's electricity sectors, he notes that investment has been low in the last two decades but is expected to rise in 2010-20 given the age structure of the existing capital stock. But which type of electricity-technology should investors choose? Alario points out that meeting the EU energy policy objectives will require substantial investments in renewable electricity generation. At the same time, he envisages an accelerating replacement of old inefficient thermal power stations by modern ones. But he sees the timing of this and the choice of technology surrounded by considerable uncertainty, arguing that despite agreement on the broad energy policy orientations by the European Council of

March 2007, policy makers continue to debate the importance of different objectives and the ways to achieve them. A case in point is the arrangement for the post-2012 EU Emissions Trading Scheme and the associated price of CO₂. Uncertainty in this respect continues to be substantial, leaving electricity producers in doubt when to decommission existing plants and whether to replace them with coal-fired or gas-fired power plants. All in all, to make the necessary investment in low-carbon technologies happen, Alario argues, policy makers need to establish a credible long-term policy framework that reduces uncertainties.

5. Energy revival – for a long life or just a temporary show?

To conclude, energy has returned to the top of the economic policy agenda for good reasons. What is more, the private sector is increasingly interested in providing energy in a manner compatible with a sustainable energy future. To illustrate the point, let us call on *The Economist* (2007) as a witness one more time. In “Cleaning up: how business is starting to tackle climate change, and how governments need to help”, the newspaper reports that energy has become the hot new area for venture capitalists and energy companies – all trying to profit from and thereby contributing to the creation of a sustainable energy system.

Is this all hype or will it last? Should energy-related environmental impacts, climate change in particular, turn out to be less damaging than currently thought, interest in energy matters will fade – for reasons as good as those explaining its recent ascend. Likewise, should stability in energy-rich regions of the world increase and relations among countries, cultures, and religions become more amicable, worries about security of energy supply will certainly recede. As both possibilities are rather unlikely, energy matters should remain high on the agendas of policy makers and businesses. But will they? And how to maintain the current momentum?

As for the climate-change challenge, a lot will depend on whether EU countries deliver on their commitment to substantially cut the emission of greenhouse gases. More important – given the global dimension of the challenge – will be to limit greenhouse gas emissions of rapidly growing developing countries. Making them join international efforts to reduce greenhouse gas emissions will not be easy, raising the thorny issue of a fair burden sharing between rich and poor countries. It will be politically impossible without the United States joining such efforts – not to speak of the substantial difference ambitious US emission reductions would make both for climate change and businesses’ interest in contributing to its mitigation.

Being optimistic and presuming that efforts at reducing greenhouse gas emissions become more global than they currently are, which type of policies can we expect to do the trick and to maintain the interest of businesses in performing it? Trying to answer this question is beyond the scope of this overview article – books have been devoted to that question (Helm 2005, for instance). Yet, economic reasoning strongly suggests that trying to ‘get prices right’ on a long-term basis ought to be a major ingredient of the recipe. As market prices do not tell the economic truth because of various market failures, they are not ‘right’ and policies should aim at correcting them so that they do tell the truth. This will further redirect entrepreneurial energy and other market forces towards the creation of a clean, enduring, and secure energy system. It is true that getting prices right might not suffice, but without it creating such a system is liable to remain elusive, turn out to be costly, or both.

Energy has returned to the top of the economic policy agenda, and businesses have joined the fray, seizing profit-making opportunities from the creation of a sustainable energy system.

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