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REGIONAL CHALLENGES IN THE PERSPECTIVE OF 2020

REGIONAL DESPARITIES AND FUTURE CHALLENGES

A report to the Directorate-General for Regional Policy

Unit Conception, forward studies, impact assessment

BACKGROUND PAPER ON:

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SUMMARY

SYNTHESIS

The energy challenge is a challenge with many dimensions. At the broad level there are issues like sustainability of energy use, security and competitiveness of supply. These broad issues themselves can be broken down to many smaller but no less important issues as e.g. global and European energy demand and supply, the availability of fossil fuel resources, renewable energy, energy transmission networks, prices for oil, gas and electricity to cite only a few of them. All these issues can be further broken down from a geographical point of view, from the global to the European, to the national and potentially to the regional level.

This large number of dimensions makes it difficult to get hold of all the issues involved in the energy challenge at the same time, nevertheless this paper aims at providing an overview of the energy challenge and its dimension. At the same time it is clear that this overview can only be the start of a much more detailed analysis, hence it is considered to be a more or less suitable basis for further research. After all this seems highly necessary in order to develop a clear view on what the effects of the energy challenge on the European regions will be.

The present paper, which intends to cover most of the dimension of the energy challenge, develops a specific structure of analysis in order to present the results in a coherent way. Amongst the many possibilities our structure splits the energy dimensions according to whether they pertain to the supply or the demand side of energy or whether they pertain to the transaction from the supply to the demand side. Thus on the supply side we analyse: Global and European energy supply, renewables and technology. With respect to energy transaction issues we focus on pipelines and LNG, energy (electricity) networks, oil prices, electricity and gas prices (incl. environmental taxes). On the demand side we analyse: global and European energy demand, GHG emissions, energy efficiency, economic effects, emission trading and finally carbon storage.

Given the number of raised issues the intention of the analysis if to provide an overview of, while an in depth analysis of each point would be far beyond the scope of the paper.

Given this the paper finally attempts to analyse the potential negative and positive impacts these dimension could have on regional disparities. Given the severe data and information limitations at the regional level and, given the fact that the energy challenge as such is a complex issue, it is extremely difficult to define two clear scenarios, as many assumptions have to be made about potential positive and negative developments in each of these challenges. Therefore, the scenario analysis is a highly speculative exercise that goes most of the components of the energy challenge and analysing them whether on to what extent they might affect the EU regions. All components are analysed with respect to their potential positive and negative impacts on regional disparities as well as with respect to the data available to investigate this issue further. As such the analysis below provides modules for scenario building, allowing to chose for each component of the energy challenge whether it is assumed to apply until 2020 or not.

The main findings are:

Renewables: If there is a strong push towards renewables this potentially opens development perspectives for the peripheral low income regions. However, there are a number of caveats, like that regions have to be endowed with skilled labour, infrastructure and investment capital in order to make full use of the development potential. Moreover production of renewable energy might increase energy prices, which negatively affects industry and consumers. Moreover introducing renewables has to be accompanied by a larger development strategy in order to provide economic perspectives for the regions. If there is not push to the production of energy from renewable sources the effects on the regions are unclear. From an environmental point of view this is clearly negative but from an economic point of view, regions can invest more in other areas of economic development that might be more important for them than renewables.

Technology: Pushing energy technologies potential positive impacts on the innovative, regions, as they might be at the centre of the development of future energy technology. Over time there might be trickle down effects to other regions, especially if the production of energy technology takes place in more industrial and/or peripheral regions. Some caveats are e.g. that the application and use of new energy technology is only possible if the regions are endowed with the necessary skills and infrastructure. Furthermore it could be that the introduction of new technology incurs high investment costs as well as higher prices. If there is no push for new technology potentially causes a loss of global competitiveness of the innovative regions as well as does not prevent energy prices from increasing. This has negative impacts on all regions, but most likely more severe effects on the more vulnerable regions.

Energy networks: If networks are improved, supply security is increased and energy markets become more competitive, which might lead to a decline in energy prices. A likely consequence is that those regions that by now have a relatively bad connection potentially become more attractive for investors, while also the households might see an increase in their disposable income. However there is also at least one caveat, namely that neither the costs of connecting even the most remote regions through an adequate network nor the benefits from doing this are known. Thus the net effect might be either positive or negative and if it is negative these the might in fact be stranded investments.

Efficiency: Pushing energy efficiency reduces the amount of energy used which will especially benefit the low income regions in Central and Eastern Europe that use energy in the least efficient way. A main caveat is that energy efficiency measures are likely to be connected to high investment costs, which might be an obstacle to their introduction. Some negative impacts are that certain elements of energy might have negative regional impacts, like e.g. road pricing as they increase the cost of production and transportation of goods.

Energy prices, GHG emissions, ETS, vulnerable industries: Basically an increase in energy prices and the emission trading scheme as well as environmental taxes have the same effect for industries. They increase the cost of production. Though in the case of energy prices an increase in prices is conceived to be a negative impact, the introduction of an ETS or environmental taxes are considered to exert positive effects (despite increasing costs), especially with respect to the environment. Given that energy prices, environmental taxes, the price of GHG emissions certificates are high vulnerable regions will suffer from higher transport and production costs (if they are specialised in energy intensive forms of production), which as an effect will lower their competitiveness vis-à-vis other, EU regions. However high prices for fossil fuel make the production of energy from renewable sources more attractive. Given that prices are low, it assumed that this is just a temporary state, as supply of fossil fuels is limited and competition for it is increasing. Thus in the medium run energy prices will rise. However currently low prices postpone the negative effects of rising energy prices and the regions (especially the vulnerable ones) have more time to adapt and develop. For higher income, central regions high energy prices and hence high transport costs strengthen their core role and divert economic activity from the low income, peripheral regions to them. As a consequence, while the most vulnerable regions might drop back in terms of incomes, the core regions even might pull ahead, and thereby increase the regional disparities within the EU even further.

1 Introduction

The present paper provides a concise analysis of the potential impact of energy risks to generate or reduce regional income disparities in Europe and on the role of neighbouring countries in this process, in the perspective of 2020. The paper aims to stimulate a discussion, involving international institutions as well as independent experts, from which two opposite scenarios will be produced.

The analysis is part of a broader project of DG REGIO, which, together with the World Bank and the Bertelsmann Foundation, has established the Regional Future Initiative, a network of experts looking at the future of regional trends. The objective of the network is to analyse and build a consensus on the future impacts of key challenges (globalisation, climate change, demographic change and migration, energy risks and social polarisation) that regions will face in the perspective of 2020 and to elaborate and discuss possible responses. The output of the network should provide a basis for policy discussion and choices in the coming years.

The present paper is based upon the analysis produced by Regional Future network itself, international institutions and scholars. Since the project will carry out five seminars, the discussion on each of the five challenges is as much as possible designed to avoid a too wide overlapping among the subjects. In the final phase each challenge analysis will be merged to produce two general scenarios.

As will be shown in this paper the energy challenge is a challenge with many dimensions. At the broad level there are issues like sustainability of energy use, security and competitiveness of supply. These broad issues themselves can be broken down to many smaller but no less important issues as e.g. global and European energy demand and supply, the availability of fossil fuel resources, renewable energy, energy transmission networks, prices for oil, gas and electricity to cite only a few of them. Finally, given the task of the paper all the above issues can be further broken down from a geographical point of view, from the global to the European, to the national and potentially to the regional level.

This large number of dimensions makes it difficult to get hold of all the issues involved in the energy challenge at the same time, especially given the limited space available to deal with all those issues. Still the attempt is made in this paper. However, from that, it is clear that this paper has its limitations, especially with respect to the depth of the analysis of each issue or dimension. Thus, the aim of the paper is to provide an overview of the energy challenge, but at the same time, provides a basis for further research (although by supplying the references to the background literature), which after all seems highly necessary in order to develop a clear view on what the effects of the energy challenge on the European regions will be.

Further research is also necessary as the analysis shows that most information and data is only available at the national level, while the regional dimension is de facto non existent, at least in European wide, publicly available sources. This is another limitation of the paper. The regional perspective cannot be analysed with the appropriate data, so that any effects of the energy challenge upon the regions are more or less just educated guesses relying on regional economic theory and conclusions from the effects at the national or European level.

The remainder of the paper is organised as follows. Chapter 2 comments on the dimensions of the energy challenge in bit more detail and develops a framework for the subsequent analysis. Chapter 3 will take an explicit regional view on the energy challenge. Chapter 4 to 6 deal with issues of energy supply, transaction and demand, respectively, while Chapter 7 analyses the role of Europe's neighbours in the energy challenge. In chapter 8 an attempt is made to measure the EU NUTS-2 regions' sensitivity to the energy challenge. Finally chapter 9 develops two scenarios of likely future impacts.

2 The dimensions of the energy challenge

In 2007 the European Commission introduced the new European Energy Policy[1], given the need that only a coordinated approach of all member states can efficiently and successfully tackle the challenges of climate change, increasing import dependence and higher energy prices. Without this, the EU's objectives in other areas, including the Lisbon Strategy for growth and jobs and the Millennium Development Goals, will also be more difficult to achieve.[2]

The new European Energy Policy (EEP) focuses on three main challenges and objectives: sustainability, security of supply and competitiveness.

§ Sustainability addresses the issue of global warming caused by anthropogenic greenhouse gas (GHG) emissions, overwhelmingly due to the production and consumption of energy. The EEP is a major step for the EU to reduce GHG emissions and thus to limit global warming to the EU's self set goal of a global temperature increase to 2°C compared to pre-industrial levels.

§ Security of supply: As European indigenous fossil fuel reserves are depleting, Europe will over the medium run become more dependent on imported fossil fuels, making it vulnerable to political and economic risks. The EEP and the measures implemented under the EEP are important tools to reduce import dependence and the associated risks. At the same time the latest gas crisis has once again shown that security of supply for each individual member state also depends on the solidarity between each member state. Here, too, the EEP plays an important role as it provides the basis to improve energy transfers and networks between member states.

§ Competitiveness addresses the issues of energy price volatility and price rises. The EEP is the basis to provide that the right policy measures and legislative frameworks are in place, so the Internal Energy Market could stimulate fair and competitive energy prices and energy savings, as well as higher investment in all areas of energy (networks, renewables, new technologies etc.).

These three objectives shall be achieved by reducing greenhouse gas emissions by 20%, increasing the share of renewables in the energy consumption to 20% and improving energy efficiency by 20%, all of it by 2020.[3]

These objectives and targets shall be met, in turn, by ten policy measures proposed by the EU Commission[4]:

§ The Internal Energy Market

§ Solidarity between Member States and security of supply for oil, gas and electricity

§ Greenhouse gases reduction and the EU Emissions Trading System

§ Energy efficiency measures

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[1] EU Commission, 2007, An Energy Policy for Europe, Communication from the Commission to the European Council and the European Parliament, COM(2007) 1 final
[2] EU Commission, 2007, op. cit. p.3
[3] The first two targets are defined in: EU Commission, 2007, An Energy Policy for Europe, Communication from the Commission to the European Council and the European Parliament, COM(2007) 1 final, while the energy efficiency target is defined in EU Commission, 2006, Action Plan for Energy Efficiency: Realising the Potential - COM(2006) 545
[4] EU Commission, 2007, op. cit. p.6 ff.

§ Renewable energy

§ A European Strategic Energy Technology Plan

§ A low CO_2 fossil fuel future

§ Nuclear power

§ A common International Energy Policy

§ Monitoring and reporting

Given that the energy challenge as such is a challenge of many dimensions that are partly heterogeneous and partly interlinked, making it difficult to analyse and present them in a concise way. This is even more the case as the ten measures to achieve the targets are in a way multi-functional, because many measures not only serve to achieve one but two or all three targets simultaneously.

For the present paper, which intends to cover most of the measures, this means that in order to present the analysis in a coherent way some kind of guiding structure is necessary. A natural way to structure the analysis would be to use the three main objectives of the EEP as main headings. However as the measures are multifunctional this would lead to redundancies and potential confusion, e.g. an analysis of renewables would fit into the sustainability objective as well as in the security, but also in the competitiveness objective.

Thus, for this paper a different structure has been chosen. Our structure basically splits the energy issues according to whether they pertain to the supply or the demand side of energy or whether they pertain to the transaction from the supply to the demand side. The structure used in this paper, as well as the topics covered are illustrated in Figure 1:

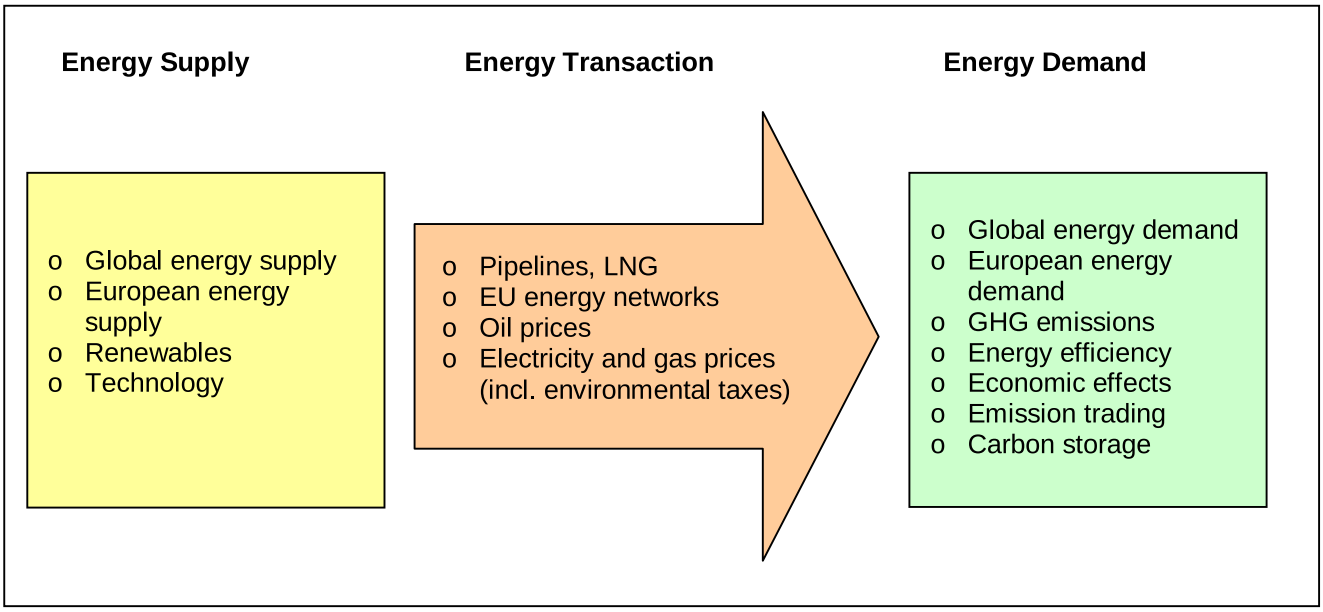

Figure 1: Structure of the paper

3 The strictly regional view

Usually, issues of energy supply and security are largely resolved at the national or the European level, whereas the regional dimension, by and large, remains unnoticed. Still, there are good reasons to believe that an increasing volatility or a shortage of energy, especially with respect to fossil fuels, has different effects on the EU regions, depending on the their characteristics.

One of the two more recent sources that relates the energy issue to regional disparities is the 4th Report on Economic and Social Cohesion (EU Commission, DGRegio, 2007). It assumes that, though energy and especially oil prices tend to fluctuate significantly, they, by certain, will increase over time as "more accessible reserves are depleted and the need to reduce greenhouse gas emissions will feed through into overall energy costs."[5]

This increase in energy costs is likely to affect the EU regions differentially, depending on their geographical location, the climate and their structure of economic activity. Thus, firstly, increasing "energy prices are likely to push up transport costs, unless they are accompanied by greater fuel efficiency to compensate"[6]. Thereby, the rise of transport costs affects disparities between as well as within regions.

As far as the disparities between regions are concerned, it are potentially the peripheral regions such as the southern parts of Italy, Portugal and Spain, the northern parts of the Scandinavian countries or the Eastern parts in the new members states that will be affected most. For them, any increase in the costs of transportation is equivalent to an increase in the price of the goods and services they export to other (the core) regions in the EU. This, in turn, erodes their, in most cases already weak, competitive position vis-à-vis more centrally placed regions even further and creates another obstacle to their economic development.

As the study "Regions 2020" (EU Commission, 2008) notes, economic and social disparities within regions are likely to increase, as high energy and fuel prices exert significant welfare effects, in particular for lower income households. For those "energy related expenditure takes a comparatively high share of their income"[7], so that high energy prices reduce the purchasing power of the poorest households within the regions. Another aspect in this respect is, that a "rise in energy costs could also encourage a shift in the pattern of settlements within regions with people tending to live closer to where they work, or vice versa, though it will take some time before this is reflected in spatial development".[8] This differential effect of increasing energy price is also highlighted in the study "Regions 2020". It notes "that metropolitan areas with compact settlements generally seem less vulnerable to the energy challenge than remote areas, owing to the higher energy efficiency of the economy and lower household consumption"[9]. However, this may be challenged by the fact that urban areas are supposed to be more transport intensive than rural areas.

Secondly, the 4th Cohesion Report remarks that an increase in "energy prices will also tend to push up the cost of some processes and products more than others and encourage less energy-intensive methods of production and new materials to be developed, such as, for example, composite materials to replace steel which uses substantial amounts of energy in its production. Regions which rely more than others on the industries most affected for income and jobs — the regions specialising in steel-making, for example,— will

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[5] EU Commission, DGRegio, 2007, 4th Cohesion Report p.43.
[6] EU Commission, DGRegio, 2007, 4th Cohesion Report ibid.
[7] EU Commission, DGRegio, 2008, Commission Staff Working Document, REGIONS 2020 - An Assessment of Future Challenges for EU Regions, p.16.
[8] 4th Cohesion Report p.43ff
[9] EU Commission, 2008, Regions 2020, An Assessment of future challenges for the EU, Commission Staff Working Paper, SEC(2008) 2868 final, p. 16.

tend to lose out unless they can respond in a like way."[10] (Similar is found in the study "Regions 2020"). Additionally, regions specialising in tourism are likely to suffers from increased price of travel.

On the other hand, both the 4th Cohesion Report as well as the study "Regions 2020" also find some positive aspects for regional development. Thus, regions that have the possibility to develop or expand the production of renewable energies are likely to benefit from the shift towards an increase use of this type of energy. Notably, this creates some major economic development perspective for the otherwise disadvantaged rural and remote regions.

To summarize, though there exist only a limited number of analysis that deal specifically with energy and regional disparities in the EU, there are good reasons to believe that an increase in energy prices, or and increase in the volatility of energy supply affects the EU regions in a differentiated way. At the same time it shows, that there is considerable scope for regional policy to engage in the current discussion on energy, as a continuous energy supply is a key determinant of the capacity of regions to develop and prosper.

4 Energy supply issues

4.1 Global Energy Supply[11]

The IEA estimates that the world's overall energy resources are adequate to meet the increasing demand up to 2030. Yet, it is noted explicitly, that an increasing share of energy demand will be met by non-conventional or frontier resources, that are more costly and difficult to exploit. Though the technology for this is constantly improving, the costs are estimated to be higher than for conventional sources, so that as a consequence the price of energy (especially fossil fuels) is likely to increase over time.

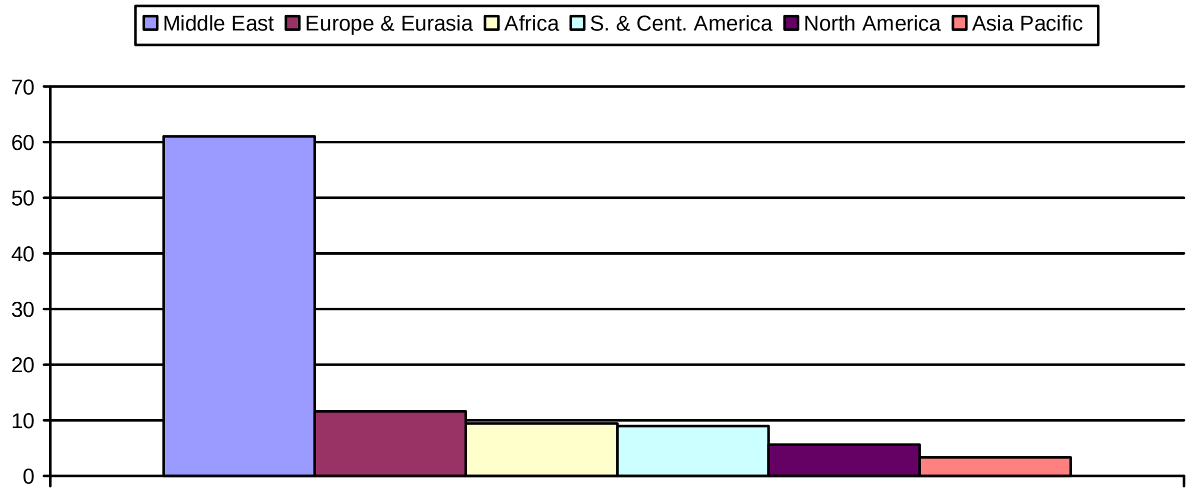
From a geopolitical point of view, energy supply will become more geographically concentrated than now. With respect to oil, it is expected that most of the increase will come from the Middle East countries, Canada (oil sands), the Caspian countries and Brazil, while the majority of oil producing countries will face a decline in production. Natural gas production is expected to increase in all countries except the OECD, especially in the Middle East, but also in Africa. By contrast, coal is much more widely dispersed. Nevertheless its production will concentrate to those areas, where extraction, transport and processing costs are lowest (i.e. China).

World reserves and resources

§ **Oil**: Over two thirds of oil reserves are concentrated in the Middle East (61%) and Russia (6.4%). South and Central America and Africa account for 18.5% of the proved reserves. Reserves tend to be concentrated in a small number of countries. Thirteen countries have individual proved reserves above 2% of the world's proved reserves. Only seven of these countries have individual proved reserves above 5% according. Apart from Venezuela and Russia, these countries belong exclusively to the Middle East. BP considers that the world's proved oil reserves amount to 41.6 years of current production, though there is some regional variation. For the Middle East the reserves-to-production ratio is around 82, while e.g. for Russia it is only 21.8 years.

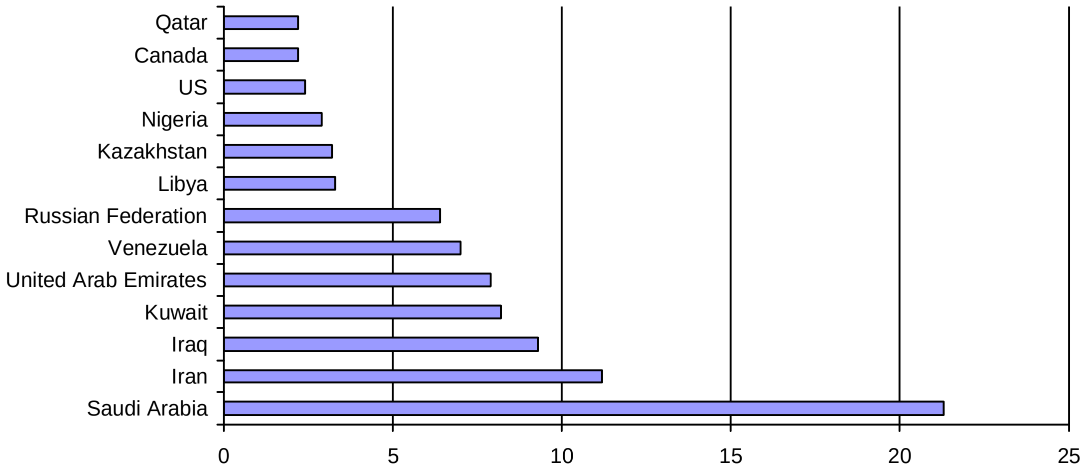
[10] 4th Cohesion Report p.44
[11] This part rests on the World Energy Outlook, 2008 by the International Energy Agency/OECD and on the "Second Strategic Energy Review - An EU Energy Security And Solidarity Action Plan" (COM(2008) 781 final).

Figure 2: Proven oil reserves, by global regions, 2007



Source: BP Statistical Review of World Energy, 2008

Figure 3: Proven oil reserves, by countries* (in % of total world)



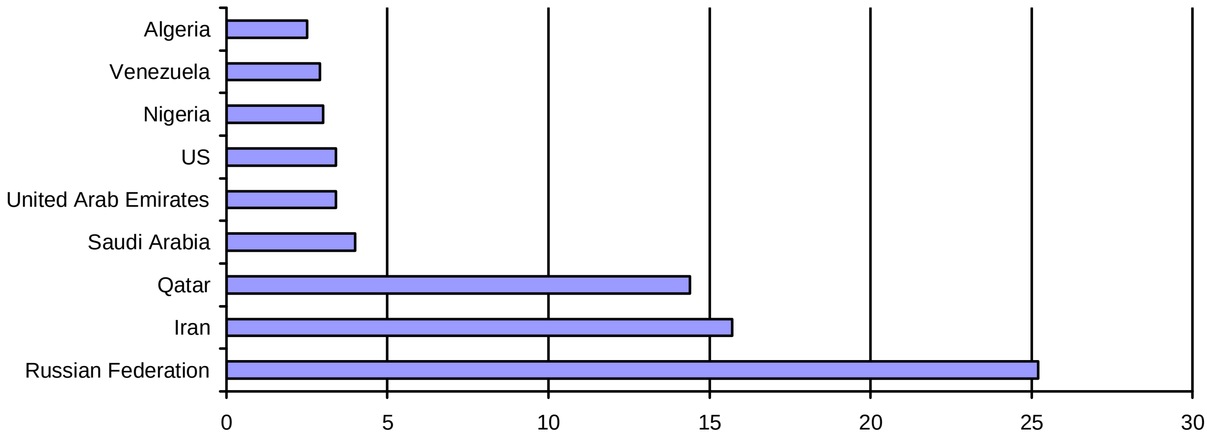
*Only countries with reserves > 2% of world reserves

Source: BP Statistical Review of World Energy, 2008

§ **Natural gas** - The world's proved reserves represent around 60 years of production. According to BP, around 41% of the world's proved reserves are located in the Middle East. The former Soviet Union accounts for more than 30% and Oceania and Africa for around 16% (8% each). Like with oil reserves, gas reserves tend to be concentrated in a small number of countries, and according to EIA, Russia, Iran and Qatar together hold about 58% of the world's oil reserves[12].

§ **Solid fuels**: Coal reserves are more abundant than oil and gas reserves. It is estimated that, at current production levels, proved reserves last more than 133 years. In contrast to other resources coal is geographically more dispersed, with recoverable reserves in around 70 countries, the leading countries being the USA, Russia and China.

Figure 4: Proven gas reserves, by countries* (in % of total world)



*Only countries with reserves > 2% of world reserves

Source: BP Statistical Review of World Energy, 2008

4.2 EU indigenous production of fossil fuels and import dependency

Independent of how the EU formulates its energy policy, EU's indigenous energy production is expected to decline sharply over the next years, because of a depletion of existing resources. Thus, oil production will decline by around 6% per year and gas production by around 3% to 4% per year till 2020. Solid fuels exploitation will also decrease, mainly because of high extraction costs, environmental issues, and diminishing state aids[13].

As a consequence, the net imports of fossil fuels are expected to increase except in the case of the New Energy Policy combined with a high oil price. Under baseline assumptions net imports would increase by 21% to 33% depending on the oil prices. Only under the New Energy Policy with oil prices over 100$/barrel net imports of fossil fuels decrease slightly in 2020 compared to the current levels, because of the substantially reduced primary energy demand and the doubling of indigenous renewable energy production.

[12] International Energy outlook 2007
[13] These numbers disregard the long-term potential offered by unconventional oil and gas.

Simultaneously with the increase in energy imports, import dependency for oil could reach 93% in 2020 under baseline assumptions, and even if the New Energy Policy is implemented vigorously, oil import dependency is estimated to be around 92%. Likewise gas import dependency is expected to rise to 77% in 2020 under baseline assumptions. Provided that the New Energy Policy is strictly followed, this would increase the role of renewables and reduces the gas and coal share in power generation. Thus, under this regime gas import dependency would be around 71% and 73% in 2020.

4.2.1 Reserves and resources in the EU/EEA

§ **Oil** - The European Economic Area (EEA, i.e. the EU27 plus Iceland, Liechtenstein and Norway) is currently an important oil producer ranking fourth in terms of global production, even though oil production has been declining since 2000. The main reserves are located in the North Sea area (Norway, United Kingdom and Denmark) and in South-East Europe (Romania).Yet, the oil resources and reserves in the EEA are limited and represent a small proportion of world reserves. Depending on the source of information[14], the proved reserves for the EU represent between 0.5% and 0.8% of world reserves. At the current production rate, these reserves secure around 7.7 to 8.3 years of domestic production.

§ **Natural gas** - The gas reserves and resources of the EU/EEA represent around 1.4% to 3.7% of the world's proved reserves at the end of 2005 and are located mainly in Norway, the Netherlands, the United Kingdom and Romania. At current production rates, the EU proved reserves secure between slightly more than 14 years of domestic production, and for the EEA, slightly more than 19.4 years.

§ **Solid fuels** - About 80% of Europe's fossil fuel reserves are solid fuel. Though being considered to be substantial, they represent only a limited share of world reserves (around 3.5% of world reserves and 50 years of today's production). The main reserves of hard coal are concentrated in Poland and the Czech Republic and to a smaller extent also in Spain, Hungary, UK and Germany. For lignite, reserves are more dispersed across Europe.

4.3 Renewables

Energy from renewable sources, though it does not solve the EU's energy problem as such, is at least considered to decrease the EU's dependency on fossil fuels and thus on imports from foreign countries. Besides that, the EU has high hopes on renewables to lead to higher levels of economic development, as "the opportunities for establishing economic growth through innovation and a sustainable competitive energy policy have been recognised. Production of energy from renewable sources often depends on local or regional small and medium-sized enterprises (SMEs). The opportunities for growth and employment that investment in regional and local production of energy from renewable sources bring about in the Member States and their regions are important."[15]

For this the EU considered it "appropriate to establish mandatory national targets consistent with a 20 % share of energy from renewable sources and a 10 % share of energy from renewable sources in transport in Community energy consumption by 2020."[16] However given that the individual member states have a different potential or starting point to develop renewable energy sources is necessary to "translate the

[14] BP 2007, BGR 2006
[15] EU, 2009, Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, §3
[16] EU, 2009, op.cit. §13

Community 20 % target into individual targets for each Member State, with due regard to a fair and adequate allocation taking account of Member States' different starting points and potentials."[17]

To illustrate Figure 5 presents the individual members states targets for 2020 as well as their 2006 share of renewable energy in total final energy demand. Figure 6 gives some more information on how far the member states are in reaching their individual targets.

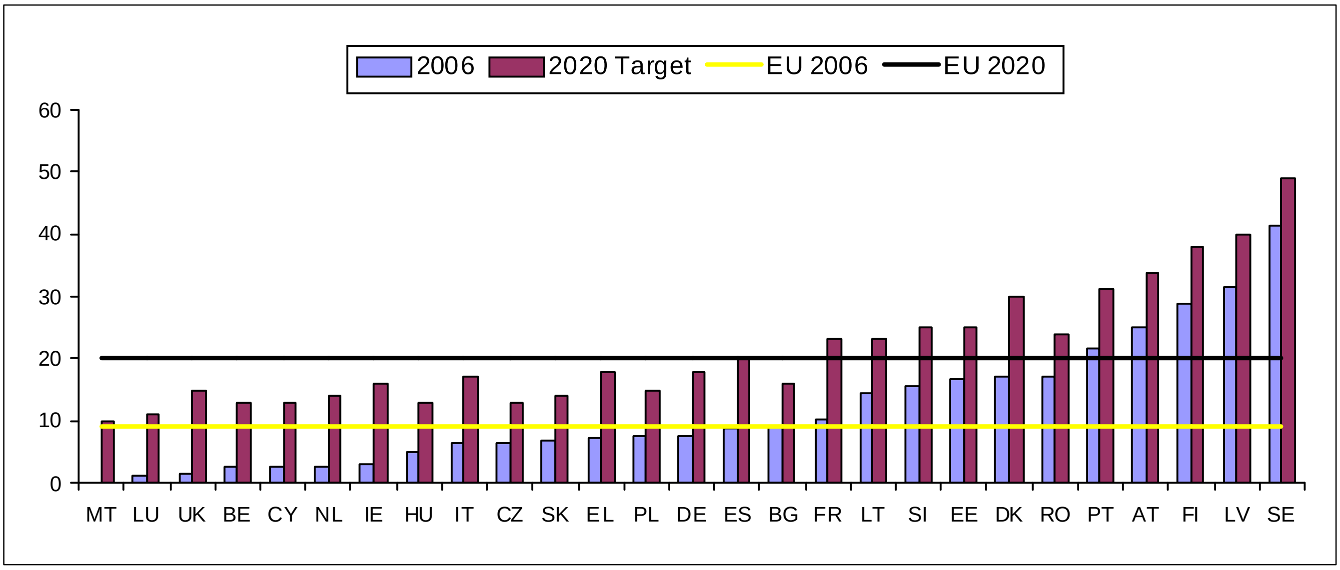
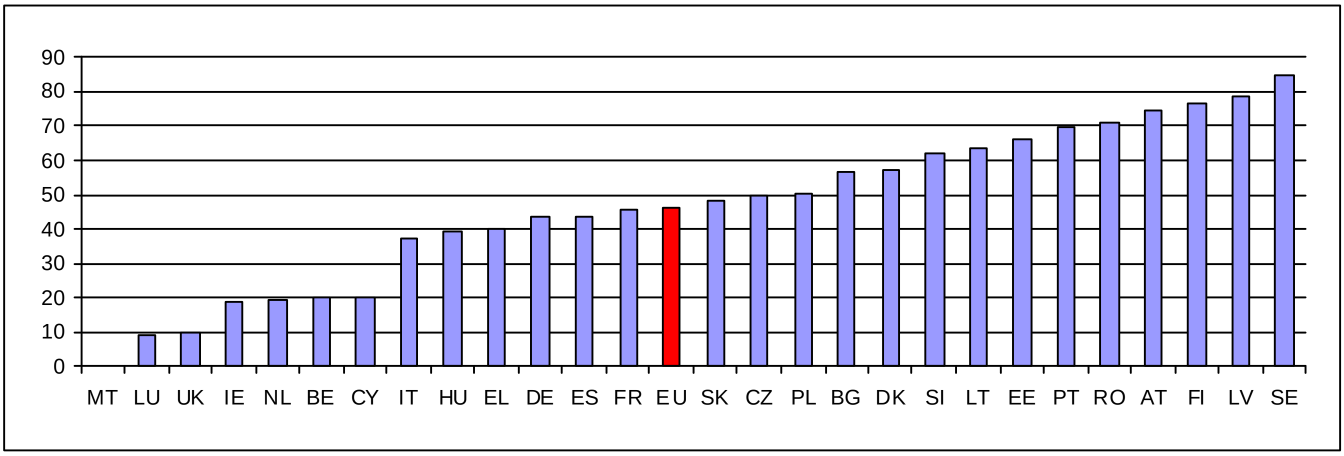


Figure 5: Share of renewable energy sources to final energy consumption, 2006 and EU target 2020

Source: DG Tren, EU Energy in Figures, 2009; EU, 2009 Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources

Figure 6: Percent of 2020 renewable target reached in 2006, by EU member state

[17] EU, 2009, op.cit. §15



Source: DG Tren, EU Energy in Figures, 2009; EU, 2009 Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources

Disaggregating energy from renewables both by supply and demand factors, there exist one the one hand a large diversity of potential renewable energy sources that at the other hand can be used for three main pillars of energy consumption (electricity, heating/cooling, fuel). To illustrate Table 1 presents an overview of potential renewable energy supply sources and their prospective use[18].

[18] DG Tren, 2007, Renewables make the difference

Table 1: Potential renewable energy sources and their use

		Electricity	Heating	Fuel
Bioenergy/Biomass	Solid biomass (like wood and straw)	**Yes**	**Yes**	
	Biogas (from organic waste)	**Yes**	**Yes**	
	Biodiesel (mostly rapeseed or sunflower)			**Yes**
	Bioethanol (fermentation of sugar from sugar beet, different cereals, fruits or even wine distillation)			**Yes**
	Second generation biofuels (cellulosic biomass feedstock)			**Yes**
Solar	Parabolic solar	**Yes**	**Yes**	
	Solar tower power plants	**Yes**		
	Solar dish/engine systems (using a 'Stirling engine')	**Yes**		
	Photovoltaic (PV) power generation	**Yes**		
	Solar thermal systems (sun heats up water) for heating and cooling		**Yes**	
Wind energy		**Yes**		
Oceans	Wave energy	**Yes**		
	Tidal schemes	**Yes**		
Hydro power	Small hydro sites (capacity of less than 10 MW)	**Yes**		
Geothermal energy		**Yes**	**Yes**	

Source: DG Tren, 2007, Renewables make the difference

As far as **electricity generation** from renewable sources is concerned the EU has set binding targets to each member state in 2001[19], in order to reach the EU wide goal that 21% of total EU electricity consumption is supplied by renewable energy sources by 2010. However so far the progress towards this goal has been very heterogeneous across member states, with some member states clearly staying behind their targets. For that reasons it seems realistic that by 2010 around 19% of the electricity consumption will be covered by renewables.[20]

By member state three countries seem to be on track to meet the 2010 target, namely Denmark, Germany and Hungary. Chances are high to reach the target in Finland, Ireland, Luxembourg, Spain, Sweden and The Netherlands. More additional efforts are needed in the Czech Republic, Lithuania, Poland and the United Kingdom, while strong additional efforts needed in Belgium, Greece and Portugal. However there is also a large number of countries that clearly stay behind their targets (mostly because of lack of either political or stable financial support). These are : Austria, Cyprus, Estonia, France, Italy, Latvia, Malta and the Slovak Republic.[21]

As far as **heating and cooling** is concerned the general impression is that the potential of renewables is by some extent under-utilised. Despite the fact that renewable energies like biomass solar and geothermal energy have a huge potential in the heating and cooling sector, so far only 10% of total heating and cooling comes from renewable energy sources.[22]

[19] EU Commission, 2001, Directive 2001/77/EC of 27 September 2001 on the promotion of electricity produced from renewable energies sources in the internal electricity market
[20] EU Commission, 2007, Green Paper follow-up action Report on progress in renewable electricity; Communication from the Commission to the Council and the European Parliament, COM(2006) 849 final, p.3
[21] EU Commission, 2007, op.cit. p.7 ff.
[22] DG Tren, 2007, Renewables make the difference, p.6

As far as **biofuels** are concerned, there are high hopes that biofuels by replacing fossil fuels contribute to save Greenhouse gas (GHG), improve security of supply and provide employment, especially in rural areas. However as a recent analysis shows the positive effects of biofuels might be quite limited in reality.[23]

As far GHG is concerned the saving potential of commercial biofuel is estimated to be between 18 and 50% given that unused land is used for the production of biofuels.

However given that most biofuels will be produced from imports, diverted EU exports, or from crops which would otherwise be used for animal feed and food in the EU the results are much more uncertain. With respect to the security of supply it is likely that bioethanol, substituting gasoline, will only increase gasoline exports without reducing imports of crude oil, while on the other hand biodiesel, replacing diesel, saves more than the same quantity of crude oil.

Furthermore the employment effects are fairly low (at least by estimations done using input-output information). Job gains in agriculture and biofuels industries were found to be largely offset by job losses in other sectors. The overall employment increase came out to be of the order of 0.1% of EU employment.

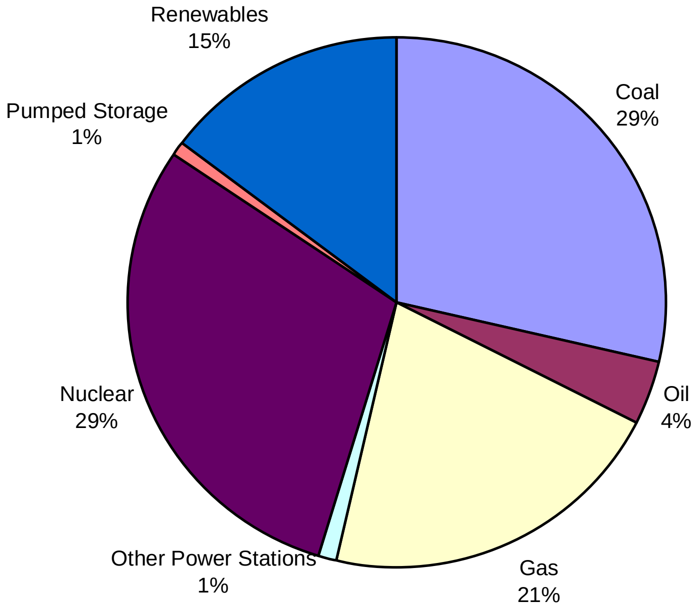
4.4 Electricity

By 2006 the EU's electricity generation mix is diversified. About 30% of power production is from nuclear and another 30% results from solid fuel power plants. Natural gas and renewables are the fuels used for the remainder of the EU's electricity production while the role of oil for electricity generation is now very limited. Compared to 1990, coal and oil have dropped respectively from 40% to about 30% and from 8% to 4%. Natural gas has been the major substitute for coal and oil. The current EU energy mix shows an increasing dependency on natural gas. Renewables have made their way into electricity production while undergoing at the same time a structural modification with an increase of wind and biomass and a relative decrease of hydro.[24]

Figure 7: Gross Electricity Generation - EU-27, share of sources in total generation

[23] European Commission and Joint Research Centre, 2008, Biofuels in the European Context: Facts, Uncertainties and Recommendations

[24] EU Commission, 2008, Second Strategic Energy Review - An EU Energy Security and Solidarity Action Plan, COM(2008) 781 final, p.46



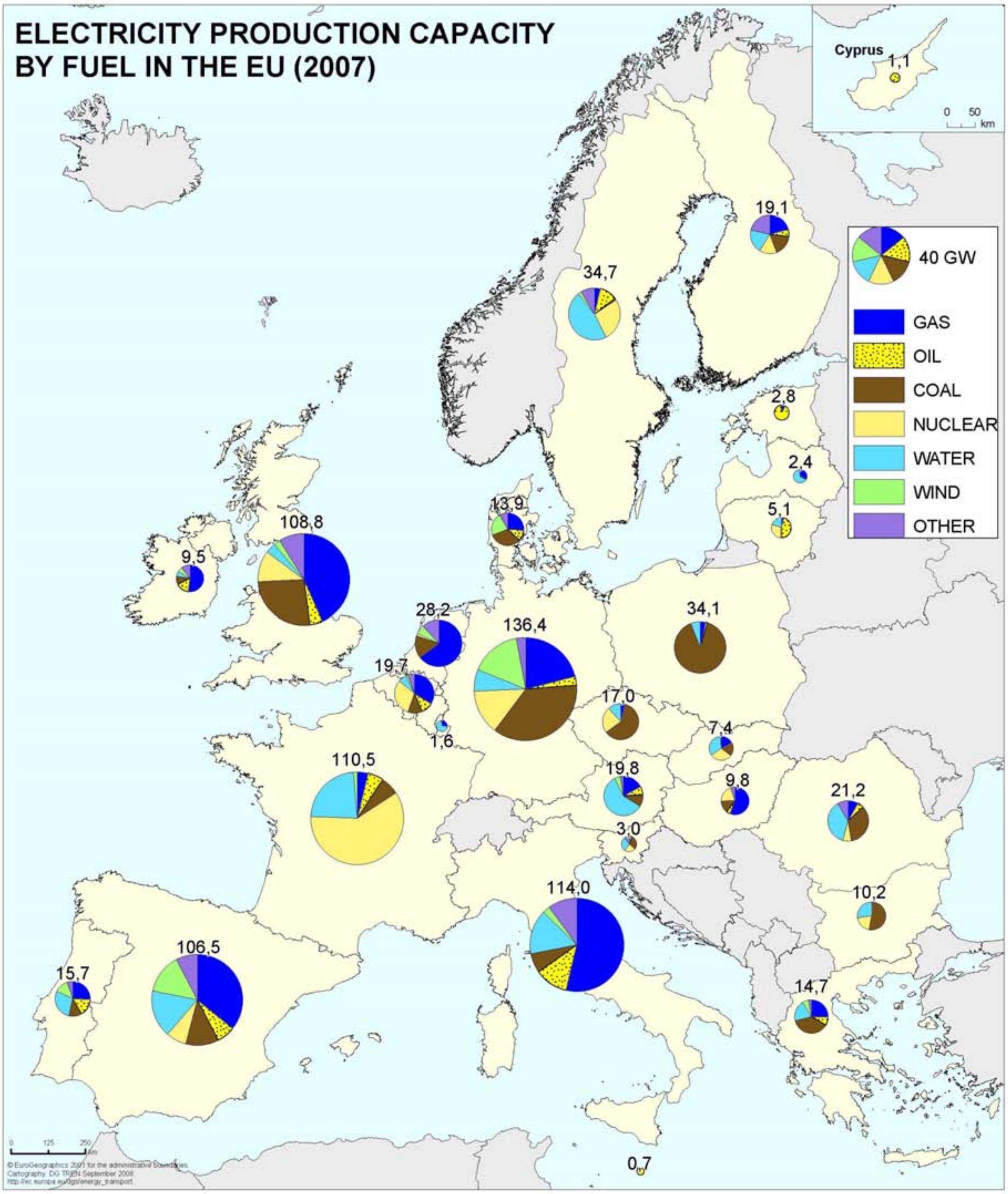
Renewables: not including generation from hydro pumped storage, but including electricity generation to pump water to storage. Municipal Solid Waste, Wood waste, Biogas included.

Source: Eurostat, December 2008

As far as generation capacities are concerned, they are considered to be sufficient in the short and, for certain parts of the EU, medium term to meet the demand. However, without new capacities coming on stream, disruptions may occur at EU level from 2015 onwards and even earlier in some parts of the EU, in particular for central Europe (CZ, HU, PL, Slovakia) and Baltic countries, notably as a result of the planned decommissioning of nuclear power plants.[25]

Figure 8: Electricity Production capacity in the EU-27

[25] EU Commission, 2008, Second Strategic Energy Review - An EU Energy Security and Solidarity Action Plan, COM(2008) 781 final, p.43



Source: EU Commission, 2008, Second Strategic Energy Review - An EU Energy Security and Solidarity Action Plan

4.5 Technology (energy supply)

Energy technology is essential to reach both, the goal of the Energy Policy for Europe to deliver sustainable, secure and competitive energy as well as the EU's target to reduce GHG emissions as well as EU global primary energy use by 20% and to ensure 20% of renewable energy sources in the EU energy mix.

Yet, at present time the impression is that Europe there is a lack in innovation and investment in new energy technologies. This has been described as the greatest and widest-ranging market failure ever seen.[26]

Public and private energy research budgets in the EU have declined substantially since peaking in the 1980s in response to the energy price shocks. This has led to an accumulated under-investment in energy research capacities and infrastructures. The energy innovation process suffers from unique structural weaknesses and is characterised by long lead times to mass market due to the scale of the investments needed and the technological and regulatory inertia inherent in existing energy systems. Innovation faces entrenched 'locked-in' carbon based infrastructure investments, dominant actors, imposed price caps, changing regulatory frameworks and network connection challenges. The market take-up of new energy technologies is additionally hampered by the commodity nature of energy. New technologies are generally more expensive than those they replace while not providing a better energy service. Some technologies face social acceptance issues and often require additional up-front integration costs to fit into the existing energy system. Legal and administrative barriers complete this innovation averse framework.[27]

As a consequence of the market's failure to provide a sufficient level of innovation the EU decided in 2007 to set up a European Strategic Energy Technology Plan (SET-Plan)[28] that shall contribute to the development of a more sustainable energy systems. The major pillars of this plan are to establish stable conditions for the finance sector and for companies, to influence citizens' socio-economic behaviour by encouraging better energy use, to stimulate technological innovation from basic research through to commercial production and to identify the most promising technologies.

Some of these technologies (mostly at the energy supply side) have been analysed with respect to their current status of usability, potential and impacts as well as with respect to existing barriers to the respective technology and also regarding existing needs to develop it further.[29] Table 2 presents an overview of these technologies, including the barriers to using them more extensively as well as their needs. As the results show, the potential of most technologies remains so far largely unused, except for nuclear fission, large scale hydropower and co-generation of heat and power. Furthermore to all but one technology (biofuels) there exist a large list of potential barriers, ranging from infrastructure deficiencies, lack of skilled professionals, lack of R&D support and administrative shortcomings.

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[26] A European Strategic Energy Technology Plan (SET-Plan), 'Towards a low carbon future', Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee Of The Regions, COM(2007) 723 final, p.3

[27] A European Strategic Energy Technology Plan (SET-Plan), 'Towards a low carbon future' p.3 ff.

[28] EU COM(2006) 847 final and EU COM(2007) 723 final

[29] EU Commission, 2007, A European Strategic Energy Technology Plan (SET-Plan) - Technology Map, Commission Staff Working Document, SEC(2007) 1510

Table 2: Future energy supply technologies, status, barriers and needs.

TECHNOLOGY AVENUE	DESCRIPTION 1) Sector 2) Current market share 3) State of the Art	BARRIERS	NEEDS
WIND POWER	1) Power generation 2) 3% of demand 3) Onshore wind: commercialised Offshore wind: Starting deployment	Inflexible grid infrastructure Lack of large-scale testing facilities Under-developed storage mechanisms Disparate level of financial support Lack of social acceptance Lack of skilled professionals	Upgrading of grid infrastructures and appropriate EU regulations for grid integration Large-scale test facilities / R&D for upscaling Better coordination of financial support schemes across the EU Specialised education programmes Support of innovation in SMEs
SOLAR PHOTOVOLTAICS	1) Power generation 2) 0.1% of demand 3) Small scale: commercialised Large scale: Development Thin films: Development	High cost of electricity Techno-economic issues Building integration Lack of skilled professionals Access to grid Regulations and administration	R&D Development of a liberalised market Financial incentives Framework to facilitating exports
CONCENTRATED SOLAR POWER	1) Power generation 2) 0% of demand 3) Parabolic trough : commercialised Central receiver: commercialised Dish receiver: Demonstrated	High cost of electricity Lack of feed-in support in most EU country Equity shortage for demonstrating first of a kind project Investments in grid infrastructure	Expansion of feed-in tariffs for CSP in the EU Risk sharing financing mechanisms for large scale demonstration and commercialisation projects R&D and Demonstration Open EU market to CSP imports Investment in a trans-European and trans-Mediterranean Super grid Framework to build-up a global market
SOLAR HEATING AND COOLING	1) Heat generation 2) 2% of demand 3) Small scale for hot water: commercialised Combi-systems: Demonstrated Cooling systems: Development Medium temperature industrial systems: development	Heat storage Lack of financial incentives Building integration Lack of skilled professionals Regulations and administration	R&D in energy storage and materials research Financial incentives for the deployment of the technology
HYDROPOWER GENERATION: LARGE HPP	1) Power generation 2) 9% of demand 3) Large scale: commercialised	Lack of institutional support Complex regulations and administration Lack of support for R&D and Demonstration Equity shortage for R&D development and Demonstration Social acceptance	Increased R&D and Demonstration public support Focussed and co-ordinated R&D and Demonstration programme at the EU level Coherent, harmonised and conducive regulation and administration frameworks across the EU
HYDROPOWER GENERATION: SMALL HPP	1) Power generation 2) 1% of demand 3) Small scale: commercialised Very small scale: Development	Lack of institutional support Complex regulations and administration Lack of support for R&D and Demonstration Equity shortage of SMEs for R&D development and Demonstration Social acceptance	Increased R&D and Demonstration public support Focussed and co-ordinated R&D and Demonstration programme at the EU level Coherent, harmonised and conducive regulation and administration frameworks across the EU
GEOTHERMAL	1) Heat and power generation 2) Less than 1% of demand 3) Heat pumps commercialised DH commercialised Enhanced geothermal power system RD&D	Lack of appropriate legislation Lack of financial incentives Lack of clarity in administrative procedures, long permit time Lack of skilled professionals Lack of social acceptance Fragmentation of existing knowledge	Coherent financial support mechanisms Additional incentives Appropriate regulations, standards, permit procedures RD&D support International collaboration and centralisation of existing knowledge Vocational and training programmes
OCEAN WAVE POWER	1) Power generation 2) Null 3) Large scale systems : Demonstrated < 1 MW, ongoing up to a few MWs	Cost competitiveness of ocean electricity High cost of technology learning Lack of dedicated engineering capacities and of private investments Cost of off-shore grid and unavailability of on-shore grid Administrative and legislative Coastal use	R&D and Demonstration Coordinated approach at EU level Long term feed-in tariff and capital investment support Coastal management at EU level
COGENERATION OF HEAT AND POWER	1) Power generation / District heating / Industry 2) 10% of demand 3) Large/medium scale: commercialised Micro-CHP, fuel cells: R&D evaluation	Lack of coherent policies in some MS Market liberalisation exposes short term profitability projects Market uncertainties about fuel and electricity prices Many (older) installations now operate with lower efficiency and uncompetitive costs level	Improved efficiency across the sectors, especially electrical Improvements in bio-CHP technology Innovations on thermal (heat) storage technologies and improved cooling systems Performance improvement for heat

		Correlation of heat and electricity demand Slow progress on micro-CHP development	distribution infrastructure for district heating R&D, demonstration and financing small scale CHP (fuel cells and micro-CHP) that lead to their mass introduction Support transition to decentralised energy supply
ZERO EMISSION FOSSIL FUEL POWER PLANTS	1) Power generation 2) Null 3) Individual components commercialised in smaller scales Overall, in advanced research and validation phase, ready to embark on large scale demonstration	Technology not demonstrated at large scale High cost of first-of-a-kind plants Unfavourable market and regulatory conditions Lack of supportive fiscal measures Lack of CO2 transmission and storage infrastructure Public acceptance	Research and development Large scale demonstration projects Development of a suitable regulatory and market framework Development of CO2 transport and storage infrastructure
NUCLEAR FISSION POWER	1) Power generation (Gen-IV with heat generation) 2) 31% of demand 3) Gen-III: Mature technology. Gen-IV: depends on concept. Basic research still required for all designs leading to strategic decisions by 2012 at the latest. First of a kind and demo plants (VHTR and SFR) by 2020	Lack of overall EU nuclear strategy Lack of harmonised regulations and standards Public/political acceptance Insufficient public R&D funding for Gen-IV Future availability of suitably qualified scientists and engineers	A stable and predictable regulatory / economic / political environment. Clear EU nuclear strategy Increased support for R&D on Gen-IV; more public funding, public-private partnerships, Joint Undertakings, etc. Better public and stakeholder information and dialogue on nuclear energy Promote education and training in scientific disciplines in general and nuclear technology in particular
NUCLEAR FUSION	1) Power generation 2) None 3) Committed construction of ITER as prototypic experiment aimed at demonstrating the technological feasibility of fusion energy	Limited industrial contributions to the financial sources due to the long-term nature Low availability of suitable trained engineers and scientists S&T challenges on frontier technologies	Strengthen the organisation of fusion development with reinforced industrial participation, in particular within the DEMO design group Reinforcement of education and training programmes Strong political will for shortening the timescale of fusion development through EU and international resources
ELECTRICITY NETWORKS (SMART GRIDS)	1) Power transmission / distribution 2) 75-85% of generation at transmission level 7-10% of electricity consumed lost at transmission and distribution levels 3) Long overhead lines Centralised network control	How to define/share reinforcement and connection cost between stakeholders under discussion Regulatory framework Social oppositions Lack of coordinated research efforts	EU Member States need to invest at least 400-450 b€ in transmission and distribution infrastructures over the next three decades Depending upon distance between new generation and a robust grid (e.g. off-shore wind, concentrated solar power), a further 10 to 25% share of connection costs may add to the global grid investment Shared design for integrating new generation technologies ICT for control and monitoring Standard rules and guidelines
BIOFUELS	1) Transport 2) 3.9 Mt of biofuels in 2005 3) 1st generation: Commercialised 2nd generation: pilot scale demonstrated	No structural barriers Biomass availability and sustainability (including allocation between energy sectors and competition with non-energy sector)	Reinforced and focused public support for R&D at national and EU levels Funding mechanisms for large scale demonstration initiatives Harmonisation of markets, regulations and policies at EU levels
HYDROGEN AND FUEL CELLS	1) Transport and Power generation 2) Null 3) Large scale hydrogen production: commercialised or under development Small scale H2: Demonstration/Commercialised Fuel cells: Demonstration	Long term and disruptive mitigation option Lack of end-use deployment support Regulation and Code and Standards High up-front infrastructure investments for hydrogen production and supply Shortage of equity for SMEs High cost of fuel cells Pending issue of primary resources allocation for hydrogen production	Focussed R&D and large scale Demonstration and market preparation efforts at EU level Long term public and private partnership Establishment of regulatory and financial support schemes Education

Source: Excerpt from EU Commission, 2007, A European Strategic Energy Technology Plan (SET-Plan) - Technology Map, Commission Staff Working Document, SEC(2007) 1510, p. 50ff.

5 Energy transaction issues

5.1 External challenges

5.1.1 Pipelines – General aspects

Recent events between Russia and Ukraine at the start of 2009 and Russia and Georgia in 2008 have demonstrated, that, though pipelines are a convenient way to transport gas or oil from the producer to the buyer, the potential vulnerability increases if the pipelines pass through potentially unreliable or unstable transit countries. Given current expectations this situation is likely to continue or even get worse in the future.

This is because firstly, though because of the current economic crisis energy demand growth has slowed, in the medium to longer term there can be little doubt that more energy will be needed. While for oil the actual amount of trade carried by transit pipelines is uncertain, given that it mostly moved on the high seas in large tankers (but by rail and trucks), there for natural gas only two serious transport options: pipelines and liquefied natural gas (LNG)[30].

Hence, especially with respect to gas, pipelines will gain in further importance as the reserves close to market are being depleted and new reserves are being discovered further away from markets. Thus, gas has to be transported not only over longer distance but also through a lot more countries, which in turn means trough a lot more different jurisdictions, making it more difficult to find fair transit arrangements (for all three partners: producer, transit country and buyer).

However, history shows that -as a matter of fact- a “fair” transit arrangement might be difficult to achieve, as such arrangements are the result of the relative bargaining power between the parties to the transit agreement and the benefits associated with the project at the time the agreement is reached. However, the nature of the ‘obsolescing bargain’ and the fact that the ‘rent’ associated with the project will change with changing oil and gas prices make conflict inevitable if terms do not reflect changing realities.[31]

Though analysis shows that there are number of ways to make transit pipelines less troublesome, spanning from military actions against the transit country, to the greater use of FDI or to develop a common jurisdiction through mechanisms such as the WTO etc. it is likely that international oil and gas markets must live with the potential instability. The only way to mitigate this would be through diversification for both consumers and producers, as far as is economically practical.[32]

5.1.2 Pipelines – diversification of EU’s external supply routes

The need to increase the number of potential gas suppliers to the EU, to reduce the EU’s vulnerability to supply shocks and the need to diversify transport routes is well established in the EU’s large scale energy infrastructure projects. Thus the Community Guidelines by the Community for the trans-European energy networks (TEN-E) state the EU has to act in order to ensure the “interoperability of natural gas networks within the Community and with those in accession and candidate countries and other countries in Europe, in

[30] Stevens, Paul, 2009, Transit Troubles - Pipelines as a Source of Conflict, A Chatham House Report, p.3
[31] Stevens, Paul, 2009, op.cit. p.29
[32] Stevens, Paul, 2009, op.cit. p.29

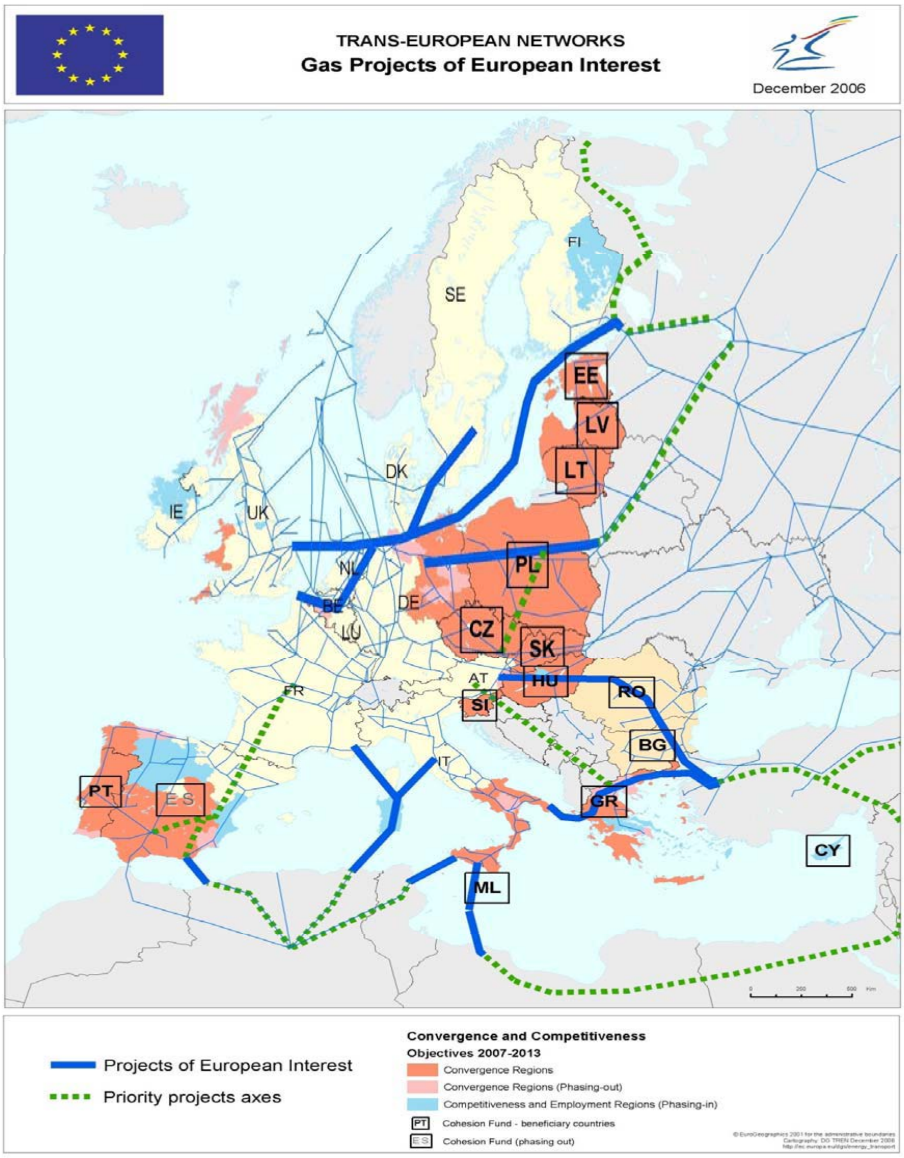
the Mediterranean Sea, Black Sea and Caspian Sea basins, as well as in the Middle East and the Gulf regions, and diversification of natural gas sources and supply routes."[33]

The TEN-E Guidelines identified in total 314 infrastructure projects ("projects of common interest") whose completion should be facilitated and speeded up. Amongst those are 42 high-priority (energy and gas) "projects of European interest" which are either cross-border in nature or have significant on cross-border transmission capacity.[34]

With respect to gas the TEN-E Guidelines identified 6 axes for priority projects ("Gas Networks") containing in total 10 gas pipelines of "European interest". Figure 9 presents a map with these pipeline projects. Amongst those 10 pipelines 7 link to EU neighbouring countries, these are[35]:

[33] EC, 2006, Decision No 1364/2006/EC of the European Parliament and of the Council laying down guidelines for trans-European energy networks, Article 4
[34] EU Commission, 2006, Priority Interconnection Plan, Communication from the Commission to the Council and the European Parliament, COM(2006) 846 final/2, p.3
[35] EC, 2006, Decision No 1364/2006/EC of the European Parliament and of the Council laying down guidelines for trans-European energy networks

Figure 9: Gas pipelines of "European Interest"



Source: EU Commission, 2006, Priority Interconnection Plan, COM(2006) 846 final/2

- Yamal (Russia)— Europe gas pipeline
- Algeria — Tunisia — Italy gas pipeline
- Algeria-Italy gas pipeline, via Sardinia and Corsica, with a branch to France
- Medgas gas pipeline (Algeria — Spain — France — Continental Europe)
- Turkey — Greece — Italy gas pipeline linking to the Caspian Sea
- Turkey — Austria gas pipeline (Nabucco) linking to the Caspian Sea

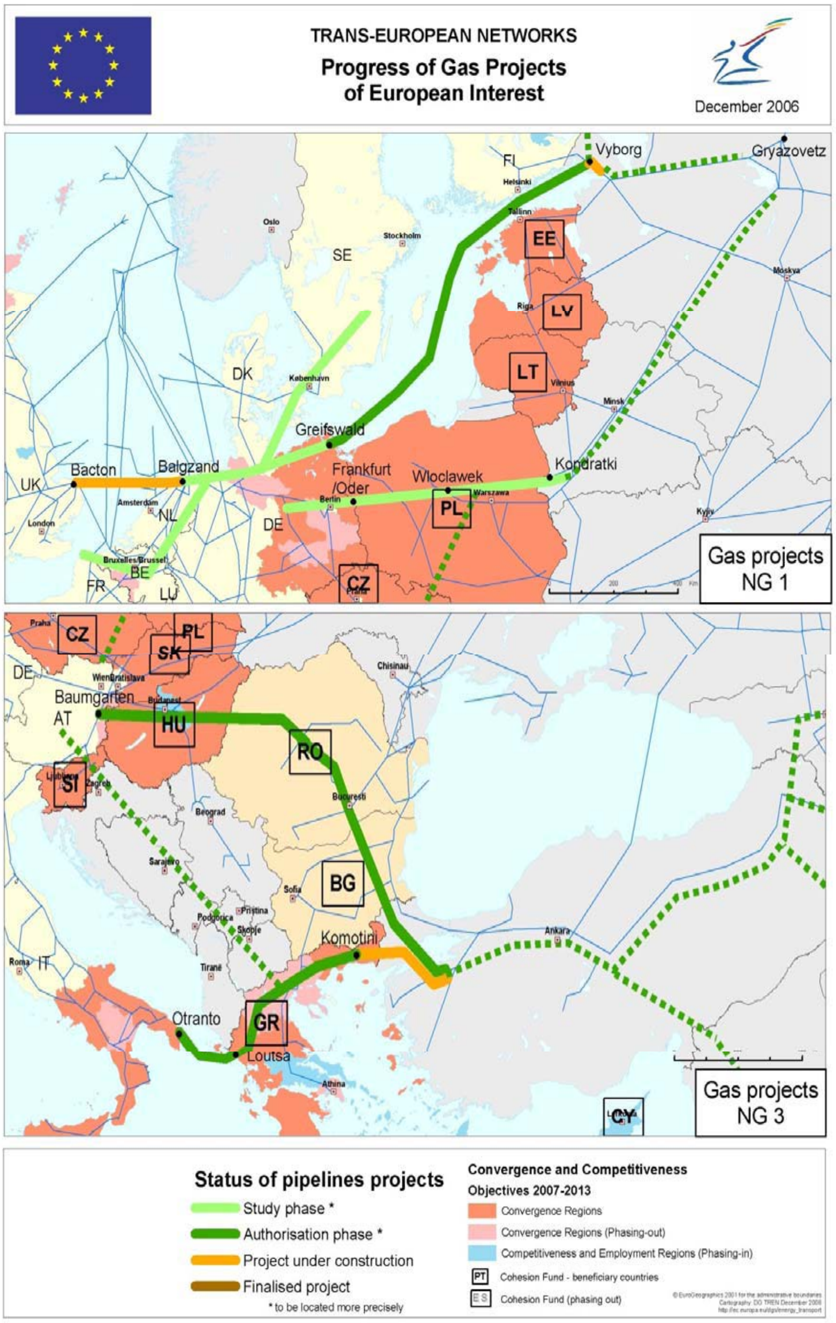
§ East Mediterranean Gas Ring: Libya-Italy gas pipeline (East Mediterranean Gas Ring)

As far as these pipelines are concerned the development seems to be satisfactory as no significant delays have been reported for the majority of the projects. At least seven of the 10 pipeline projects of European interest should start operating by 2010-2013: one gas pipeline has already been completed[36], two are under construction[37], and two others are partly under construction[38]. This infrastructure will represent yearly additional import capacity for the EU of around 80-90 bm³ by 2013 (16-17% of EU estimated gas needs for 2010).[39]

The status of these pipelines is also shown in Figure 10 and Figure 11.

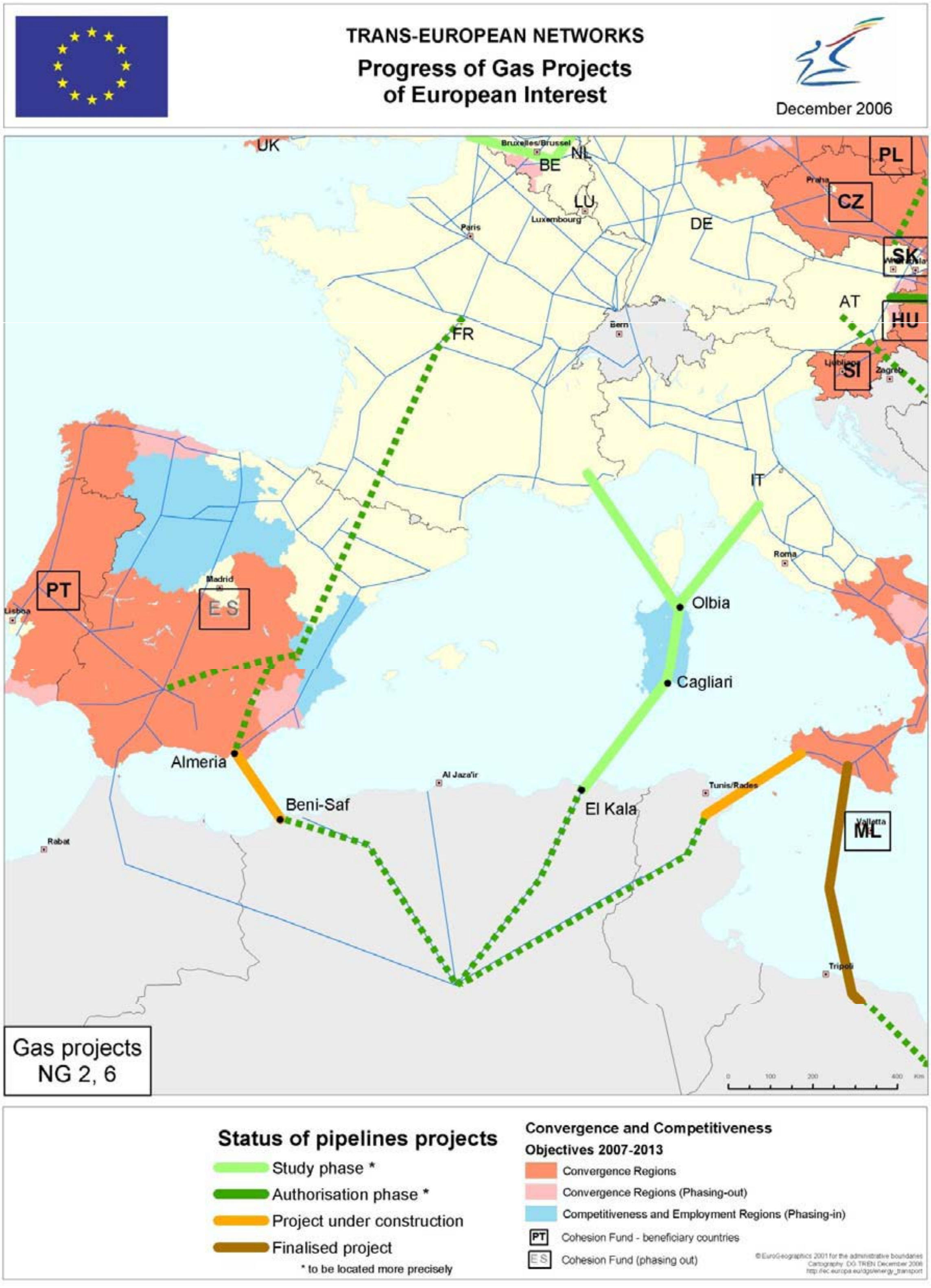
[36] The Green-stream pipeline between Libya and Italy via Sicily
[37] TRANSMED II pipeline between Algeria-Tunisia and Italy via Sicily; the Balgzand – Bacton pipeline between NL and UK
[38] North European gas pipeline; Turkey-Greece-Italy gas pipeline
[39] EU Commission, 2006, Priority Interconnection Plan, COM(2006) 846 final/2, p. 7ff.

Figure 10: Progress of European gas pipeline projects - 1



Source: EU Commission, 2006, Priority Interconnection Plan, COM(2006) 846 final/2

Figure 11: Progress of European gas pipeline projects - 2



Source: EU Commission, 2006, Priority Interconnection Plan, COM(2006) 846 final/2

5.1.3 Liquefied Natural Gas (LNG)

The increase of gas demand in Europe, the growing gap between consumption and indigenous supply and the need to bring in additional gas volumes from diversified sources provide LNG with an excellent opportunity to play a relevant role in the gas supply to Europe.[40] To illustrate, by 2006 LNG represented on average around 10% of total gas demand in Europe. However its importance is steadily growing. Thus in 2006, global LNG trade grew by 12% (on a year to year basis), which by that time was the highest rate ever recorded over the last decade. For Europe the growth rate was even higher, i.e. 21%, giving Europe a market share of 27% of global LNG trade.[41]

In recognition of the potential importance of LNG for supply security and diversification a number of LNG projects (LNG receiving facilities, i.e. terminals) were included in the TEN-E guidelines, though not as priority projects. However the implementation of these projects seems to be less satisfactory than the implementation of the gas pipelines, as work on the 29 LNG terminals and storage facilities has been seriously hampered in various Member States. Nine projects[42] had to be abandoned and it was necessary to look for alternative solutions. Five other LNG's are currently blocked[43].[44]. In 2009 the Commission will assess the global LNG situation and identify gaps with a view to proposing an LNG Action Plan.[45]

Following the preparatory work for the LNG Action Plan, though, it seems likely that "there is not a case, nor a compelling need, for an LNG Action Plan at EU level though there is room for some action."[46] Thus market forces limit the effectiveness of Community action and put under question the need for a specific LNG plan to further promote the development of LNG in Europe.

5.2 Internal challenges – connecting the member states

Europe's energy networks are the arteries on which we all depend for the energy to fuel our homes, businesses and leisure. The EU's energy policy sets out clear goals and objectives (the 20-20-20 target) for sustainable, competitive and secure energy. The renewable energy and climate change package of January 2008 will commit Member States to ambitious renewable energy and emissions reductions targets. However, the EU will not achieve its ambitions unless its energy networks change considerably, and fast.[47]

In order to support an effective energy infrastructure in Europe the EU has formulated a series of policies such as the TEN-E Guidelines, defining high-priority "projects of European interest" (for the high priority gas projects see Figure 9 above) and the introduction of specific rules to ensure an appropriate level of electricity interconnection and gas supply between Member States[48]. Political will to foster the development of

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[40] Study on Interoperability of LNG Facilities and Interchangeability of Gas and Advice on the Opportunity to Set-up an Action Plan for the Promotion of LNG Chain Investments, commissioned by DG TREN Framework Contract: TREN/CC/05-2005, lot 3; Part I p. 4
[41] Study on Interoperability of LNG Facilities and Interchangeability of Gas and Advice..., p.10ff.
[42] LNG terminals on the Ionian Coast, at Corigliano Calabro, on the Tyrrhenian Coast, at Montaldo di Castro, Tyrrhenian Lamezia Terme, Tyrrhenian San Ferdinando, on the Ligurian Coast, at Vado Ligure and second LNG terminal in continental Greece.
[43] LNG terminal at Muggia, LNG terminal at Brindisi, LNG terminal at Taranto, LNG terminal in Sicily, LNG terminal at Livorno (offshore)
[44] EU Commission, 2006, Priority Interconnection Plan, COM(2006) 846 final/2, p. 8.
[45] EU Commission, 2008, Second Strategic Energy Review - An EU Energy Security and Solidarity Action Plan, COM(2008) 781 final, p.5
[46] Study on Interoperability of LNG Facilities and Interchangeability of Gas..., Part II, Task D, p.1
[47] EU Commission, 2008, Green Paper Towards a Secure, Sustainable and Competitive European Energy Network, COM(2008) 782 final, p.3
[48] Directive concerning measures to safeguard security of electricity supply and infrastructure investment, Directive 2005/89/EC of the European Parliament and of the Council of 18 January 2006; and Council Directive concerning measures to safeguard security of natural gas supply, Council Directive 2004/67/EC of 26 April 2004.

European energy infrastructure was also expressed at the European Council June 2006 meeting, as the conclusions asked to "give full support to infrastructure projects compatible with environmental considerations and aimed at opening up new supply routes with a view to diversifying energy imports which would benefit all Member States". In similar fashion, in December 2006 the European Council highlighted the importance of the 'realisation of an interconnected, transparent and non-discriminatory internal energy market, with harmonised rules,' and 'the development of cooperation to meet emergencies, in particular in the case of disruption of supply.'[49]

While in the case of gas (see above) the progress that has been made to connect the EU internally and externally seems to be satisfactory the case is different for electricity networks.

Thus, the Communication "Priority Interconnection Plan"[50] notes that energy trade is still discriminatory and prevents EU companies from entering other members states energy markets. Moreover the level of investment as well as co-ordination between national energy networks to facilitate cross-border trade of energy are much too low. Furthermore Networks are operating each year closer to their physical limits with an increased probability of temporary supply interruptions. Many countries and regions are still an "energy island", largely cut off from the rest of the internal market. This holds in particular for the Baltic States and the new Member States in South-East Europe.

The investments in the cross-border infrastructure in Europe are considered much to low. To illustrate, only €200 million yearly is invested in electricity grids with as main driver the increase of cross-border transmission capacity. This only represents 5% of total annual investment for electricity grids in the EU, Norway, Switzerland and Turkey. These figures do not even match the needs of an effective infrastructure in line with the objectives of the European Energy Policy. The EU will need to invest, before 2013, at least €30 billion in infrastructure (€6 billion for electricity transmission, €19 billion for gas pipelines and €5 billion for Liquefied Natural Gas (LNG) terminals), if it wants to address fully the priorities outlined in the TEN-E Guidelines. Moreover, connecting more electricity generated from renewable sources to the grid and internalising balancing costs for intermittent generators will for instance require an estimated €700-800 million yearly.

Thus the Communication "Priority Interconnection Plan" concludes that, "if the EU continues on its present infrastructure course, none of the EPE objectives will be met. Because of congestion, energy prices will be higher. The development of renewable energy sources will be hampered by the lack of network transmission capacities either within or between Member States. Recent experience shows that a significant bottleneck exists for the development of green sources of energy. As a result of insufficient network transmission capacities and constrained production, each national electricity market will also need more reserve generation capacity to face unpredicted peak increases of demand or unexpected failures of generators leading to a less efficient power system".[51] Similar critique is raised in the Green Paper: "Towards a Secure, Sustainable and Competitive European Energy Network" (COM(2008) 782 final).

[49] EU Commission, 2006, Priority Interconnection Plan, COM(2006) 846 final/2, p.4
[50] EU Commission, 2006, Priority Interconnection Plan, COM(2006) 846 final/2
[51] EU Commission, 2006, Priority Interconnection Plan, p. 5ff.

5.3 Energy prices: oil

High oil prices can lead to substantial impacts on core areas of economic activity[52]. Before the economic crisis oil prices have risen to record levels, have been more volatile, and have more often than not confounded the expectations and forecasts of leading energy analysts and institutions. Still oil and gas prices are one of the key determinants of the future EU energy policy, as e.g. high prices for fossil fuels would speed up the production of fuel from alternative sources, while low prices would have the opposite effects. Likewise, (abrupt and unforeseen) changes in oil prices have a differentiated impact on countries or regions depending on their degree of specialisation in energy intensive sectors of production or depending on the reliance on exporting activities. At the same time they also have a differentiated effect on consumers, e.g. depending on their income levels or depending on whether they have to commute (by car) from the place where they live to the place where they work.

Thus, as oil prices have a significant impact on macroeconomic and individual welfare a clear view on how oil prices are going to develop in the future would enhance the potential to adapt to future price levels for all layers of economic decision making.

Referring to the literature there exist a number of recent analysis attempting to explain how oil prices are formed on the market. Firstly, the role of market tightness (lack of spare production capacity, low stockholdings, tight refining capacity) is clearly recognised, though recent empirical research[53] suggest that the role played by commercial stocks in oil importing countries for the oil price is higher than expected so far. Other analysis, focusing on the supply side, find that past economic and financial shocks can have long-lasting and persistent effects on oil price formation given the long lead times of investments in production capacity[54]. In turn, game theoretic approaches suggest that from 1986 to 2003 oil prices fluctuated within a given "target price zone", a pattern that they suggest is consistent with strategic arrangements between Saudi Arabia and the United States, and which ceased to operate after 2003.[55] In parallel, the concentration of market power and the degree of cartelisation is a well-recognised factor on the supply side[56]. The latter also concludes that recent price increases were mostly driven by a demand shock (from China and other emerging economies) which exceeded industry expectations. Interestingly the same analysis also finds that purely political factors have very limited explanatory power. Furthermore other analysis suggest that the expectations of financial investors reflected on oil futures markets could affect real industry decisions in terms of inventory (stock) holdings, thereby affecting real demand flows.[57]

Overall, recent literature offers a number if potential determinants of oil price formation. Though this deepens our understanding, it simultaneously leaves the uneasy feeling that in reality oil prices are either hard or hardly predictable.

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[52] for a recent overview see Christie E., Pellenyi G., Barta J., Hegedus M., Holzner M., Oszlay A. and Sass M. (2008), "Economic and trade policy impacts of sustained high oil prices", wiiw Research Reports, No. 346, April.

[53] Dées S., Gasteuil A., Kaufmann R.K. and Mann M. (2008), "Assessing the factors be-hind oil price changes", ECB Working Papers, No. 855, January

[54] Aune F.R., Mohn K., Osmundsen P. and Rosendahl K.E. (2007), "Industry restructuring, OPEC response – and oil price formation", Discussion Paper No. 511, Statistics Norway Research Department, July

[55] Slaibi A., Chapman D. and Daouk H. (2006), "An Econometric Evaluation of a Geopolitical Theory of Oil Price Behavior", Working Paper, Department of Applied Economics and Management, Cornell University.

[56] Wirl F. (2008), "Why do oil prices jump (or fall) ?", Energy Policy, 36 (3), 1029-1043

[57] Domanski D. and Heath A. (2007), "Financial investors and commodity markets", BIS Quarterly Review, Bank for International Settlements, March.

5.4 Electricity and gas prices

Energy networks are not only important for the EU member states' energy supply security or potential to exploit renewable energy sources, they are also key for the liberalisation of the EU's electricity and gas markets beyond national borders. This liberalisation, as much as it encourages the entrepreneurial as well the production of diverse forms of renewable energy or the creation of financial markets, also intends to foster competition between energy suppliers, which in the end should benefit the final consumers of electricity and gas in the form of lower prices.

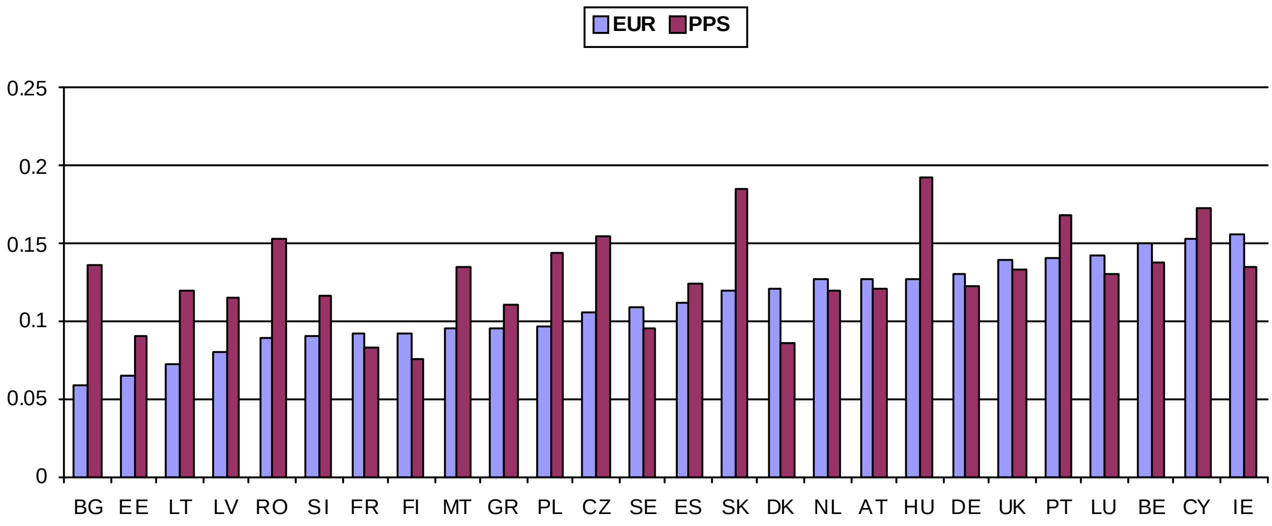
Though liberalisation developments are regarded to be encouraging and underline the benefits of the liberalisation process, the full potential of liberalisation has not yet been realised. There are still a number of areas and Member States where the existing legislation (second internal market package) has not yet been properly implemented or where the need for new legislation has become apparent.[58]

Thus, it is found that e.g. the EU member states electricity and gas markets are so far not adequately connected as the magnitude of congestion rents on the electricity markets suggests that investment in cross-border capacity needs to be increased in order to achieve full market integration.[59]

For that, though there is a clear trend towards increased volumes being traded on the power exchange spot market and power exchanges the physical volumes delivered at most of the hubs are still relatively low compared to the total consumption in their markets. As far as electricity is concerned various factors explain the differences in electricity prices EU countries. First, there are the differing costs of generating electricity (in particular the fuel mix). The second element is the availability of sufficient generation capacity. Thirdly, there is an important role played by the level of competition on the wholesale and retail market. Finally, regulated prices also lead to price differences between Member States.[60] (see Figure 12)

Figure 12: Electricity prices household consumers (without taxes), in €/kWh, 1st half 2008, Euro and PPS

[58] EU Commission, 2009, Report on progress in creating the internal gas and electricity market, Communication from the Commission to the Council and the European Parliament, COM(2009) 115 final, p.2
[59] EU Commission, 2009, op. cit., p.3
[60] EU Commission, 2009, op. cit., p.7ff.



Source Eurostat

In Euro terms electricity prices are lowest in Bulgaria, the Baltic states and Romanian and highest in Belgium, Cyprus and Ireland. Apparently the five Member States with the lowest household electricity prices all have regulated prices. When purchasing power standards (PPs) are taken into account, electricity prices are high for households in Hungary, Slovakia, Czech Republic and Romania (all taxes included). Electricity prices are lower for households in Finland, France, Denmark and Estonia.

As far a gas prices are concerned (see Figure 13), the UK has the lowest (non-regulated) gas price for household consumers, though prices are higher than in most of the new member states in Central and Eastern Europe. In the Netherlands, too, gas prices are relatively low. Both of these Member States are major producers of indigenous gas. In terms of PPS, the highest prices to household gas consumers were in Sweden, Bulgaria, Austria, Portugal, the Czech Republic, Slovakia and Slovenia; gas prices were lowest in the UK, Hungary, Latvia, Ireland, France and Estonia.

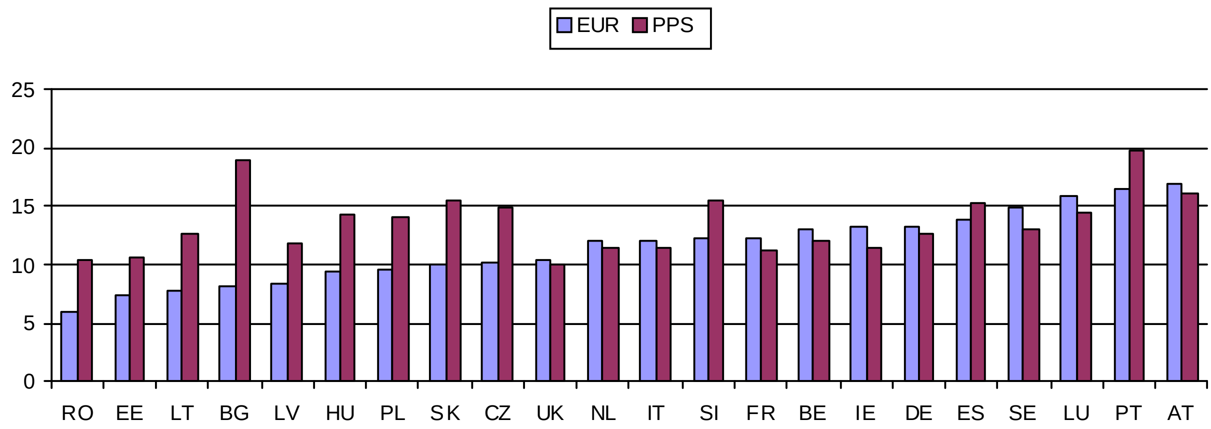


Figure 13: Gas prices for household consumers (without taxes), in €/kWh, 1st half 2008, Euro and PPS

Source Eurostat

5.4.1 Environmental taxes

The share of 'environmental' taxes in 2005 varied significantly across the EU Member States: from around 11.6 % of the total tax revenue and social contribution in Denmark to 5.2 % in Belgium. Over the period from 1995 to 2005, the change in the percentage of taxation varied considerably too: with six Member States increasing their share by more than 25 % and more than nine Member States reducing their share by over 10 %. The share of taxes applied directly to pollution/resources is much smaller, with the exception of Denmark and the Netherlands, where in 2005 it accounted for about 2.6 % and 1.6 % of the total revenue, respectively.

It is difficult, however, to draw conclusions about the 'environmental friendliness' of the tax system in each country without examining the specifics of that system (32). In principle, a low share of the total revenue may indicate little use of environmental taxes, or, conversely, it may indicate successful use, whereby the consumers' behaviour has been influenced by the tax and shifted away from the polluting goods, thus eroding the tax base. Almost all of these taxes are not directly related to the internalisation of external costs and are implemented primarily to fulfil a range of policy objectives, in particular general revenue raising.[61]

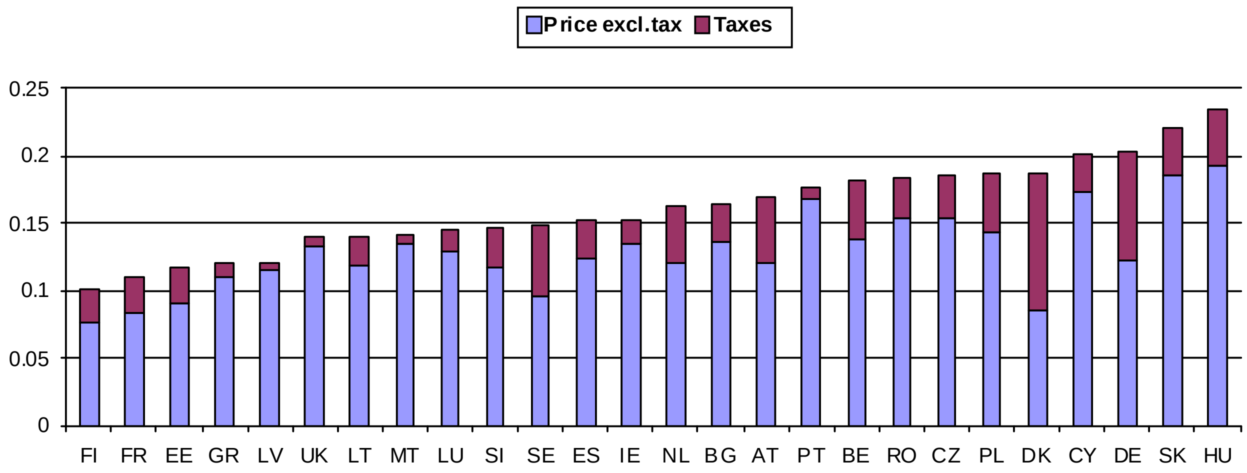
From 1995 to 2005, a number of countries (such as Slovakia, Estonia, Latvia, Poland and Lithuania) have seen increases of over 50 % in the share of 'environmental' taxes in their total tax revenue, though from a low level. This has been driven largely by an increase in energy taxes (via a combination of the tax base being broadened, raising existing and introducing new taxes). Whilst growth in taxes on pollution/resources has been more rapid in a number of cases, this has been from a very low base. A notable exception is Denmark, where the share of pollution/resource taxes in the total revenue increased from 0.7 % in 1995 to

[61] European Environment Agency, 2008, Energy and environment report 2008, p.62

2.6 % in 2005 (accounting for most of their increase in 'environmental' taxes over this period) from the introduction of excise duty on a number of polluting substances (such as nitrogen or certain pesticides). [62]

The share of taxes in the household electricity prices in 2008 varied across the Member States from a high of 55 % in Denmark to 5 % in the case of Malta. The average for the EU-15 is 24 %. Similarly, this share in the gas prices ranges from 54 % (in Denmark) to 4 % (in the United Kingdom), with the EU-27 (excluding Italy) average being 19%. The wider differences in taxation in this sector tend to reflect different priorities, High taxes in Denmark are part of a deliberate policy to encourage energy efficiency (following from the earlier oil crises in 1973 and 1979). By contrast, the rate of VAT in the United Kingdom is set at a much lower level as the emphasis is, primarily, on affordable supplies of energy for all consumers, particularly those with lower incomes.

Figure 14: Electricity prices household consumers (with and without taxes), in €/kWh, 1st half 2008,



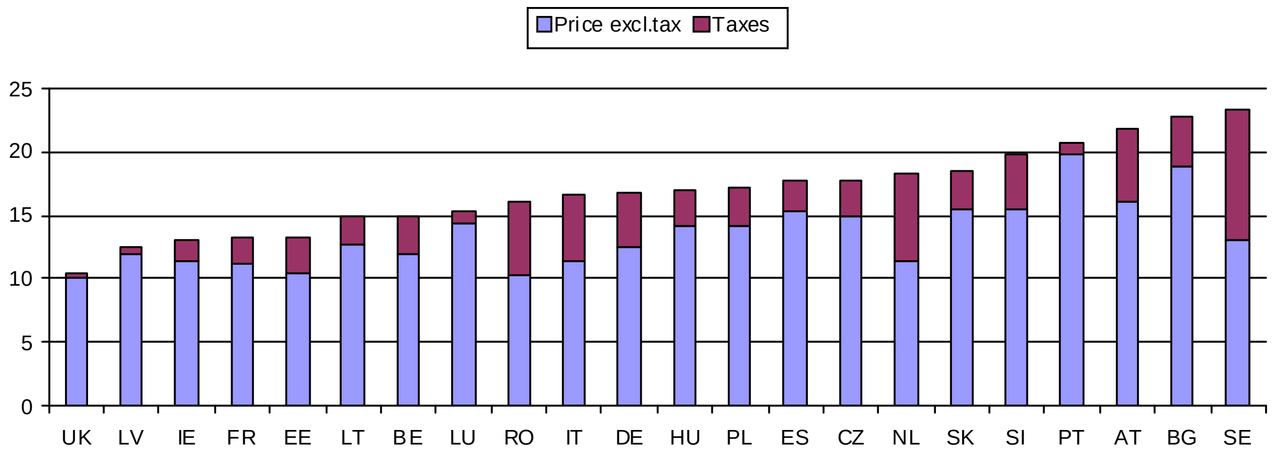
PPS

Source Eurostat

With respect to gas there is an equally wide spread of taxes. Thus, the share of taxes in total gas price to households in 2008 is highest in Romania, the Netherlands and Sweden (35% to 44%) and lowest in the UK, Portugal and Latvia (below 5%). The average share for the EU (22 countries, excluding Denmark, Finland, Greece, Malta and Cyprus) is 19%.

[62] European Environment Agency, 2008, Energy and environment report 2008, p.63

Figure 15: Gas prices for household consumers (with and without taxes), in €/kWh, 1st half 2008, PPS



Source Eurostat

6 Energy demand

6.1 Global trends in energy demand[63]

Trends in global energy demand – fuels

Projections made by the International Energy Agency (IEA) and the OECD suggest that energy demand will increase steadily over the next 20 years[64]. Thus despite a worldwide slowdown of economic growth gross primary energy demand will grow by about 1.6% per year[65].

The demand for fossil fuels is expected to decreases slightly, though in 2030 they will still account for around 80% of the world's primary energy mix. Oil will remain the most important source, though the global demand for it will increase slower (price effect) than for other sources, especially coal, which is projected to grow strongest amongst all fuels. Natural gas is also expected to grow slightly (by around 1.8% per year), and in 2030 it will have a share of around 22% in world primary energy. The share of nuclear power is supposed to decline by one percentage point (from 6% to 5%), while hydropower is expected to increase by 1.9% per year. Nevertheless it's share in world primary energy remains low (around 2%), whereas it's share in the global electricity generation drops by 2 percentage points to 14% until 2030.

Non-hydro renewables (biomass and waste) will increase by around 1.4% per year and thus slightly less than global energy demand. Yet, there are some major differences between countries. Thus, for the OECD countries the use of biomass and waste for energy production is expected to increase by around 5.4 % per year, and other renewables (wind, solar, geothermal, tidal and wave energy) are projected to grow faster than any other energy source (by around 7.2% per year). This will increase their share in total power generation from 1% to 4% until 2030.

Trends in global energy demand – countries

Until 2030 energy demand is expected to grow much stronger in non-OECD countries than in the OECD countries (by 2.4% and 0.5%, respectively). Consequently the share of the non-OECD countries in primary energy demand will rise from 51% to 62% until 2030. The increase in demand will be strongest in India (3.5% per year), the Middle East (3.2%) and China (3.0%), though in absolute numbers (i.e. correcting for the size of the economy) China's energy demand is by far higher than elsewhere. Thus, China's share in the incremental global oil demand (up to 2030) is around 43% (and thus four times bigger than the share of combined Latin America and Africa) and with respect to coal it is even 66%. The contribution of the Middle East and India to the incremental oil demand is around 20% each.

The changes in the fuel mix is highly differentiated between world regions. In the OECD countries, oil demand is expected to fall, while the demand for natural gas and renewables will increase strongest. China and India, by contrast, continue to rely mostly on coal. In Latin America and other Asian countries the additional energy demand is covered mostly by a mix of oil, gas and renewables, while in Africa around 40% of the incremental energy demand refers to renewables. The Middle East overwhelmingly relies on gas and oil.

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[63] This part rests on the World Energy Outlook, 2008 by the International Energy Agency/OECD and on the "Second Strategic Energy Review - An EU Energy Security And Solidarity Action Plan" (COM(2008) 781 final).
[64] The IEA/OECD projects global energy trends until 2030.
[65] These projections were made before the full extent of the global economic crisis was visible. Because of that it can be assumed that the projections have an upward bias.

Table 3: World energy demand by region, projections until 2030

	2000	2006	2015	2030	annual average growth 2006-2030
OECD	5,325	5,536	5,854	6,180	0.5
North America	***2,705***	***2,768***	***2,914***	***3,180***	***0.6***
Europe	***1,775***	***1,884***	***1,980***	***2,005***	***0.3***
EU	1,722	1,821	1,897	1,903	0.2
Pacific	***845***	***884***	***960***	***995***	***0,5***
Non-OECD	**4,563**	**6,011**	**8,067**	**10,604**	**2.4**
E.Europe/Eurasia	***1,015***	***1,118***	***1,317***	***1,454***	***1.1***
Russia	615	668	798	859	1.1
Asia	***2,191***	***3,227***	***4,598***	***6,325***	***2.8***
China	1,122	1,898	2,906	3,885	3.0
India	460	566	771	1,280	3.5
Middle East	***389***	***522***	***760***	***1,106***	***3.2***
Africa	***507***	***614***	***721***	***857***	***1.4***
Latin America	***460***	***530***	***671***	***862***	***2.0***
World	**10,034**	**11,730**	**14,121**	**17,014**	**1.6**

IEA, World Energy Outlook, 2008, reference scenario

Trends in global energy demand – sectors

On a worldwide basis final energy demand in the sectors of economic activity is projected to grow strongest in industry, which, as an effect will overtake transport as the second largest final use sector behind the combined residential, services and agricultural sector. While industry demand grows especially strong in the Middle East and non-OECD Asia, the declining role of the transport sector is mainly due to the increase in fuel efficiency of the transport fleet.

6.2 Current trends in EU energy demand

Energy consumption in the EU27 has stagnated over recent years[66]. Looking at the final energy demand by sector, the transport sector is the biggest consumer. Its share in final energy demand is around one third, while the industrial sector and households account for 28% and 26%, respectively and services for around 13%. Moreover, in contrast to the other sectors, transport was the only sector, where energy demand

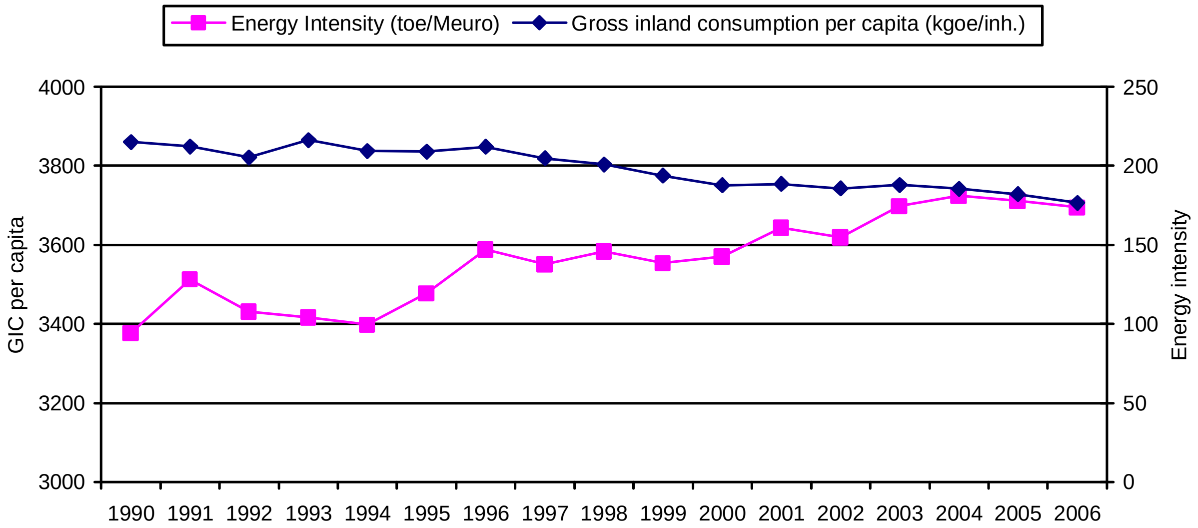
[66] This section rests on the “Second Strategic Energy Review - An EU Energy Security And Solidarity Action Plan” (COM(2008) 781 final)

increased over the last decade (because of the increase of road transport in the CEE new members states, but also in Denmark, Greece, Ireland, Spain, and the UK).

One important reason for the stagnation of EU energy demand was the improvement of energy intensity, especially in industry and to a lesser extent also in transport and services.

As far as the fuel mix is concerned, oil has the highest share in gross inland consumption in the EU-27 (37%). The share of natural gas and solid fuels is around 24% and 20% and the share of nuclear energy is around 14%. Renewables hold a share of around 7%. Over the last years the share of gas, nuclear energy and renewables increased, while there was a significant decline (10 percentage points) of solid fuels.

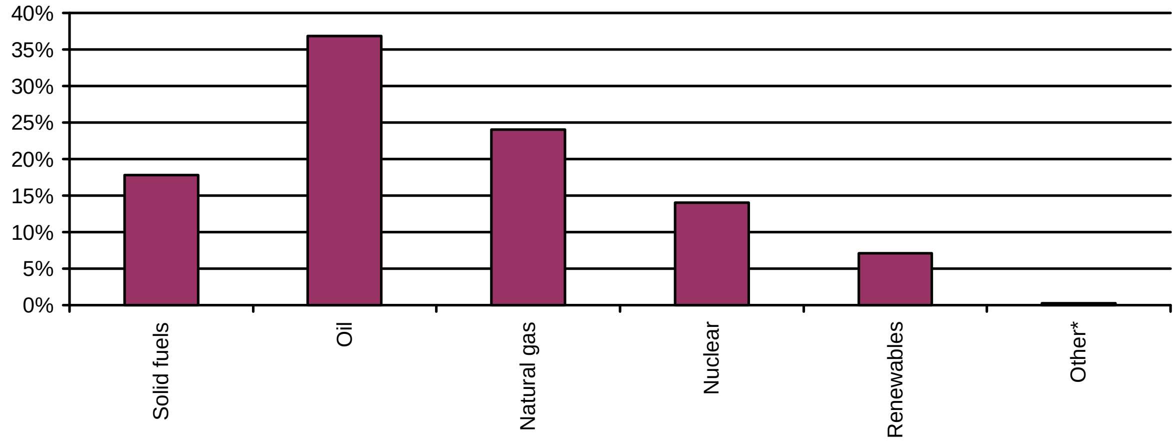
Figure 16: Energy consumption, energy intensity, EU-27



Source: DG Tren, EU Energy in figures 2009

Though, for the aggregate EU-27 the fuel mix is relatively diversified, this is not necessarily the case at the level of individual countries. Hence, oil producing countries like the UK and Denmark rely much more on oil (and in the case of the UK on gas), while e.g. Poland, Estonia favour solid fuels, given their own resources of this fuel type. Similar holds for countries that operate nuclear power plants (foremost France and Sweden).

Figure 17: EU-27 Gross inland consumption by fuels, 2006, in % of total GIC



Source: DG Tren, EU Energy in figures 2009

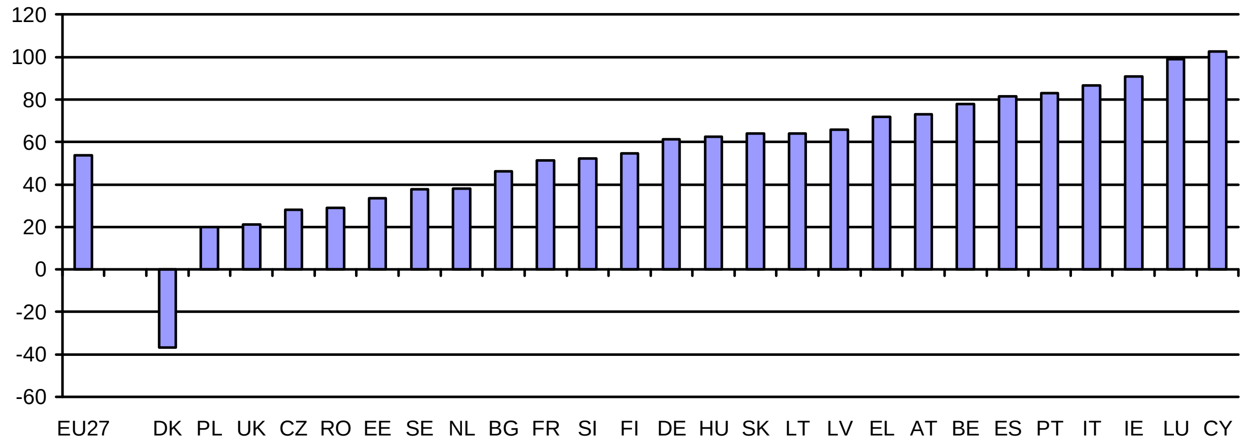
Overall the EU27 is a net importer of energy and its dependency rate is around 54% in 2006; i.e. around half of the energy is covered through indigenous production. Oil comprises the bulk of total EU energy imports (60%) followed by imports of gas (26%) and solid fuels (13%). The proportion of imported electricity and renewable energy is negligible (less than 1%).

The main source countries for oil are the OPEC (38%), followed by Russia (33%). Norway and Kazakhstan provide 16% and 5%. As far as natural gas is concerned, around 40% of EU-27 domestic consumption is covered through own production, though this share is likely to decline in the future as reserves are depleting. Still the majority of the demanded natural gas is imported, predominantly from Russia (42%), Norway (24%), Algeria (18%).

Although overall energy import dependency in the EU is high and continues to increase, the situation varies significantly from country to country. Denmark is the sole country which is completely energy independent, while for some countries, like Poland and the United Kingdom, import dependency ratios are quite low (close to 20%). At the other extreme, Ireland, Italy, Portugal and Spain have import dependency ratios exceeding 80%, while small island countries like Malta and Cyprus along with Luxembourg are fully dependent on energy imports[67].

Figure 18: EU-27 Import dependency, 2006, all fuels

[67] Apart from the high import dependency it is also the case that countries are highly dependent on one single supplier. E.g. Estonia, Latvia, Lithuania, Bulgaria, Slovakia, Ireland, Sweden and Finland are dependent on one supplier for gas imports.



Source: DG Tren, EU Energy in figures 2009

6.3 Future trends in EU energy demand

Primary energy demand and energy intensity

The development of primary energy demand over the next years strongly depends on whether current trends and policies are continued. Thus, given that there is no change in the current trends and policies, primary energy demand in the EU-27 is expected to grow, though a bit slower than in the past. Depending on the oil price EU energy demand will grow by 5% to 9% up to 2020. The main driver for this is the transport sector. By contrast, in the case that policies to enhance energy efficiency are vigorously implemented, energy demand would decline by about 6% to 8% until 2020.

Independent of the implemented polices, energy intensity is projected to improve, as the structure production shifts more and more from energy intensive forms towards services and service oriented forms. Still the extent of the improvements depends on the implemented policies. Under baseline assumptions energy intensity gains would amount to 1.8% to 2% per year, while under the EUs New Energy Policy (NEP)[68] gains would increase to 2.7% to 2.9% per year by 2020. This corresponds to an additional saving of energy of around 13% to 15%.

Fuel mix

Given that current trends and policies are continued, the current fuel mix of the EU-27 that is dominated by oil, gas and solids (oil covers ca. 37% of the demand., natural gas ca. 25% and solids 18%) would largely remain unchanged. Only in the case of high oil and gas prices the demand for oil and gas, the demand for both fuels would decline by around three and two percentage points, respectively.

Contrastingly, under the NEP regime the combined share of oil, gas and solids of in primary energy demand could drop from currently 80% to around 70 % by 2020 (given high oil prices). In that case, the main substitutes are especially renewables and nuclear fuels that could increase their share in the EU's fuel mix to around 28%-30%.

[68] EU Commission, 2007, An Energy Policy for Europe, COM(2007) 1 final

Notably renewables are projected to gain in importance under any circumstances. Thus under baseline assumptions renewables will increase their market share in primary energy to 10% in 2020, while under the NEP the share of renewables increase even to 16% in 2020 making them the third largest source in the EU's fuel mix.

Electricity

Given current trends and policies, final electricity demand is expected to increase over the period to 2030, requiring additional generation capacities. Under the baseline scenario, the EU would need a net power capacity in the year 2020 which is, depending on the oil prices, about 160 or 200 GW higher than today. Under the New Energy Policy scenario, the net power capacity in the year 2020 would be higher than today by about 150 GW to 180 GW depending on the oil price. In addition to creating this amount of extra capacity, it will be necessary to replace existing installations, as an increasing number of the current nuclear and coal power plants reach the end of their life cycle. Thus, capacity expansion covering both replacement of existing capacities and building of new capacities amounts to 360 GW until 2020 under the NEP and slightly more under the baseline scenarios. The estimated investment costs range somewhere around 400 billion Euros till the year 2020.

6.4 GHG emissions

By 2006 the EU-27 accounted for approximately 10.5 % of global anthropogenic GHG emissions. Within the EU the largest greenhouse gas emitters Germany, the UK, Italy, France and Spain, while Poland is the largest greenhouse gas emitter in the new member states (Figure 19). With respect to activities the largest producers of GHG emissions are the production of electricity and heat, road transportation, fossil fuel combustion from households, agriculture, and iron and steel production (Figure 20). Carbon dioxide (CO_2) emissions account for 83 % of total greenhouse gas emissions, while methane (CH_4) and nitrous oxide (N_2O) each represent approximately 8 % of total emissions.

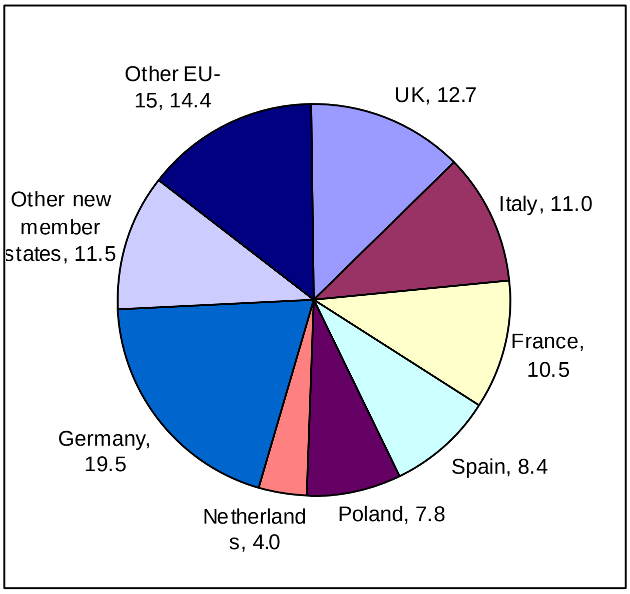


Figure 19 Share of GHG emissions in the EU-27 by main emitting countries

Source European Environment Agency, 2008, Greenhouse gas emission trends and projections in Europe 2008

In per capita terms GHG emissions tend to vary widely across Europe. On average the EU-27 produced in 2006 10.4 t CO2-equivalent per capita, whereby the EU-15 countries produced slightly more than average (10.7 t CO2-equivalent per capita) (Figure X3)

Over the last two decades or so GHG emissions decreased by 7.7 % in the EU-27, especially in Germany, the United Kingdom and most of the new member states. By contrast emissions increased most (in absolute terms) in southern EU-15 Member States (Spain, Portugal, Greece and Italy). In per capita terms emissions in the EU-27 tended to decreased between 1990 and 2006. However, in the new member states per capita emissions have been increasing in recent years, pari passu with their strong increase in the level of economic development (Figure 21).

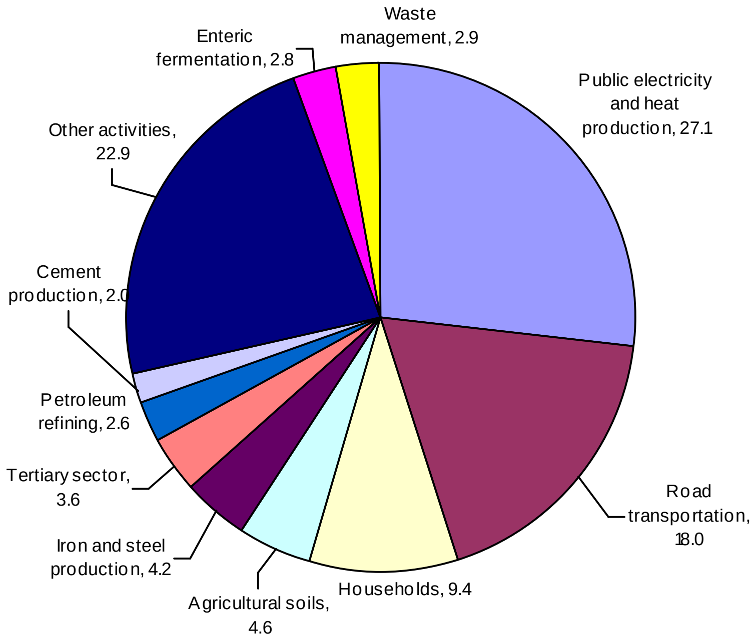


Figure 20: Share of GHG emissions in the EU-27 by main activities

Source European Environment Agency, 2008, Greenhouse gas emission trends and projections in Europe 2008

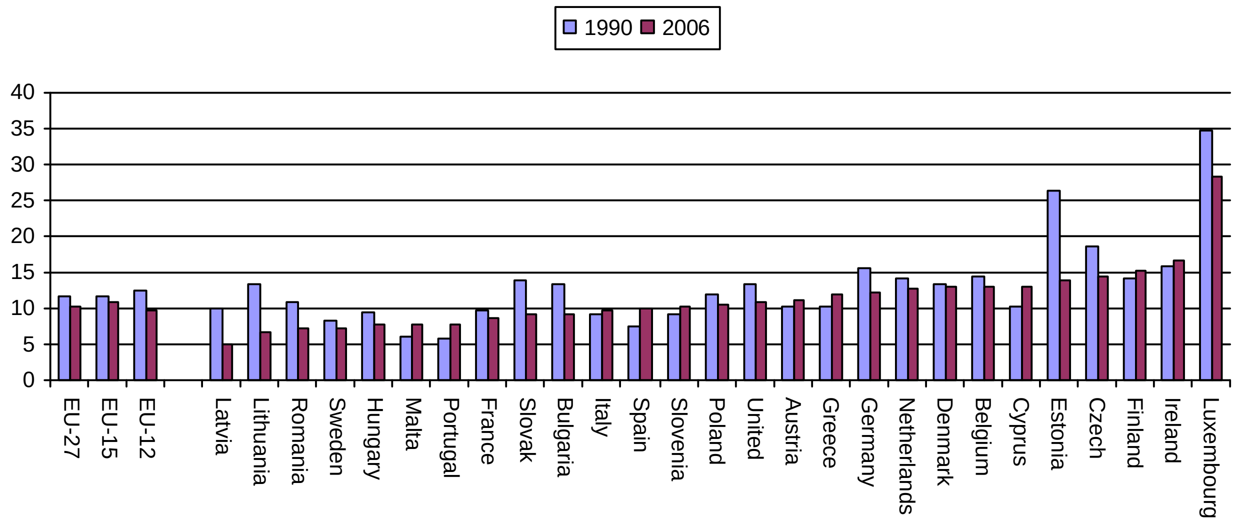
As far as future developments with respect to GHG emissions are concerned, the 27 Member States have ratified the Kyoto Protocol and committed themselves to reduce GHG by 8% below 1990 levels (the target for Poland and Hungary is 6%, while Malta and Cyprus do not have a target). As such, provided all member states reach their respective Kyoto targets by 2012 this would contribute to a 2.4 % reduction of the total greenhouse gas emission of industrialized countries. By 2006 GHG emissions in four EU-15 Member States (France, Greece, Sweden and the UK) as well as nine of the new member states (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and the Slovak Republic) were below their respective Kyoto targets. By contrast, seven EU-15 countries (Austria, Denmark, Finland, Germany, Ireland, Italy and Spain) need further reductions of their domestic GHG emissions until 2012.

Until 2010 EU-15 emissions are projected to decrease by 1.0 % (compared to 2006) and the implementation of additional measures in ten member states is projected to bring a further reduction of 3.3 (main contributors are Germany, Italy, the UK and Spain). In the new member states Cyprus, the Czech Republic, Estonia and Slovenia are the only Member States projecting that their emissions will decrease between 2006 and 2010. As far as the Kyoto targets are concerned, the EU-15 will, provided that all policies and measures exploit their full potential, reduce its emissions 11.3 %, well below the Kyoto target of – 8.0 %. The case is similar for the new member states.

However, though reaching the Kyoto target current projections also suggest that the EU-27 will not be able to reach its self-set goal of a 20 % reduction of GHG emissions target.[69]

[69] Source European Environment Agency, 2008, Greenhouse gas emission trends and projections in Europe 2008, p. 27ff.

Figure 21: GHG emissions per capita in the EU 1990 and 2006



Source European Environment Agency, 2008, Greenhouse gas emission trends and projections in Europe 2008

6.5 Energy efficiency

The analysis of energy supply has shown that advances in energy generating technology could contribute to the EU's energy targets. This is just one side of the coin, however, as equally important contributions can be made from the energy demand side through improvements in the efficiency of energy use.

According to the EU Commission's "Action Plan for Energy Efficiency"[70] the direct cost of the EU's inability to use energy efficiently amounts to more than 100 billion Euros annually by 2020. Thus it follows that energy saving is the by far the most effective way concurrently to improve security of energy supply, reduce carbon emissions, foster competitiveness and stimulate the development of a large leading-edge market for energy-efficient technologies and products.[71]

Furthermore, following the same source, it is estimated that even with current technologies it is feasible to save at least 20% of total primary energy by 2020. Thereby the largest energy saving potential lies in the residential and commercial buildings sector (mainly services), where energy consumption could be reduced by up to 30%. Almost equally large savings are possible in the manufacturing industry as well as for transport (around 25-26% each). Table 4 summarizes these information and also provides some details on the current and future energy demand by these sectors.

[70] EU Commission, 2006, Action Plan for Energy Efficiency: Realising the Potential, Communication from the Commission, COM(2006)545 final
[71] EU Commission, 2006, Action Plan for Energy Efficiency: Realising the Potential, p.3

Table 4: Estimates for full energy saving potential in end-use sectors

Sector	Energy consumption (Mtoe) 2005	Energy Consumption (Mtoe) 2020 (Business as usual)	Energy Saving Potential 2020 (Mtoe)	Full Energy Saving Potential 2020 (%)
Commercial buildings (Tertiary)	157	211	63	30%
Households (residential)	280	338	91	27%
Transport	332	405	105	26%
Manufacturing Industry	297	382	95	25%

Source: EU Commission, 2006, Action Plan for Energy Efficiency: Realising the Potential, Communication from the Commission, COM(2006)545 final, p.6

To achieve this energy savings there exists quite a large number of potential options. The impact assessment of the EU's Action Plan for Energy Efficiency"[72] notes that in total there were around 160 actions that were assumed to contribute to energy saving. Out of these number 54 actions were chosen for an overview analysis and from that 18 priority measures were identified.[73] These 18 actions range from increasing the efficiency of energy producers, suppliers and distributors, increasing the efficiency of buildings, using tax incentives as well as a number of measures with respect to transport. An overview of the 18 measures is provided in Table 5. (The list of the 54 actions is provided in EU Commission, 2006, Action Plan for Energy Efficiency: Realising the Potential, Communication from the Commission, COM(2006)545 final, p.20ff.)

Table 5: Energy efficiency measures proposed by EU Commission – Impact assessment of Action Plan for Energy Efficiency

Option description	Potential Energy savings (Mtoe)
Extending Energy Performance of Buildings Directive to include smaller buildings (<1000 m2), inspection requirements to smaller installations and higher minimum standards for public buildings	80
Extending the concept of white certificate[74] schemes, after evaluation of present national schemes, to all EU-countries and implement obligations on energy suppliers to provide energy efficiency	60
1) Setting maximum CO2 emission standards for different type of cars (absolute, related to specific performance properties, or related to the mean value of all cars sold by one company). 2) Making more stringent agreement with car and truck producers after 2008-2009.	28
Decreasing fuel use by making fuel more expensive. By making the differences between countries less, the incentive of buying cheap fuel across the boarder will decrease. Secondly a lower car tax can be introduced when an efficient car is bought or a financial penalty, which make the buying of a less efficient (second hand) car much more expensive. Thirdly a bigger difference in road tax related to the fuel consumption of a car can be introduced. Even a km charge can be fuel economy dependent.	22
Setting up regulation and/or incentives to increase the average conversion efficiency per fuel type, by installing new plants with best available technology	20
Including running costs in Energy Efficiency Product Listing / labelling or equivalent consumer information	18

[72] EU Commission, 2006, Action Plan for Energy Efficiency: Realising the Potential - Impact Assessment, Commission Staff Working Document, SEC(2006)1174
[73] EU Commission, 2006, Action Plan for Energy Efficiency: Realising the Potential - Impact Assessment, p.16.
[74] White certificates are documents certifying that a certain reduction of energy consumption has been attained.

Making driving costs more km depending. For instance the car or road tax can be made variable. Finally area and congestion charges used for traffic management also have a km reduction effect.	3 to 15
Promoting regulatory change towards facilitation of penetration of "off-grid" power generation – many obstacles to be removed through different measures	16
Stimulating production of energy efficient products through favourable taxation rate in Member States	15
Introducing a policy for labelling fuel efficient tyres or minimum performance requirements for tyres, tyre pressure indicators (dashboard tyre pressure sensors mandatory on cars and freight vehicles, valve pressure indicators compulsory on existing vehicles tyres from 2010) and free facilities at service stations.	15
Promoting regulatory change towards facilitation of penetration of "grid-connected" combined heat and power (CHP), via different measures	14
Stimulating the use of intermediaries for small energy efficiency loans etc	13
Restricting unnecessary power of car engines by technical devices like maximum speed limiters and/or limitation of maximum acceleration. Or limit the maximum power related to the vehicle weight (or maximum load) for new cars and trucks.	11
Including energy efficiency training and information in national education curriculum for primary and secondary schools as part of sustainability awareness.	10
Developing schemes recognising retailers providing information on energy efficiency by allowing public recognition through logo or certification scheme.	6
Increasing policy support for ESCOs (Energy Service Companies) through (1) dissemination of their activities, (2) the development of EU wide quality standards for ESCO projects, (3) standardised project monitoring and verification schemes, (4) model contracts and (5) improve access to (private) financial sources (e.g. cooperation with private banks). These measures could be combined with providing low-interest loans to ESCO projects	<6
Adapting appliance label regulation as to regular updating of the label system, in order to stimulate the marketing of ever more efficient appliances, and extend the system to other devices.	2
Introducing new CEN STANDARD to regulate district heating systems	2

EU Commission, 2006, Action Plan for Energy Efficiency: Realising the Potential - Impact Assessment, p.18ff..

However the introduction of energy efficiency measures or the exploitation of their full potential is often complicated by a number of barriers, such as:

- The lack of internalisation of external costs in current tariff and taxation structures further aggravated by the adverse effects of not fully competitive markets, leads to a situation where a strong incentive to use less energy or electricity is missing.
- Potential divergence of interests, as some peoples' short term gains can be other peoples' long term losses (interpretation of shareholders' value, and the split incentive (owner – tenant) issue, for instance pose barriers to taking up the cost effective potential.
- The income effect (higher income leading to higher energy and electricity consumption) and the rebound effect (energy efficiency gains at same or higher income leading to purchase of products with more options and features and higher energy consumption than the replaced products) lead to higher energy consumption and equally to an increasing mobility and fuel use by different transport modes.
- A lack of enforcement capabilities at all policy making levels, which aggravates the lack of ambition in implementing EU/nationally/regionally or locally decided energy efficiency measures.[75]

[75] EU Commission, 2006, Action Plan for Energy Efficiency: Realising the Potential - Impact Assessment, Commission Staff Working Document, SEC(2006)1174, p.7ff.

6.6 Economic effects

6.6.1 Macroeconomic effects

Oil price shocks have negative impacts on oil importing countries. While this statement was controversially discussed it is supported by the econometric literature, as well as various economic models.[76] To illustrate, the International Energy Agency[77] finds that in the OECD countries an increase oil prices will decrease GDP and raise inflation. Thereby, the effects are stronger in the Asian and developing countries, as energy intensity higher than in the OECD countries. Similar is shown by the US Energy Information Administration [78].

In a recent analysis Lutz and Meyer (2008) [79] analyse in more detail the effects if increasing oil prices on macroeconomic development, looking at the direct and indirect price increases in the major economies, the induced shifts in international trade and structural changes in these countries.[80] Lutz and Meyer work with two scenarios, that were made before the economic crisis and the subsequent drop of oil prices. In their baseline scenario, the oil price reaches 100 $ per barrel in 2010 in current prices and increases to 135 $ in 2020. Coal and gases prices follow the oil price development. In their alternative high energy price (HEP) scenario only the oil, gas and coal world market prices will double until 2010. Thus, given the current situation these prices are too pessimistic, however the results are still indicative of the effects of changes in energy prices (independent of the starting level).

Not surprisingly Lutz and Meyer find that increasing oil prices have strong positive effects on the GDP of the oil exporting countries/regions OPEC and Russia, whereas the net energy importing countries US, Japan, China and Germany suffer losses. Only the UK as a large oil and gas producer with a strong service sector is able to keep its GDP level.

Still, the differences in GDP losses among the different countries have various reasons. Among others, the impact depends on the energy intensity and especially on the share that fossil energy fuels have in energy consumption. The substitution possibilities determine the cost push that hits the economy and its prices. The reaction of domestic demand on the price changes will be important for the total result. Finally, the response of monetary and fiscal policy to stabilize the economy influences the performance of the economy is important. Because of higher energy (oil) intensity emerging Asian economies suffer higher GDP losses than other countries.[81]

To illustrate economic losses because of increasing oil prices will be higher in Japan than e.g. in the US and UK as the latter are oil producing countries, keeping at least part of the growing energy expenditures within the economy. Japan on the other hand is fully dependent on imports, and at the same time linked to China and other emerging economies, so that increasing oil prices firstly hit Japan directly and secondly indirectly through reduced international trade.

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[76] Lutz, C., Meyer, B., 2008, Rising fuel prices and trade. A macro-economic impact analysis for big traders with a focus on Germany, OECD Working Party on International Trade in Goods and Trade in Services Statistics, p.2

[77] International Energy Agency. Analysis of the impact of high oil prices on the global economy. Economic Analysis Division Working Paper: Paris; 2004

[78] Energy Information Administration: Annual Energy Outlook: Washington DC; 2006

[79] Lutz, C., Meyer, B., 2008, op.cit.

[80] Their results are based on the GINFORS (Global INterindustry FORecasting System) model, covering 50countries and two regions (OPEC and Rest of the World) in structural detail and links them using bilateral trade with 25 commodities and 1 service sector.

[81] Lutz, C., Meyer, B., 2008, op.cit. p. 7ff.

By contrast, Germany, whose dependence on oil is just as large as Japan's, the effects are less strong, because Germany differs in its export ratio and the regional distribution of international trade. (German exports account for 53% of GDP, whereas in Japan it is only 16% in the model). The large export shares turn out to be an advantage, especially if energy producing countries demand high shares of investment goods, in which Germany has specialized.[82]

In more detail, Germany suffers on the one hand from a decline in domestic demand due to higher prices, that will hurt especially low income groups as they consume relatively more energy than others. On the other hand, international competitiveness improves on the import and on the export side, because of improved terms of trade. Increasing exports and lower imports under increasing energy prices compensate the decrease in final consumption expenditure if oil prices increase. In the medium-term until Germany can almost completely cut down GDP losses and in the longer run GDP might even be higher than in the case if oil prices remained stable, at least according to the model results.

However the model also shows that Germany's global export shares in the most important industries, machinery and motor vehicles are almost stable, as it might not be able to increase trade shares in Russia and the OPEC countries. But as the price increase in Germany is lower than in other countries, exports in (constant) domestic prices grow faster and positively influence GDP in constant prices.[83]

Overall high oil prices not necessarily translate into production decreases. Relative price changes in relation to overall price development and in relation to international price development are important. Most producers of investment goods such as machinery and motor vehicles can even increase their production if oil prices increase. Other sectors depending mainly on domestic demand cannot profit from smaller price increases. Production in all service sectors is lower compared to the situation of mildly increasing oil prices as a result of reduced final consumption.[84]

These results suggest that the analysis of the economic impact of rising energy prices has to take into account effects induced by international trade, as this could significantly alter results. This is not only valid for the example of Germany, but for all other countries as well.

6.6.2 Vulnerable industries

Christie (2007)[85] calculates the petroleum products intensity and the natural gas intensity[86] of industry as a whole (mining and quarrying plus the entire manufacturing industry) as well as for 11 sub-industries for the EU-15 countries. Using time series for both indicators from 1995 to 2005, and correcting for changes in prices, he constructs time series of real fuel intensity by total country industry as well as by country-specific sub-industry. His results for the petroleum products intensity of industry is shown in Figure 22 and the results for natural gas intensity in Figure 23.

According to Christie there are large differences among the EU-15 countries. This is partly due to the very different choices made in each country with respect to each industry's energy product mix, itself dependent on domestically available prices, but it is also due to intra-single market specialization patterns which have led to very specific location patterns of industrial production by sub-industry. Furthermore, overall energy

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[82] Lutz, C., Meyer, B., 2008, op.cit. p. 9
[83] Lutz, C., Meyer, B., 2008, op.cit. p. 11
[84] Lutz, C., Meyer, B., 2008, op.cit. ibdm.
[85] Christie, E, 2007, Oil and Gas Dependence of EU-15 Countries, wiiw Research Reports 343, The Vienna Institute for International Economic Studies.
[86] Both intensities are expressed in thousands of tonnes of oil equivalent (ktoe) per billion euro of output (production) at current prices

efficiency also plays a role, itself partly driven by cross-country energy price differences. In any case, petroleum products intensity in industry is particularly high in Greece and Portugal, and particularly low in Belgium, Austria and Germany.

As for natural gas intensity, the most vulnerable countries are Luxembourg, Spain and the Netherlands, while the least vulnerable are Finland, Ireland and Sweden. It is interesting to note that the rankings differ quite significantly from those for overall petroleum products and natural gas intensity. The main reason for this is that three key sectors in terms of energy consumption are not part of industry, namely transport, the residential sector (private and public housing and buildings), and the power generation sector.[87]

[87] Christie, E, 2007, Oil and Gas Dependence of EU-15 Countries, wiiw Research Reports 343, p.6 ff.

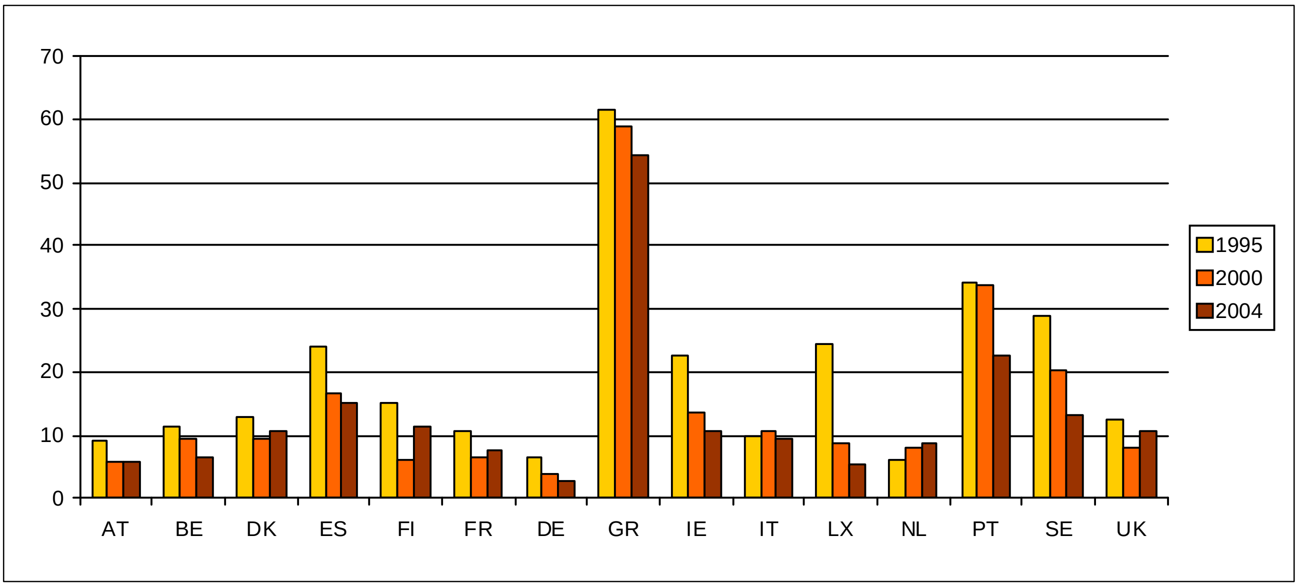

Figure 22: Petroleum products intensity of industry by country, 1995, 2000 and 2004

Units: ktoe per billion Euro of output (production) at current prices. (Due to data constraints comparisons over time can only be made until 2004)

Source: IEA Energy Balances, Eurostat and Christie, 2007.

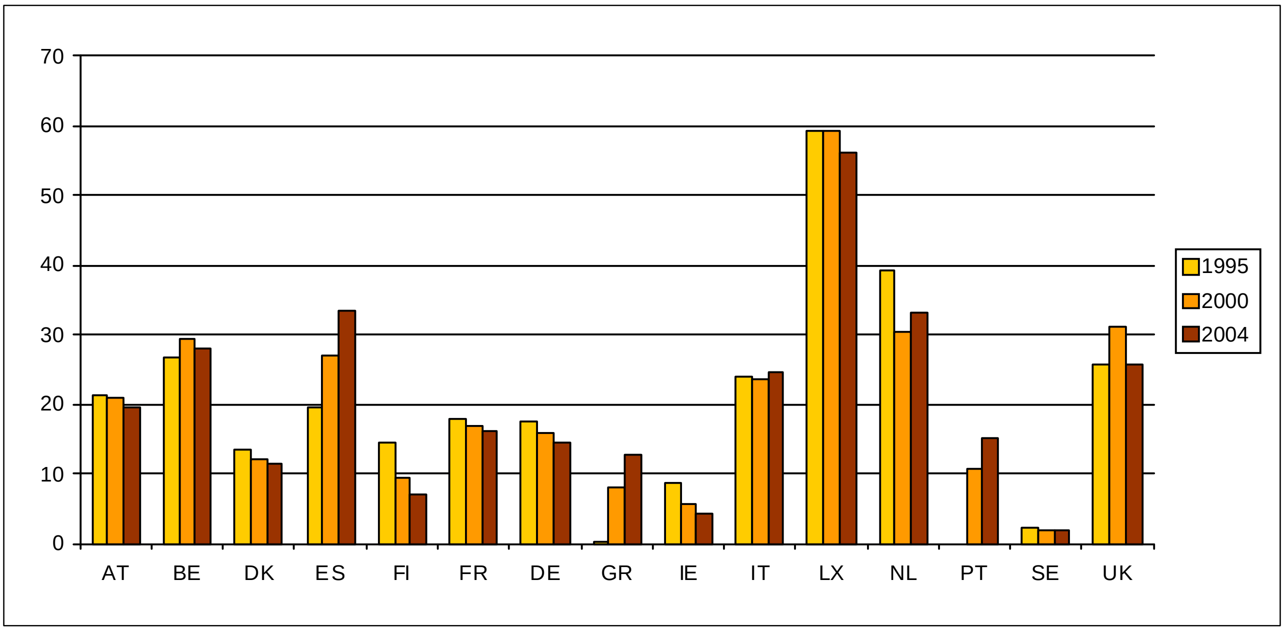

Figure 23: Natural gas intensity of industry by country, 1995, 2000 and 2004

Units: ktoe per billion Euro of output (production) at current prices. (Due to data constraints comparisons over time can only be made until 2004)

Source: IEA Energy Balances, Eurostat and Christie, 2007.

Over time the broad evolution has been very positive in the case of petroleum products, but less so in the case of natural gas, as industry has become more petroleum product efficient in most countries, while natural gas efficiency of industry has not improved significantly. However, in interpreting these figures, it is important to recall that they each represent partial fuel intensities of fuels that are, to some extent, substitutes. Therefore a fall in one of these partial fuel intensities does not by itself imply that an overall improvement in energy efficiency has occurred. Nevertheless, where these indicators are useful is in helping us to gauge the recent direction of change of EU fuel demand patterns.

With respect to specific branches within industry, one expects to find the industries that are usually the most energy intensive in most countries, notably non-metallic minerals (cement, glass, ceramics), basic metals and chemicals. Christie's results confirm this general picture, though his approach allowed to differentiate further, by both country and sub-industry, resulting in 162 country-specific sub-industries.[88]

Tables 6 and 7 show the 20 most vulnerable industries in the EU-15 in terms of petroleum products intensity and in terms of natural gas intensity respectively.[89]

According to Christie non-metallic minerals, basic metals and chemicals are the most sensitive industries with respect to oil and gas intensity. Thus 9 of the 15 national non-metallic minerals industries are among the 20 most petroleum products intensive industries in the EU-15. The second most frequently found industry is mining and quarrying.

Table 6: Petroleum products intensive industries, top 20, EU-15, 2005

Country	Industry	Petroleum product intensity
Ireland	Basic Metals	241.3
Greece	Non-Metallic Minerals	177.6
Portugal	Non-Metallic Minerals	148.7
Denmark	Mining and Quarrying	116.9
Greece	Non-specified Industry	106.7
Greece	Mining and Quarrying	100.1
Denmark	Non-Metallic Minerals	96.4
Ireland	Non-Metallic Minerals	92.3
Spain	Non-Metallic Minerals	76.2
Italy	Non-Metallic Minerals	73.8
Greece	Chemicals and Petrochemicals	72.3
Luxembourg	Mining and Quarrying	71.8
UK	Non-specified Industry	70.6
Greece	Basic Metals	60.6

[88] This was based on a breakdown of industry into 11 sub-industries for each of the 15 countries, leading to estimates for 165 country-specific sub-industries. Three of these had to be dropped due to data availability problems.

[89] Because of data limitations certain industries where put in the group 'non-specified industry'. These industries are rubber and plastics (NACE 25), medical, precision and optical instruments and watches and clocks (NACE 33), furniture and other manufactured articles not elsewhere classified (NACE 36), and recycling (NACE 37).

France	Non-Metallic Minerals	55.9
Sweden	Non-Metallic Minerals	50.2
Luxembourg	Non-specified Industry	41.8
Spain	Mining and Quarrying	40.6
Greece	Total industry	38.9
Belgium	Non-Metallic Minerals	38.4

Units: ktoe per billion Euro of output (production) at current prices.

Source: IEA Energy Balances, Eurostat and Christie, 2007.

Given these results, there seems to be a geographical pattern in evidence, i.e. that countries belonging to the geographical periphery of the region are over-represented. Greece, for example, appears six times in Table 6, whereas Germany, Austria and the Netherlands do not appear at all, while France, Italy, Belgium, Luxembourg and the UK each appear only once. This core–periphery effect, which has a bearing on product market competition and transport costs, may be further compounded by the smaller average size of the EU-15's periphery countries. Both effects (being on the periphery and being small) also have an impact on energy infrastructure, as natural gas is an especially attractive fuel if production facilities are located close to a pipeline terminal. This is much more likely to be the case in core countries such as Germany, Austria, Belgium or the Netherlands than it is in countries of the periphery. Conversely, the relative (financial) unattractiveness of such regions for gas pipeline development is what makes them less dependent on natural gas today, but it is also in some cases what makes them more dependent on petroleum products.[90]

Table 7: Natural gas intensive industries, top 20, EU-15, 2005

Country	Industry	Natural gas intensity
Luxembourg	Non-specified Industry	249.3
Luxembourg	Basic Metals	126.7
Spain	Non-Metallic Minerals	118.0
Portugal	Non-Metallic Minerals	105.7
Netherlands	Non-Metallic Minerals	99.9
Italy	Non-Metallic Minerals	86.2
France	Non-Metallic Minerals	81.6
Germany	Non-Metallic Minerals	80.8
Austria	Chemicals and Petrochemicals	80.3
Spain	Chemicals and Petrochemicals	68.4
United Kingdom	Non-Metallic Minerals	58.5
Belgium	Chemicals and Petrochemicals	58.4
Austria	Non-Metallic Minerals	57.7
Denmark	Non-Metallic Minerals	52.6
Italy	Basic Metals	51.8
Denmark	Mining and Quarrying	51.6
Belgium	Non-Metallic Minerals	50.7

[90] Christie, E, 2007, Oil and Gas Dependence of EU-15 Countries, wiiw Research Reports 343, p.8 ff.

Spain	Mining and Quarrying	49.2
Netherlands	Basic Metals	49.1
Netherlands	Chemicals and Petrochemicals	46.8

Units: ktoe per billion Euro of output (production) at current prices.

Source: IEA Energy Balances, Eurostat and Christie, 2007.

While the periphery of the EU-15 region was over-represented among petroleum products intensive industries, the reverse is true for natural gas intensive industries. The Netherlands appears three times among the top 20, Italy, Luxembourg and Belgium twice each. Again it is non-metallic minerals which is by far the most frequent occurrence in the top 20, appearing 10 times, i.e. two thirds of the region's national non-metallic minerals industries can be described as very natural gas intensive. Chemicals and petrochemicals also appears quite prominently in the ranking, followed by basic metals.[91]

6.7 Emission trading in the EU

Article 20 of the Emission Trading Directive states that a European wide emission trading scheme (ETS) will "encourage the use of more energy efficient technologies, including combined heat and power technology, producing less emissions per unit of output".[92] Thus, it is considered to be one of the main measures in reducing the emission of GHG and to stop global warming.

The EU ETS covers CO2 emissions from large stationary sources including power and heat generators, oil refineries and installations for the production of ferrous metals, cement, lime, glass and ceramic materials, and pulp and paper. Together these sectors accounted for approximately 41 % of the EU's total greenhouse gas emissions in 2005; other sectors (e.g. transport, agriculture and waste) or greenhouse gases (CH4, N2O and F-gases) are not covered by the current scheme. The aviation sector will be covered starting from 2012. Under the ETS, operators receive emission allowances from their government, according to the actual verified emissions of their installations during the previous year. Operators holding more allowances than verified emissions may either sell unneeded allowances to other operators in the EU who are in need of more allowances, or keep them for future years.[93]

Under the Emission Trading Directive, Member States prepare national allocation plans (NAPs) for each trading period, which have to be reviewed by the Commission. The allocation plans include the total quantity of allowances that will be available during a trading period, along with the rules for allocating these allowances to operators, amongst others.[94]

The **first trading period** of the European ETS took place from 2005 to 2007 and generally is considered to have been a learning period for the European Union, as there were only limited information was available on historic emissions for individual installations during the drafting and assessment of the first national allocation plans. Though the first period brought about important institutional developments such as a sound monitoring mechanism and a robust electronic trading system (the CITL). It also created a real market (volumes and price) for carbon trading. However given the lack of information at the begin of the trading scheme, it became

[91] Christie, E, 2007, Oil and Gas Dependence of EU-15 Countries, wiiw Research Reports 343, p.10.
[92] DIRECTIVE 2003/87/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC
[93] European Environment Agency, 2008, Greenhouse gas emission trends and projections in Europe 2008, p.81
[94] European Environment Agency, 2008, ibdm.

evident that the ambition level set nationally during the first phase was too low for achieving carbon prices sufficiently high to trigger much needed changes in the energy market.[95]

Furthermore there was some mismatch between the allocation of EU allowances (EUA) and the verified emissions with respect to countries and sectors. Thus verified emissions were higher than allocations in only six member states (Austria, Ireland, Italy, Slovenia, Spain and the UK). In contrast, allocations exceeded verified emissions by more than 10 % in twelve countries, is a clear difference between EU-15 and the new member states. EU-15 operators were, on average, neither long (excess of allowances) nor short (deficit of allowances), whereas new member states operators were, on average, 14 % long.

As far as the sectors are concerned it showed that the first set of national allocation plans tended to favour installations producing iron and steel (18 % long), manufacturing ceramics (19 % long) or producing pulp, paper and board (21 % long)[96].

Because of these results, the a stricter cap was fixed for the **second trading period** (2008-2012) to ensure that the sectors covered would either reduce emissions or acquire emission allowances. Overall the annual cap for 2008–2012 is by 6.0 % lower than of the average verified emissions for 2005 to 2007. However the lowering of the cap was heavily objected by some of the new member states (Czech Republic, Estonia, Hungary, Latvia and Poland) arguing that the caps would damage their economic development.[97]

6.7.1 Effects of the ETS

Because of the of data constraints accurate estimates of the effects of the does not exist (at least not for all member states). However, the EEA estimates[98] that the ETS reduced the EU-15 total GHG by approximately 139 Mt CO2, which represents 3.3 % of EU-15 base-year GHG emissions[99]. On the other hand there was a net increase of emissions by 12 Mt CO2 for the new member states in Central and Eastern Europe.

Similar the effects of the ETS, on the end-use energy price at present and in the near future (2008–2012) are difficult to estimate, as the energy price depends on a combination of different factors (fossil fuel prices, market structure, different levels of taxes and subsidies as well as specific climate and energy policies). The impact produced by the EU ETS after 2012 will depend, largely, on the future design of the scheme as well as on the intensity of efforts to step up the energy efficiency at the point of the end-consumer. Experiences so far (the first phase of ETS and limited experiences during the second phase) show that end-use energy prices could increase.[100]

For the period beyond 2012 it is planned that an EU-wide cap is supposed to replace the current 27 national caps. The EU-wide cap will decline by 1.74 % annually as of 2013, to meet the 2020 target of a reduction of GHG by 20%. The scope of the Directive will be extended to include new sectors and two new gases (N2O and PFCs) so that around 50 % of all EU emissions would be covered.[101]

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[95] European Environment Agency, 2008, Energy and environment report 2008, p.60
[96] European Environment Agency, 2008, Greenhouse gas emission trends and projections in Europe 2008, p.83 ff.
[97] European Environment Agency, 2008, Greenhouse gas emission trends and projections in Europe 2008, p.87 ff.
[98] European Environment Agency, 2008, Greenhouse gas emission trends and projections in Europe 2008, p.88 ff.
[99] The effect of the EU ETS in the EU-15 needs to be seen as a lower boundary, on the assumption that average annual CO2 emissions from industry between 2008 and 2012 would not have been lower in the absence of the EU ETS than they were in 2005-2007
[100] European Environment Agency, 2008, Energy and environment report 2008, p.60
[101] European Environment Agency, 2008, Greenhouse gas emission trends and projections in Europe 2008, p.82

6.8 *A note on Carbon Capture and Storage*[102]

Carbon Capture and Storage (CCS) has been identified by leading policy-makers at the European and global levels as an important option to help achieve a low-carbon future in the European Union and globally. CCS is seen as the bridging technology which may enable an easier transition for the global energy system, roughly between 2020 and 2050, from a mostly fossil-fuel-based system to a mostly renewables-based system, without creating significant economic or environmental dislocations. It should not crowd out or cancel other crucial objectives such as improvements in energy efficiency and investments in renewable energy. It should however be seen as an important and very useful complement to other measures.

CCS is the process whereby the combustion of fossil fuels is modified so as to capture the bulk of the CO2 that would otherwise be emitted, compress it, transport it, and then store it permanently. CCS is foreseen as an option for reducing emissions in coal-fired power generation, gas-fired power generation and biomass-fired power generation; in energy-intensive industries such as cement production, iron and steel, pulp, and chemicals and petrochemicals; and in fossil fuel production and transformation.

There are several technological options for the capture stage, including industry-level technology-specific options. Focusing just on the case of power generation, the three main options are post-combustion capture, pre-combustion capture, and oxy-firing (oxy-fuel). In the medium-run it is not clear which of these three main options will prevail, if any. It is however highly likely that the first wave of commercial CCS plants will consist of coal-fired power plants only.

The two main suitable options for storing are depleted oil and gas fields (in the ground or in the sea-bed) and deep saline aquifers. The consensus view is that Europe has enough potential storage sites for large-scale deployment of CCS.

CCS is a rather new and hence developing technology and would not be commercially viable initially. It is generally predicted that CCS technologies would evolve progressively, gaining from the experience of practical full-scale applications called demonstration projects, so as to be fully commercially viable under reasonable assumptions about CO2 prices from 2020. Smaller-scale demonstration projects that would be launched today would however only be commercially viable assuming a carbon price of 60-90 Euros, levels that are not expected to occur in the short-run. In other words, CCS demonstration projects would be loss-making for several years and would only generate positive returns under high CO2 prices. The role of the demonstration projects, in addition, is also to help industry choose the right technological options within CCS.

In order to ensure that the CCS demonstration projects occur, the European Union has decided to commit 300 million allowances from the new entrants reserve for supporting up to 12 demonstration projects, as well as innovative renewables projects. Member states are not under any obligation to accept carbon storage on their territories, in the demonstration phase or beyond. However, member states hosting winning CCS demonstration projects have the option of providing additional co-financing to those projects. In parallel the EU has adopted an ambitious vision, the 20/20/20 initiative, which implies that scarcity in emission trading allowances will be imposed on the market, up to but also beyond 2020, so that a robust price signal should emerge. The future set-up of economic incentives will probably be conducive to a successful commercial deployment of coal-fired power plants equipped with CCS, starting some time around or a bit after 2020. However there is a risk that commercial deployment will be delayed if allowance prices remain comparatively

[102] This section is based on Christie, 2009, wiiw internal research (not published)

low for a longer period. CCS projects will also effectively compete with other low- or zero-carbon solutions, including renewables and nuclear power.

Given differing national energy strategies and differing natural endowments, CCS is most likely to be implemented in EU Member States that are relatively abundant in coal and/or that have suitable storage sites on their territories or offshore.

7 Energy and European neighbourhood

7.1 Political Aspects

Energy security is a key element for the well-being of an economy. Since the EU is a net importer of fossil fuels, the external relations to oil and gas producing countries are of prime importance for the EU member states and as a consequence for the EU regions. The following section reviews, quite briefly, the European position vis-à-vis its most important suppliers.

Russia

Russia is the single most important importer of fossil fuels to the EU-27. In 2005 around 30% of the EU's oil and around 45% of the EU's gas imports were supplied by Russia.

While Russia's resources and proximity to Europe make Euro-Russian collaboration a necessity, Russia's apparent willingness to use its energy wealth to achieve its foreign policy objectives and how to react to this is highly disputed in the EU.

Even though the EU leadership moves forward with its ideas on a common external energy strategy, many questions remain open, such as in how far individual member states will agree to push Russia (and Gazprom) to adopt the EU's principles of competition, open its energy sector to outside investment, and ratify the Energy Charter. Some believe that without such Russian concessions, Europe will ultimately find its energy security largely under Russian control. Indeed, several member states have pursued bilateral energy deals with Russia that will increase their dependence on Russia for years to come (like Germany and Italy). [103]

A key element of the EU to lower its dependence on Russia's resources and to increase its supply security is the diversification of import sources. While with oil the situation is less dramatic, as the number of potential suppliers is relatively large, the situation is quite different with natural gas, as Russia has the by far highest amount of proven gas resources while Europe's own resources are small and declining.

Nevertheless, despite ongoing efforts to diversify the suppliers (e.g. via various pipeline projects to the Caspian basin), but as Chrisie (2007) notes "*it is fair to say that the case for diversification is overwhelming, but that the concrete end-result will most likely not lead to a significant reduction of Russia's importance for the EU*".

[103] Belkin, Paul, 2008, The European Union's Energy Security Challenges, Congressional Research Service.

Still, given that Europe is an important market for Russian gas[104], there is the argument that "*the EU and Russia need each other and, barring seriously adverse developments, should remain very important partners in the field of energy.*

However, Russia's attempts to cement the EU's dependence on Russian supplies does raise serious questions. Russia is actively seeking to thwart some of the EU's diversification efforts, notably through its interventions in Central Asia, as well as through its interest in North African production and its expressed interest in creating an international cartel for natural gas. These developments are entirely understandable from the Russian perspective, but they are not conducive to reassuring the EU about its energy security. "[105]

Central Asia and the Caspian / Black Sea Regions.

One of the focal points of European energy diversification strategies is Central Asia and the Caspian and Black Sea regions. Though the Caspian Sea region is a significant, but not major supplier of crude oil to world markets, the existing reserves held by some countries bordering the Caspian Sea might offer Europe an opportunity to move away from increased dependence on Russian energy.

This diversification attempts are formalised through two initiatives (Interstate Oil and Gas Transport to Europe program – Inogate and the "Baku Initiative") promoting the construction of regional pipeline systems and facilitating the integration of the Caspian Sea region into the EU energy market. However, apart from Russian efforts to undermine the EU's diversification attempts, other issues, like regional and internal political stability could impede a full realization of the energy potential of the region. [106]

Middle East/North Africa. The European efforts to diversify European energy supplies and decrease dependence on Russia have heightened calls within Europe for stronger political and economic engagement in the Middle East and North Africa. However, political instability in the region and strong competition for its energy resources from countries in Asia and North America present challenges to European efforts.

Given the vast resources of oil and natural gas Europe already depends on the Middle East/North Africa region for close to 30% of its oil imports and approximately 15% of its gas imports. Europe's primary supplier of natural gas has been Algeria, via two pipelines that enter Europe through Italy and Spain. A smaller amount comes from Libya via pipelines to Italy. Two additional gas pipelines from Algeria to Spain and Italy are under construction.

On the political front, European relations with the states of the Persian Gulf and North Africa have steadily improved over the years. EU relations with North Africa were formalized in 1995 with the creation of the Euro-Mediterranean Energy Partnership. The EU has also created the EU-Gulf Cooperation Council (GCC) Dialogue with the states of the Persian Gulf and has initiated a formal dialogue with the nations of OPEC. European energy companies have also become more involved in the Middle East. In sum, the potential for growth in Europe's energy diversification strategy with respect to the Middle East and North Africa is significant. However, competition with Asia and North America and long-term political instability throughout the region will likely temper the degree to which Europe seeks to increase its reliance on the region.[107]

Norway

[104] especially for natural gas from Western Siberian fields, for which it would make no economic sense to export production other than to Europe.
[105] Christie, 2007
[106] Belkin, Paul, 2008
[107] Belkin, Paul, 2008

Norway, is the second-largest exporter of oil and natural gas to the EU, behind Russia. Norwegian exports represented 24% of European gas and around 15% of oil consumption in 2005. Though Norwegian resources are a stable source for the EU, oil and gas production are likely to decrease in the near future, which might be an obstacle to the EU's diversification efforts.

7.2 Statistics

This section presents a short overview of energy statistics of the EU's neighbourhood countries. Here, the neighbourhood is defined as the European non-EU countries, Eurasia, the Middle East and North Africa. The statistical information is taken from the US Energy Information Administration (EIA). As the EIA provides an abundance of energy data that, because of limited scope, cannot be fully reflected here, the overview focuses on four main topics: energy consumption, proved reserves of oil and natural gas, electricity (taking into account renewables) and emissions.

Looking first at energy consumption, the analysis differentiates between consumption per head of population and consumption per unit of output (GDP per head at purchasing power parities), i.e. energy intensity.

The numbers in Table 8 show that in per capita terms most EU neighbourhood countries use on average less energy than the EU-27 on average. A notable exception to this are the Eurasian countries, where especially in Russia, Kazakhstan and Turkmenistan energy demand per head is significantly higher than in the EU-27 on average –by 34%, 22% and 9% respectively. As Russia is the biggest country (not only in this group) it is also the main reason why the Eurasian average consumption per head is slightly higher than the EU-27 average.

Though the averages for all other country groups are lower than that of the EU-27, Table 8 also shows that there is a wide variation of per capita energy consumption across the countries in the respective groups. In most cases –except some special areas like Gibraltar or the Faroe Islands – it are mainly the oil producing countries that have a high energy consumption per head, like Norway, Qatar, UAE, Bahrain and Kuwait as well as Libya in North Africa.

By contrast, energy consumption per unit of output, energy intensity, is in most EU neighbourhood countries higher than in the EU-27 on average. This is the case in Eurasian countries and here especially in Turkmenistan and Tajikistan as well as in the Middle East countries Bahrain and Qatar. In the North African countries energy intensity tends to be lower in Morocco, the Sudan and Tunisia or approximately equal to the EU average (Algeria and Egypt). Only Libya uses around twice as much energy for one unit of output compared to the EU.

Table 8: Energy consumption per head & energy intensity

	Per Capita Total Primary Energy Consumption (Million Btu)	**Energy Intensity- Total PEC, GDP at PPP** (Btu per (2000) U.S. Dollars)
Country	**2006**	**2006**
EU-27	**159.7**	**6,513.9**
Non-EU Europe	**81.4**	**7,059.9**
Albania	34.3	11,766.9
Bosnia and Herzegovina	56.3	7,315.3
Croatia	92.1	7,528.9
Faroe Islands	223.9	.
Gibraltar	2,065.8	.
Iceland	568.6	17,205.3
Macedonia	55.2	10,957.6
Montenegro	68.4	11,945.9
Norway	410.8	9,489.1
Serbia	68.4	11,945.9

Switzerland	170.7	5,152.0
Turkey	55.5	5,728.6
Eurasia	**162.2**	**20,687.2**
Armenia	67.6	20,330.4
Azerbaijan	86.7	7,6578.7
Belarus	117.0	20,664.7
Georgia	29.1	11,055.8
Kazakhstan	195.3	23,494.2
Kyrgyzstan	38.1	32,443.7
Moldova	33.9	26,972.4
Russia	213.9	18,776.8
Tajikistan	40.4	42,825.1
Turkmenistan	174.1	77,512.8
Ukraine	125.9	23,677.3
Uzbekistan	80.9	30,614.4
Middle East	**127.2**	**13,708.6**
Bahrain	695.4	28,325.1
Iran	118.2	14,120.2
Iraq	46.6	18,527.6
Israel	123.5	5,627.2
Jordan	52.2	14,649.6
Kuwait	469.8	10,240.2
Lebanon	53.3	6,240.1
Oman	177.2	9,747.7
Qatar	1,023.3	22,890.3
Saudi Arabia	255.0	15,153.0
Syria	42.9	11,508.5
United Arab Emirates	577.6	19,159.5
Yemen	12.4	6,331.6
North Africa	**29.4**	**5,881.5**
Algeria	46.6	6,492.9
Egypt	32.2	6,550.8
Libya	132.0	13,047.7
Morocco	15.2	2,970.8
Sudan	4.8	3,148.3
Tunisia	32.9	3,833.8
Western Sahara	11.3	.

Source: Energy Information Administration, International Energy Annual 2006, own calculations

Looking at the proved reserves of natural gas and oil in the EU neighbourhood Table 9 shows that most of the 44 neighbourhood countries or areas have some own reserves (31 countries), but only in 14 countries the reserves amount to one percent or more of the total reserves in the EU neighbourhood. Moreover reserves can only be regarded to be considerable in six countries, especially in Russia (34% of total neighbourhood reserves), Iran (20%) and Qatar (18%).

With respect to oil the situation is similar. 26 out of the 44 countries have at least some reserves, but only six countries (Russia, UAE, Kuwait, Iraq, Iran and Saudi Arabia) have reserves higher than 6% of total EU neighbourhood reserves, most of them (over 81%) being located in the Middle East.

Table 10 present some information on electricity production, more precisely on the sector of electricity production, notably nuclear and conventional thermal generation as well as renewable production, split into hydroelectricity and non-hydro renewable electricity (i.e. geothermal, solar, wind, wood and waste).

Given the information in Table 10 all neighbourhood countries with the exception of four (Armenia, Russia, Switzerland and Ukraine) do not produce nuclear electricity. Especially in the Middle East countries and North Africa the overwhelming share of electricity is produced by conventional thermal power plants, small exceptions being the Sudan and Egypt as well as Iran, Lebanon and Syria that also generate some hydroelectricity. The situation is more heterogeneous for Eurasia and European non-EU countries. Those countries that either have the potential to run either reservoir or river power stations rely in certain cases almost to the full extent on hydroelectricity, like Albania, Norway, Kyrgyzstan and Tajikistan. With respect to non-hydro renewable electricity, it is with the exception of Iceland and Switzerland almost non existent in any of the EU's neighbourhood countries.

Finally looking at CO_2 emissions (Table 11) the situation is almost identical to the situation in energy consumption. Thus in per capita terms most neighbourhood countries, except the oil producing, emit less CO_2 than the EU-27 on average, partly considerable less. By contrast, the oil producing countries produce much more emissions, e.g. in Qatar CO_2 emissions per head are 8 times as high as in the EU27 and in Bahrain and Kuwait around 4 times.

In terms of CO_2 emissions per one unit of GDP, most countries especially those in the Middle East, Eurasia emit more CO_2. Only the North African countries, with the exception of Libya and the more developed European non-EU countries, including Turkey emit less.

Table 9: Proved Reserves of natural gas and oil, 2009

	Proved Reserves of Natural Gas		Crude Oil Proved Reserves	
	(Trillion Cubic Feet)	in % of EU neighbours total	(Billion Barrels)	in % of EU neighbours total
Country	**2009**	**2009**	**2009**	**2009**
EU-27	**84.3**		**6.3**	
Non-EU Europe	**83.1**	**1.7**	**7.3**	**0.8**
Albania	0.0	0.0	0.2	0.0
Bosnia and Herzegovina	0.0	0.0	0.0	0.0
Croatia	1.1	0.0	0.1	0.0
Faroe Islands	0.0	0.0	0.0	0.0
Gibraltar	0.0	0.0	0.0	0.0
Iceland	0.0	0.0	0.0	0.0
Macedonia	0.0	0.0	0.0	0.0
Montenegro	.	.	.	.
Norway	81.7	1.7	6.7	0.7
Serbia	.	.	.	.
Switzerland	.	.	0.0	0.0
Turkey	0.3	0.0	0.3	0.0
Eurasia	**1,993.8**	**40.3**	**98.9**	**10.8**
Armenia	0.0	0.0	0.0	0.0
Azerbaijan	30.0	0.6	7.0	0.8
Belarus	0.1	0.0	0.2	0.0
Georgia	0.3	0.0	0.0	0.0
Kazakhstan	85.0	1.7	30.0	3.3
Kyrgyzstan	0.2	0.0	0.0	0.0
Moldova	0.0	0.0	0.0	0.0
Russia	1,680.0	34.0	60.0	6.5
Tajikistan	0.2	0.0	0.0	0.0
Turkmenistan	94.0	1.9	0.6	0.1
Ukraine	39.0	0.8	0.4	0.0
Uzbekistan	65.0	1.3	0.6	0.1
Middle East	**2,591.7**	**52.4**	**746.0**	**81.3**
Bahrain	3.3	0.1	0.1	0.0
Iran	991.6	20.0	136.2	14.8
Iraq	111.9	2.3	115.0	12.5
Israel	1.1	0.0	0.0	0.0
Jordan	0.2	0.0	0.0	0.0
Kuwait	63.4	1.3	104.0	11.3
Lebanon	0.0	0.0	0.0	0.0
Oman	30.0	0.6	5.5	0.6
Qatar	891.9	18.0	15.2	1.7
Saudi Arabia	258.5	5.2	266.7	29.1
Syria	8.5	0.2	2.5	0.3
United Arab Emirates	214.4	4.3	97.8	10.7
Yemen	16.9	0.3	3.0	0.3
North Africa	**277.2**	**5.6**	**65.0**	**7.1**
Algeria	159.0	3.2	12.2	1.3
Egypt	58.5	1.2	3.7	0.4
Libya	54.4	1.1	43.7	4.8
Morocco	0.1	0.0	0.0	0.0
Sudan	3.0	0.1	5.0	0.5
Tunisia	2.3	0.0	0.4	0.0
Western Sahara	0.0	0.0	0.0	0.0
EU Neighbours Total	**4945.8**	**100.0**	**917.1**	**100.0**

Source: Energy Information Administration, International Energy Annual 2006, own calculations

Table 10: Share of sectors in total electricity generation, 2009

	Nuclear Electricity	Hydroelectricity	Non-Hydro Renewable Electricity	Conventional Thermal Electricity
	in % of total electricity generation			
EU-27	**29.9**	**9.7**	**5.6**	**54.8**
Non-EU Europe	**6.1**	**53.5**	**1.5**	**38.9**
Albania	0.0	98.3	0.0	1.7
Bosnia and Herzegovina	0.0	45.2	0.0	54.8
Croatia	0.0	52.5	0.2	47.3
Faroe Islands	0.0	32.2	0.0	67.8
Gibraltar	0.0	0.0	0.0	100.0
Iceland	0.0	74.2	25.7	0.0
Macedonia	0.0	24.5	0.0	75.5
Montenegro	0.0	31.2	0.0	68.8
Norway	0.0	98.6	0.9	0.5
Serbia	0.0	31.2	0.0	68.8
Switzerland	43.9	50.9	3.7	1.5
Turkey	0.0	26.1	0.2	73.7
Eurasia	**17.1**	**17.8**	**0.2**	**64.8**
Armenia	43.1	32.1	0.0	24.7
Azerbaijan	0.0	10.9	0.0	89.1
Belarus	0.0	0.1	0.1	99.8
Georgia	0.0	73.9	0.0	26.1
Kazakhstan	0.0	11.3	0.0	88.7
Kyrgyzstan	0.0	86.8	0.0	13.2
Moldova	0.0	8.2	0.0	91.8
Russia	15.3	18.5	0.3	65.9
Tajikistan	0.0	97.8	0.0	2.2
Turkmenistan	0.0	0.0	0.0	100.0
Ukraine	46.5	7.1	0.0	46.4
Uzbekistan	0.0	13.4	0.0	86.6
Middle East	**0.0**	**3.6**	**0.0**	**96.4**
Bahrain	0.0	0.0	0.0	100.0
Iran	0.0	9.5	0.1	90.5
Iraq	0.0	1.6	0.0	98.4
Israel	0.0	0.1	0.0	99.9
Jordan	0.0	0.5	0.0	99.5
Kuwait	0.0	0.0	0.0	100.0
Lebanon	0.0	7.9	0.0	92.1
Oman	0.0	0.0	0.0	100.0
Qatar	0.0	0.0	0.0	100.0
Saudi Arabia	0.0	0.0	0.0	100.0
Syria	0.0	11.3	0.0	88.7
United Arab Emirates	0.0	0.0	0.0	100.0
Yemen	0.0	0.0	0.0	100.0
North Africa	**0.0**	**7.9**	**0.4**	**91.7**
Algeria	0.0	0.7	0.0	99.3
Egypt	0.0	11.7	0.5	87.7
Libya	0.0	0.0	0.0	100.0
Morocco	0.0	7.2	0.8	92.0
Sudan	0.0	33.9	0.0	66.1
Tunisia	0.0	1.2	0.3	98.6
Western Sahara	0.0	0.0	0.0	100.0
World	**14.8**	**16.6**	**2.3**	**66.3**

Source: Energy Information Administration, International Energy Annual 2006, own calculations

Table 11: Emission Indicators

Country	CO2 Emissions per head (Metric Tons of Carbon Dioxide) 2006	Carbon Intensity-GDP at PPP (Metric Tons of Carbon Dioxide per Thousand (2000) U.S. Dollars) 2006
EU-27	**8.8**	**0.4**
Non-EU Europe	**4.1**	**0.4**
Albania	1.3	0.4
Bosnia and Herzegovina	3.9	0.5
Croatia	4.8	0.4
Faroe Islands	14.5	.
Gibraltar	160.2	.
Iceland	11.5	0.3
Macedonia	3.5	0.7
Montenegro	4.8	0.8
Norway	9.8	0.2
Serbia	4.8	0.8
Switzerland	6.1	0.2
Turkey	3.3	0.3
Eurasia	**9.2**	**1.2**
Armenia	3.5	1.0
Azerbaijan	4.9	4.4
Belarus	6.7	1.2
Georgia	1.0	0.4
Kazakhstan	14.0	1.7
Kyrgyzstan	0.9	0.8
Moldova	1.7	1.4
Russia	12.0	1.1
Tajikistan	1.1	1.1
Turkmenistan	10.0	4.5
Ukraine	7.1	1.3
Uzbekistan	4.4	1.7
Middle East	**8.0**	**0.9**
Bahrain	38.4	1.6
Iran	7.3	0.9
Iraq	3.7	1.5
Israel	9.8	0.4
Jordan	3.4	0.9
Kuwait	30.9	0.7
Lebanon	3.7	0.4
Oman	11.2	0.6
Qatar	61.2	1.4
Saudi Arabia	15.7	0.9
Syria	2.7	0.7
United Arab Emirates	35.1	1.2
Yemen	0.8	0.4
North Africa	**1.8**	**0.4**
Algeria	2.8	0.4
Egypt	1.9	0.4
Libya	9.1	0.9
Morocco	1.0	0.2
Sudan	0.3	0.2
Tunisia	2.1	0.2
Western Sahara	0.8	.

Source: Energy Information Administration, International Energy Annual 2006, own calculations

8 Regional exposure to energy risks

8.1 Sensitivity ranking of European regions

The previous part has highlighted the many dimension of the energy challenge. At the same time it has shown that, though there are potential impacts on the regions, the data to measure these impacts is hardly available. This creates some difficulties for the following task, which is to create a ranking of the regions with respect to their sensitivity to the energy challenge. Overall, there are simply to many aspects of the energy challenge that are not adequately covered by data, so that the analysis below, to be honest, can hardly be regarded to be representative of the energy challenge as such.

Still, the assessment of regional sensitivity is based on a summary index which combines four indicators that are supposed to reflect one or more aspects of the regions vulnerability to changes in energy supply or energy prices. In detail, the index consist of:

§ **Regional GDP per head in Euros**, 2005: This variable is supposed to reflect, firstly, the ability of regions to purchase energy (especially fossil fuel) for the production of goods and services, assuming that energy prices will rise over time. Secondly, this variable also reflects potential welfare effects of rising energy prices on households and individuals. Since it is assumed that energy is sold at world market prices, GDP per head is measured in Euros.

§ **National import dependence**: This variable is taken directly from the “Regions 2020” study and shows the ratio of energy imports to gross inland energy consumption. Notably these data are at the national level rather than at the regional level.

§ **Energy consumption by households**: This variable is also taken from the “Regions 2020” study and in conjunction with the data on regional GDP is supposed to reflect potential welfare effects of rising energy prices.

§ **Energy efficiency**: Basically this variables gives the consumption of energy per one unit of output – at the regional level. The data for this variable were calculated, by using national data on the final energy consumption of 13 sectors of economic activity and projecting it to the regional level by using detailed employment data. From this, the total regional energy consumption was calculated and put in relation to regional GDP. Because of the use of sectoral data, this variable not only reflects how efficiently energy is used within the regions, but to some extent also in how far the regions are specialised in the production of energy intensive goods and services.

The summary index has been calculated with these four variables, only. Thus, it is slightly different from the indicator used in the “Regions 2020” study, as it disregards the national carbon intensity as well as the estimated energy consumption by transport, industry and services. While the former variable has been discarded to sharpen the focus on purely energy matters, the more so as environmental aspects will be covered in a different paper, the latter variable has been dropped because it correlated strongly with the measure on energy efficiency.

In the calculation of the summary index, equal weight has been given to all four variables. This is a compromise between a number of different variants that have been played through in the background analysis. Regional differences with respect to the individual variables and hence with respect to regional specific forms of vulnerability to rising energy prices will be highlighted in the text below, where necessary[108].

The EU NUTS 2 regions were ranked according to the summary index into three groups, given their perceived vulnerability to rising energy prices and volatile energy supply. The three groups consist of one group of regions with **low vulnerability**, another regional group of **medium vulnerability** and regions with a **high vulnerability.**

It has to be noted that the ranking of regions into these three categories is not entirely clear cut, but in some instances floating. This means that in certain cases (especially with respect to Portuguese and Southern Spanish regions) the decision, whether certain regions are medium or highly vulnerable is more a matter of personal judgement than purely suggested by data[109]. For the time being the three categories have been chosen as such that in each group there is an approximately equal number of regions.

8.2 Main patterns of sensitivity in the EU

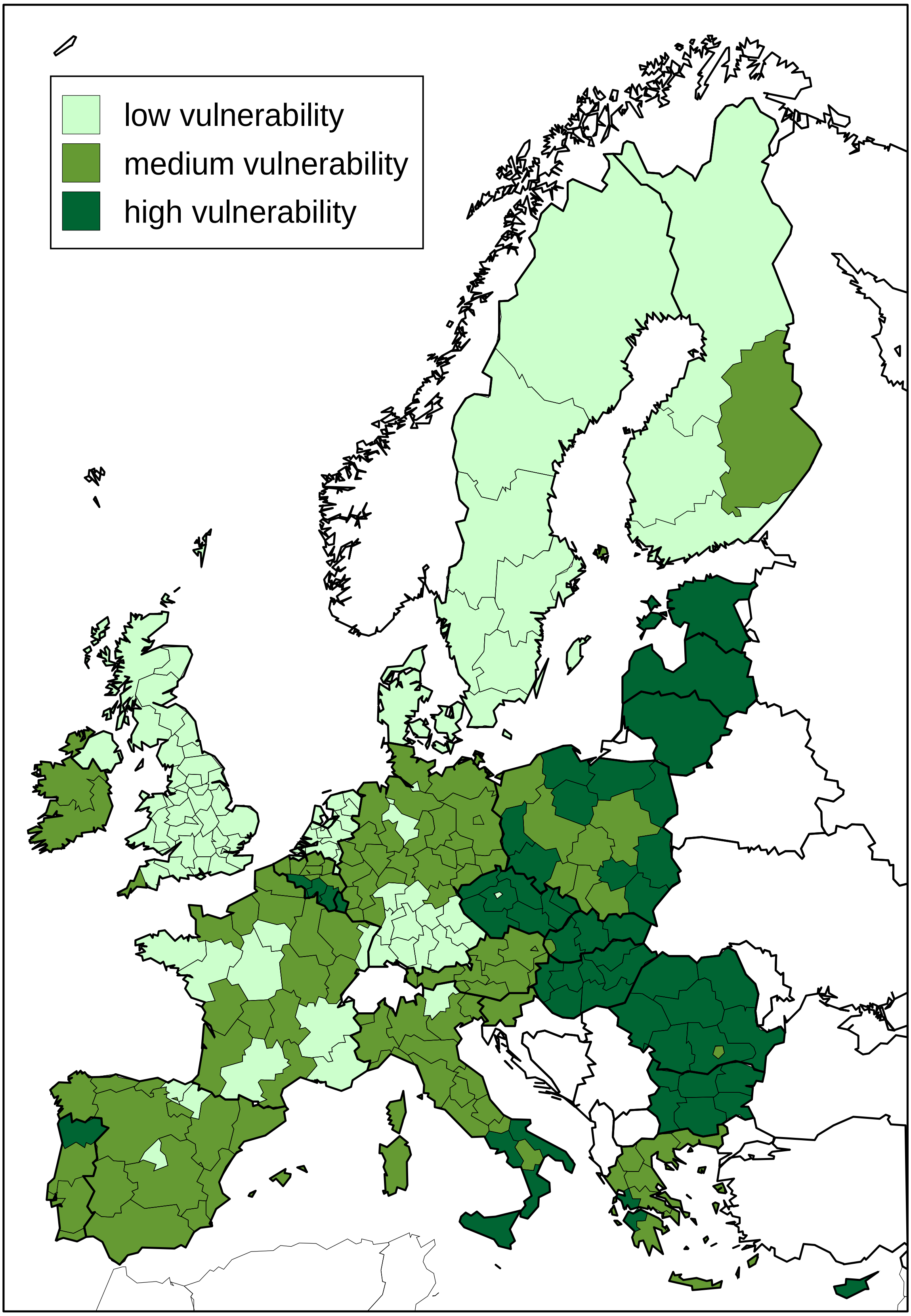
The geographic distribution of the regions[110] energy vulnerability is presented in Figure 24. From the geographic illustration we can identify four major regional patterns of energy vulnerability:

The first and most robust pattern, with respect to changes in the weights of the four energy vulnerability variables, is the split between the old member states of the EU-15 and the 10 new member states in Central and Eastern Europe (CEE). This is mainly because of the low energy efficiency in the production of goods and services in the CEE regions, in combination with low income levels. Contrastingly household energy consumption in the CEE regions is in general – in reflection of the lower standard of living – lowest in the EU, while with respect to energy dependence the CEE countries are mostly at intermediate levels, with the exception of Poland, which has a relatively low level of dependence.

Still, the high level of energy intensity in the CEE regions does not only increase the vulnerability, but also is an obstacle for economic development. Thus, the CEE regions use a lot more energy than the other EU regions on average to produce their goods and services, which, in turn, means that a larger proportion of their output has to be devoted to the purchase of energy. Since, at the same time the average GDP per head is only a fraction of the EU average GDP per head (especially in Euro terms), the relative share of their income that has to spent on the import of energy is much higher than the mere differences in energy efficiency would suggest. In economic terms this incurs high opportunity costs, as the money spent on energy cannot be spent for consumption or investment, and thus slows down economic development.

[108] Moreover more detailed data and maps will be available in the Annex.
[109] As a matter of fact, the distribution of the index over the regions is almost bell shaped. This makes it difficult to identify three distinctly different groups of regions.
[110] For data reasons, certain regions had to be aggregated into bigger regions. This refers to certain Finish, Portuguese, German and Italian regions.

Figure 24: Energy vulnerability index



The second, also fairly robust pattern, is a core – (South-East) periphery pattern, with less vulnerable regions in the centre of Europe and with vulnerability increasing the further the regions are away from this centre (at least to the South and the East). The underlying reason for this is firstly, a decline of income levels from the centre to the periphery, though to some extent this is mitigated by lower household energy consumption in the periphery. Still the relatively high vulnerability of the peripheral regions other than the CEE, is also caused by a high import dependency of the individual countries (i.e. Southern Italy, Spain, Portugal and also Ireland).

The third pattern relates to the country level and separates the part of the more developed EU-15 countries with own energy resources (mineral oil, natural gas, coal and nuclear power) from the other countries. Thus, so far the lowest energy vulnerability is found in Denmark, as well as throughout the Dutch, Swedish and the UK regions, while in France and Germany there is a bit more regional differentiation.

Finally, corresponding to the "Regions 2020" study, metropolitan areas seem to be less vulnerable than other regions. This rests partly on their higher efficiency of energy use – caused by the dominance of the less energy intensive services sector, combined with high income levels, while household energy consumption tends to be around the country average level, or in certain cases also below it.

9 Analysis of impacts of energy prices on regional disparities TO BE REVISED

9.1 Main hypotheses for future scenarios

The analysis above was, because of severe data and information limitations, confined to investigate the energy challenge at the national level or at the level of the EU. Thus the impression could be that the energy challenge is more a challenge to the individual member states or the EU as a whole. However this is not entirely true. Though data might be missing the analysis above suggest that at least individual components of the energy challenge might have a differentiated impacts on the EU regions, and thus they potentially might increase or in other cases decrease economic and social disparities between the regions.

However from the above analysis it is also clear that the energy challenge as such is a complex issue, consisting of many smaller, individual components, that are sometimes independent from each other and sometimes strongly linked. The large number of smaller components makes it difficult to define two clear scenarios, as many assumptions have to be made about potential positive and negative developments in each of these challenges. Thus there is the danger that such scenarios either becomes highly superficial or utterly complex. Since there is some limitations with respect to space in the study, we therefore to suggest to take a slightly different approach.

Therefore, to highlight the regional impacts this section engages in a somewhat speculative exercise by going once again through most of the components of the energy challenge and analysing them whether on to what extent they might affect the EU regions. All components will be analysed with respect to their potential positive and negative impacts on regional disparities as well as with respect to the data available to investigate this issue further. As such the analysis below provides modules for scenario building, allowing to chose for each component of the energy challenge whether it is assumed to apply until 2020 or not. In the end these modules can be put together to form an overview of the likely impacts of the energy challenge as a whole. However this cannot be done at the present study, because we analyse 6 components (i.e. modules) according to whether they have a positive or negative impact on disparities (i.e. 2 cases for each component). Given would be 2 to the power of 6 potential (i.e. 64) ways to group these modules, which is beyond the scope of this paper.

9.2 Energy – positive and negative impacts on regional disparities

In the following we will analysis the positive and negative impacts on regional disparities of six main topics:

- o Demand, supply of energy, indigenous production/resources
- o Renewables
- o Technology
- o Energy networks (including pipelines)
- o Efficiency
- o Energy prices, GHG emissions, ETS, vulnerable industries

Except for the first point, all are analysed with respect to their potential impact on regional disparities, depending on whether the point are strongly pushed (either by policy or economic incentives etc.) or whether they are neglected. Depending on this the attempt is made to derive the potential impact of e.g. the introduction (or non-introduction) of renewables on the regions economy and hence on regional disparities.

Importantly, all these points are analysed individually. Though this simplifies the analysis, it is a major shortcoming as some of these points are strongly interlinked. Thus, e.g. the production of energy from renewable sources cannot work without a certain level of technology or with an appropriate energy network in place. Likewise development in fossil fuel prices might have some impact on the introduction of renewables, as low fossil fuel prices might delay this. This has to be kept in mind when going through the individual points.

9.2.1 Demand, supply of energy, indigenous production/resources

- § ***Impacts on regional disparities***: Though this is largely an issue that is resolved at the national rather than at the regional level, there are potential regional effects. These however affect all regions within one country. Hence some impacts might occur if, e.g. certain member states have special arrangements with prime energy suppliers, giving them an advantage over other member states. The case is similar in the case of those countries, and the regions therein, that benefit from their endowment with natural resources (like the UK). More individual effects might be visible for regions with coal resources, though it is not entirely clear whether they will benefit or loose. This depends other things on the price of alternative fuels (fossil and renewables) as well as on the competitiveness of the coal mining sector in the specific region.

- § ***Data availability:*** At the national level for oil and gas resources, for coal data on the mining areas is available through data on the sectoral structure by regions. However no EU-wide regional information is available with respect to the competitiveness of this sector at the level of the EU and the global level.

9.2.2 Renewables

- § ***Positive impacts on regional disparities***: Potential positive impacts of a push of renewable energy sources on the regions depend on the regions characteristics and natural endowments, i.e. whether regions have the resources to produce renewable energy (coasts for wave power, agricultural land for the production of biofuels etc.). Renewables are frequently regarded to be a development option for the peripheral low income regions. If this is true, regional disparities –ceteris paribus- are likely to decline, as investments in the production of renewable energy will give a boost to economic development in the so far less favoured regions. However, there are a number of **caveats** to be kept in mind:

- Firstly, in order to develop the production of renewables certain preconditions have to be met in the region. A) Regions need an adequate endowment with **skilled labour**, in order to install and apply the technology to produce renewable energy. B) There has to be a proper **infrastructure** in place in order to exploit the full potential. This refers not only to energy infrastructure, as networks have to be installed that allow energy to be sold to extra-regional markets, but also to more common infrastructure like roads etc. as the areas where renewables can be produced must be made accessible. C) especially in the peripheral regions it could be the case that there is a lack of **capital** to be invested in the production of renewables.

- Secondly, production of renewable energy might increase energy prices if prices for renewable energy is above the price of conventional energy. This has potential negative effects on the energy intensive industries and the regions that specialise in those industries. It also has negative effects on the consumers as a larger part of their disposable income has to be spent on energy.

- Thirdly, pushing renewables alone is likely to have some impact on the regions concerned, but the impact may be small if the promotion of renewable energy production is not accompanied by a larger development strategy. To illustrate, growing crops for fuel production in an Eastern Polish regions, would –in the first instance- not change much, as those regions are anyway agricultural regions, except the kind of crops would change. However, growing crops for fuel production is likely to be organised in an industrial fashion, using big units of agrarian land for efficiency reasons. This might be at odds with current farming structures, as in many cases they are small scale subsistence farming, and in many cases a refugium for those who would otherwise be unemployed. Thus, growing energy crops in such places would mean a significant shift in agricultural production, eroding the base for subsistence farming and as a consequence potentially creating social problems. Moreover, to refer also to first caveat again, it is not clear how many jobs

- Fourthly, some studies that suggest that the overall positive economic impacts of renewables and the negative impacts (as jobs might be lost in the fossil fuel sectors) almost cancel out. As this is mostly a shift between regions (e.g. employment increases in a peripheral region, but declines in a more central region), this still would decrease disparities, but creates some tensions connected to structural change in the fossil fuel producing regions. Moreover it is by no means clear how many jobs there will be created through the production of renewable energy. Thinking of windmills for example, once they are installed, their maintenance could be done by a comparatively small number of workers, so that the employment effect might be low. One way out would be if to locate up- and downstream industries or services close to the production of renewable energy. Whether this is feasible and economically meaningful, however, needs further research.

§ **Negative impacts on regional disparities**: If there is no push towards renewables there is certainly one development perspective for the regions less. Disregarding potential effects on the climate and concentrating on economic and social impacts, the question is whether this reduces or increases regional disparities. Potentially the effects could go either way. There might be positive impacts, as energy prices might be lower than in the case of a push of renewable energy, which favour energy intensive industries and consumers. Furthermore engaging in renewable energy productions incurs opportunity costs of investment, i.e. money invested in renewables cannot be invested in other things, like e.g. transport infrastructure, telecommunication, business environment, education etc. Thus, especially for the highly vulnerable regions in Central and Eastern Europe the question is, whether it is more sensible to invest in renewables or in other –more general- factors of economic development. In fact the latter may be even better for the long run development. This however is highly speculative, as neither investment costs for renewable energy production, nor the effects of general investment can be clearly assessed in this study. However this leaves ample space for future research.

§ ***Data availability:*** Data on natural resources, as well as on skill endowments are potentially available from public sources. However there is little information on regional infrastructure (especially with respect to energy networks) and capital. However even the existing data must be checked whether it is appropriate to start analysing this topic in more depth, as e.g. information on skill endowment might to aggregated to draw conclusions on the regions potential to apply renewable technology.

9.2.3 Technology

§ ***Positive impacts on regional disparities***: Pushing energy technologies potential positive impacts on the innovative, mostly low to medium vulnerable, regions, as they might be at the centre of the development of future energy technology. As the innovative regions in many cases are also higher income regions immediate economic effects of energy technology might pertain to those regions and as a consequence increase regional disparities. However over time there might be trickle down effects to other regions, especially if the production of energy technology takes place in more industrial and/or peripheral regions. A different point is that once a technology is developed and marketable it should be possible for every region to use this technology. Therefore, though economic effects might only be seen in the innovative regions, environmental improvements may affect all regions. However, there are some **caveats**.

- o It may be doubted that R&D and innovation in energy technology will take place or can be located (by policy) in each and every region of the EU. Following economic theory, existing innovative centres or regions have big centripetal forces on new innovations, as those regions (mostly larger cities) are already endowed with the necessary infrastructure and skills (apart from other things like quality of living etc.), which makes it attractive for new innovators to locate there (also because of knowledge spillovers), rather than in a remote region.

- o Moreover, when it comes to the application and use of new energy technology, it is by no means guaranteed that knowledge can be transferred from the innovation centres to other regions, unless the latter regions are endowed with the necessary skills and infrastructure.

- o It could be the case that new technology for energy production or consumption initially incurs high investment costs as well as higher prices for the energy generated with new technology. Especially with respect to investments in high technology this might therefore favour higher income regions, well lower income regions might face difficulties in acquiring these technologies.

§ **Negative impacts on regional disparities**: Not investing in energy technologies basically preserves the status quo in the technology sense. In practical terms it is in fact no status quo, as the continued use of current technologies leads to a deterioration of the economic, social and environmental sphere.

- o To illustrate, given that there is an increased global competition for fossil fuels in the future, this is likely, even if energy prices are low under the current economic crisis, to push up energy prices. This has negative consequences for energy and transport intensive industries, consumers and as a consequence on regions. Ceteris paribus, this will increase regional disparities between those regions that are close to the markets (i.e. those with a high market potential) and the peripheral regions, were both transporting goods from the place where they are produced to the placed where they are sold, as well as commuting will become more expensive.

- o Moreover not investing in new technologies potentially causes a loss of competitiveness of the innovative regions, though this might not occur at the European level but an international scale, as other regions in the world might take the leadership in energy innovation. Though this might not have an effect on regional disparities within the EU it is certainly not good for the EU economy either. However one might even construct a scenario, where a declining global role of the European economic centres have some effects on regional disparities. Thus, it could be likely that the decline of the centre regions might have even stronger effects on the peripheral regions, as the latter may be more specialised and rely more on the purchasing power of the centres. A shock in the centre might hit the peripheral regions harder, as they find it harder to diversify. As a consequence overall income across regions might be lower or grow slower if no innovation takes place, but on a relative basis the peripheral regions loose more than the central regions. However, this is just one line of reasoning and the potential costs of non-innovating have to be analysed in a much more focused context.

§ ***Data availability:*** Data on R&D and skills are principle available, but it is highly questionable whether these data are of sufficient quality or disaggregation at the regional level to allow drawing accurate conclusions.

9.2.4 Energy networks (including pipelines)

§ ***Positive impacts on regional disparities***: If networks (gas, electricity) are improved, this has at least two direct positive effects: Firstly, supply security is increased and secondly energy markets are potentially more competitive, which, given that there is competition might lead to a decline in energy prices. The secondary effects of these are, that regions, that by now have a relatively bad connection (though there exist no regional data from EU sources to analyse this in detail) potentially become more attractive for investors (given a secure energy supply and low energy prices). Moreover, due to lower prices a smaller share of disposable income has to be spent on energy, increasing the demand for other goods and services. This might be especially important for the more remote regions. However there is also at least one **caveat**. The construction of an adequate network even to the most remote regions is potentially connected with high investment costs. While the costs could in principle be estimated, the potential positive effects, especially with respect to investment cannot be estimated (at least not in this paper), as there exist many other reasons why investors prefer on location rather than another. Hence it might be the case that part of these networks might in fact be stranded investments, without having a significant impact on economic or social development.

§ **Negative impacts on regional disparities**: With an insufficient connection to European energy networks regions cannot reap the potential benefits in case an appropriate network would be in place. Though, while the existence of a good energy connection does by itself not guarantee that regions benefit from it, the lack of such a network is for certain detrimental as it puts them in comparatively worse competitive position than other regions that have a secure energy supply and low energy prices. As a consequence over the longer run the absence of a sufficient (though the question might be asked what “sufficient is) energy network will increase disparities between well and badly connected regions.

§ ***Data availability:*** Data are available at the national level, but there are no EU-wide regional data available for analysis. Data might be available at the national level, but this raises issues of comparability and homogeneity of data that could be an obstacle to an EU-wide analysis. Moreover it cannot be estimated what efforts it takes to collect data from national sources (if they are made available)

9.2.5 Efficiency

§ ***Positive impacts on regional disparities***: Introducing measures to increase energy efficiency does have some positive impacts on regions as the amount of energy used to produce one unit of output (this is quite generally defined and might include output in the production sense, but also fuel for transport, heating requirements for houses etc.) reduces and hence the money spent on energy decreases. Ceteris paribus this will increase firms profits as well as disposable income for households (excluding energy expenditure). With respect to regional disparities it is likely that they will decrease as it are especially the low income regions in Central and Eastern Europe that use energy in the least efficient way – compared to other regions in the EU. A main caveat is that energy efficiency measures are likely to be connected to high investment costs, which might be an obstacle to their introduction.

§ ***Negative impacts on regional disparities***: Certain elements of energy might have negative regional impacts, like e.g. road pricing. Provided that road pricing increases the cost of transportation, this will – ceteris paribus- hurt people and industries located in regions further away from the main economic centres more than others, as it increases the cost of commuting as well as the cost of transporting goods from the regions where they are produced to the places where they are sold. Moreover it is questionable, especially for the Central and Eastern European regions a shift to energy efficient methods of production is feasible. Thus an enforcement to use energy efficient production techniques might

§ ***Data availability:*** To the authors knowledge there is no energy efficiency information available at the level of regions.

9.2.6 Energy prices, GHG emissions, ETS, vulnerable industries

Basically an increase in energy prices and the emission trading scheme as well as environmental taxes have the same effect for industries. They increase the cost of production. Though in the case of energy prices an increase in prices is conceived to be a negative impact, the introduction of an ETS or environmental taxes are considered to exert positive effects (despite increasing costs), especially with respect to the environment. They are therefore treated jointly here, though it is not differentiated between positive and negative impacts, but between impacts of higher and lower costs/prices on regional disparities.

§ ***Impacts of high prices on regional disparities***: High prices for production because of high energy prices, high environmental taxes or emission trading have some general effects on the regions, which affects them in a more or less equal manner:

- o High energy prices will lead to a shift in production, away from energy intensive sectors towards more services oriented forms of production. This will create economic and social problems usually connected to structural change, e.g. an adaption process on the labour markets with respect to changing skill requirements.

- High energy prices might also reduce the competitive position of the EU's economy on the global market. Thus, not only the EU might find it harder to export its goods and services, if there is an energy related increase in prices of exported goods (through transportation or production), but also investments might be diverted from Europe to places where energy prices are lower and energy supply more secure.

- High transport costs for the private sector might lead to an increase in the degree of urbanisation (at the sub-regional level), creating economic and social tensions both in the abandoned, rural and in the urban areas.

More specific effects on the regions are likely to be:

- High and increasing energy (especially oil) prices will increase transport costs. Since most vulnerable regions are peripheral regions, this makes it more difficult for them to export their goods and services to other regions. Simultaneously, increasing energy and emission prices also lead to an increase in the cost of production for the energy/emission intensive sectors, which in the case of the highly vulnerable regions might be higher than for other regions, as their energy efficiency is considerable lower than elsewhere.

- Higher production costs (through energy prices and ETS) are expected to lower the competitiveness of the highly vulnerable regions vis-à-vis other, more centrally located regions in the EU. Moreover, since the majority of those regions are less prosperous regions, they might find it difficult to raise sufficient funds to invest in alternative forms of energy to guarantee a sufficient supply. In turn, this lowers their attractiveness for potential investors.

- The consequence of this is a sharp reduction in the potential for economic development and the danger of a further peripheralisation of the vulnerable regions, including an increase in regional disparities throughout the EU.

- Given that those regions that specialise in energy/GHG intensive forms of production will loose in competitiveness they might be forced to shift existing production to environmental friendly/energy saving techniques, or undergo a significant change in their structure of economic activity.

- A positive side aspect is that under higher prices for energy/emission it become more economically rational to produce renewable energy. Though this does not necessarily change the competitive position of the regions, it is environmental that is central here.

- For European core regions especially higher transport costs (because of fuel prices or taxes, e.g. road pricing) will strengthen their core role and divert economic activity from the low income/ low potential peripheral regions to the high income central regions. Moreover, since the core regions are also centres of knowledge they might additionally benefit from increasing investments in innovation and R&D in the energy sector. As a consequence, while the most vulnerable regions might drop back in terms of regions incomes, the core regions even might pull ahead, and thereby increase the regional disparities within the EU even further.

§ **Impacts of low prices on regional disparities**: Some effects of low energy/GHG are relatively similar across regions. These are

- o Even if energy prices are low and the EU's fuel mix changes towards renewables over the next decade, the problems of depleting European fossil fuels resources, limited global resources and an increasing competition for these resources remain. Thus energy prices are likely to rise in the future, so that in the end it low energy prices now, might just be a postponement of the problem.

- o There is a dilemma between low energy prices and the introduction of energy from renewable sources. As long as prices of traditional energy (oil, gas) are sufficiently low the economic impetus to invest in renewables is relatively low. This bears the danger that necessary investments will be delayed or abandoned completely.

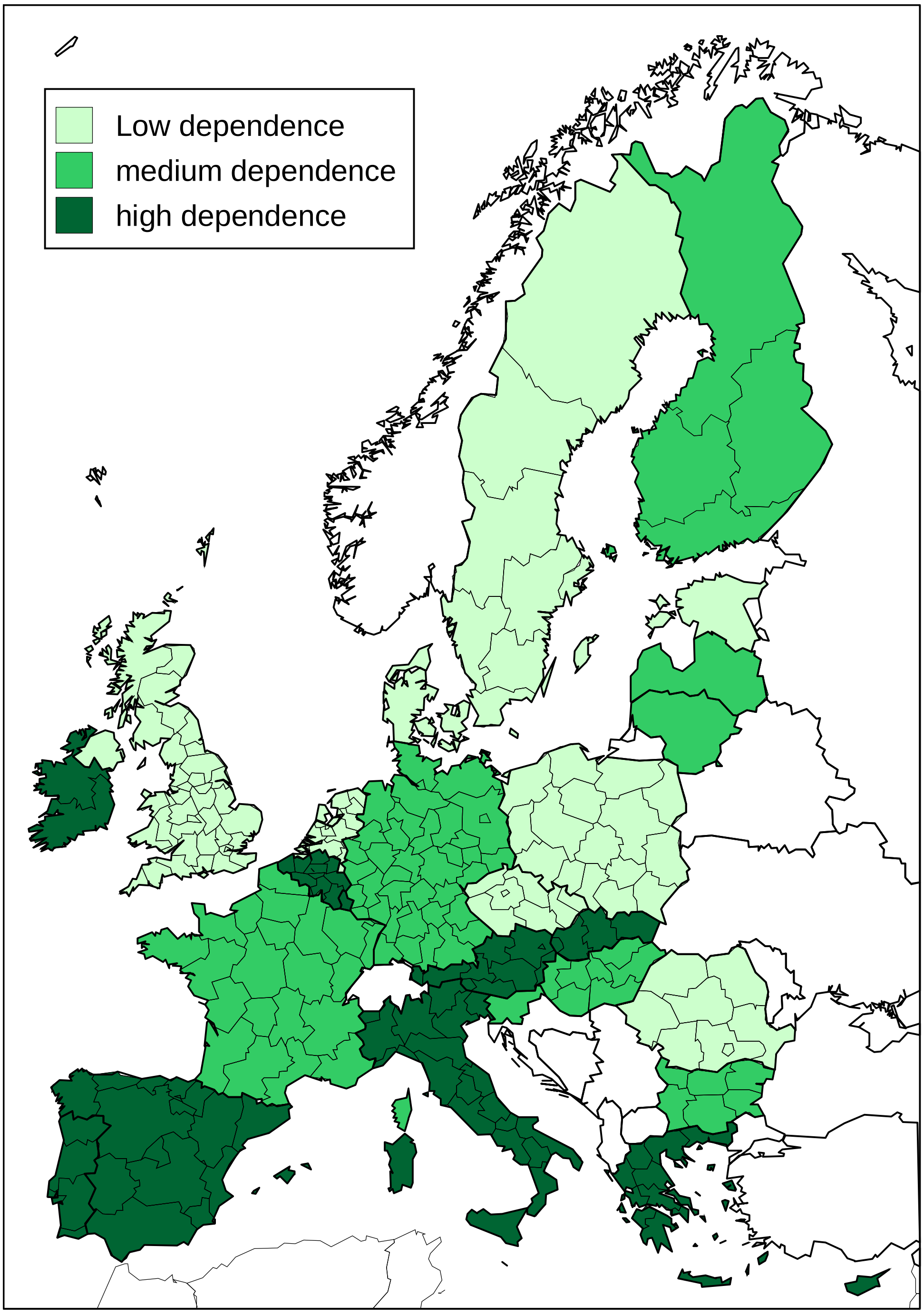
Specific regional effects of low prices are:

- o It is likely that the peripheral, most vulnerable regions benefit more than other EU regions from low energy and GHG prices. Given their lack of economic development the additional time gained can be used to prepare for the changes to come and at the same time to economically develop further to become more stable.

§ ***Data availability:*** To the authors knowledge there is no energy price information available at the level of regions. Data on sectors are in principle available, though not on regional emissions in total or by sector. Though these data could be constructed (from national data), these constructed data does not allow an accurate assessment of the regional situation and in fact might even be misleading. Thus a proper analysis would require empirical (not estimated) data.

Annex

Figure A1: Energy import dependence



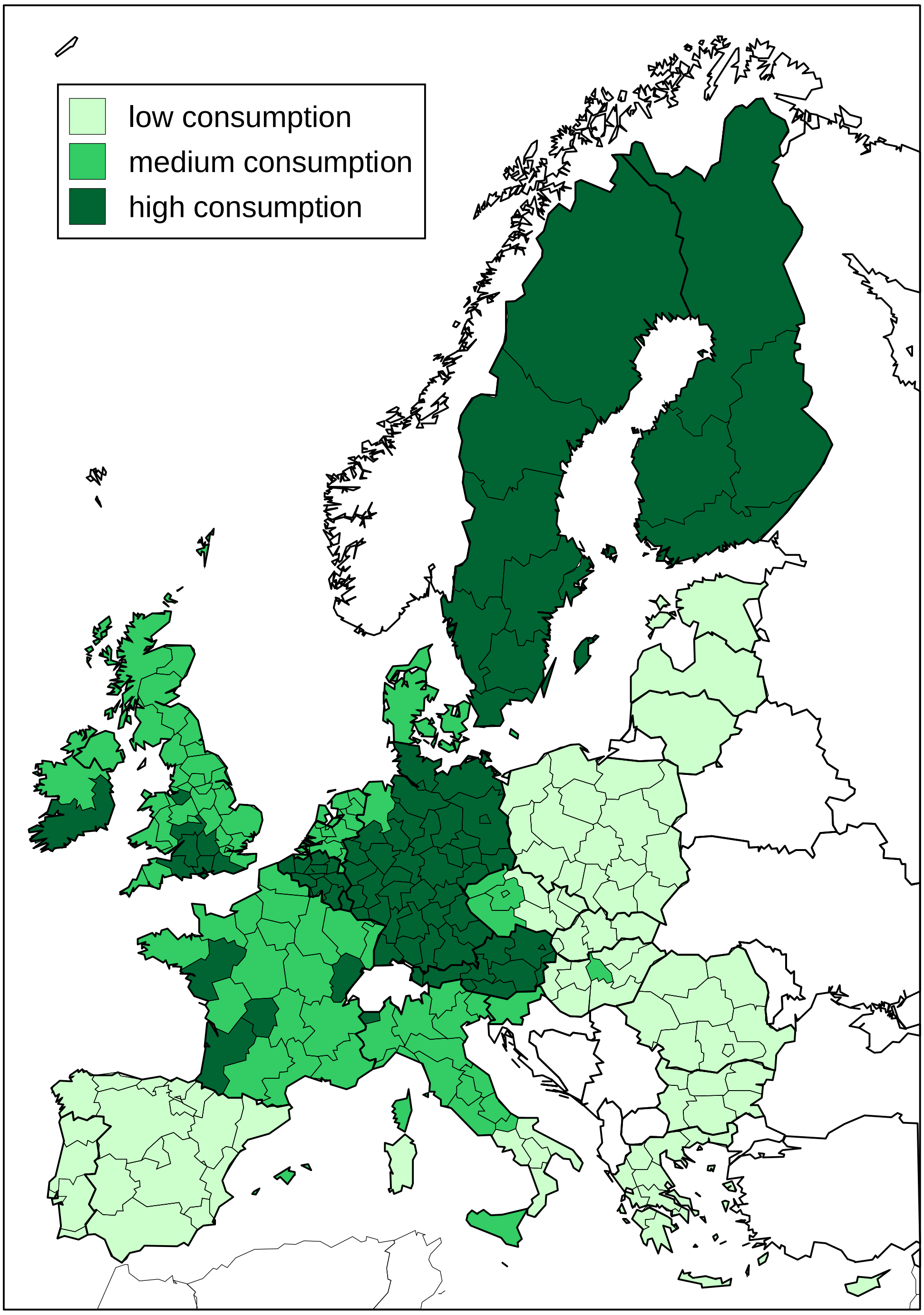
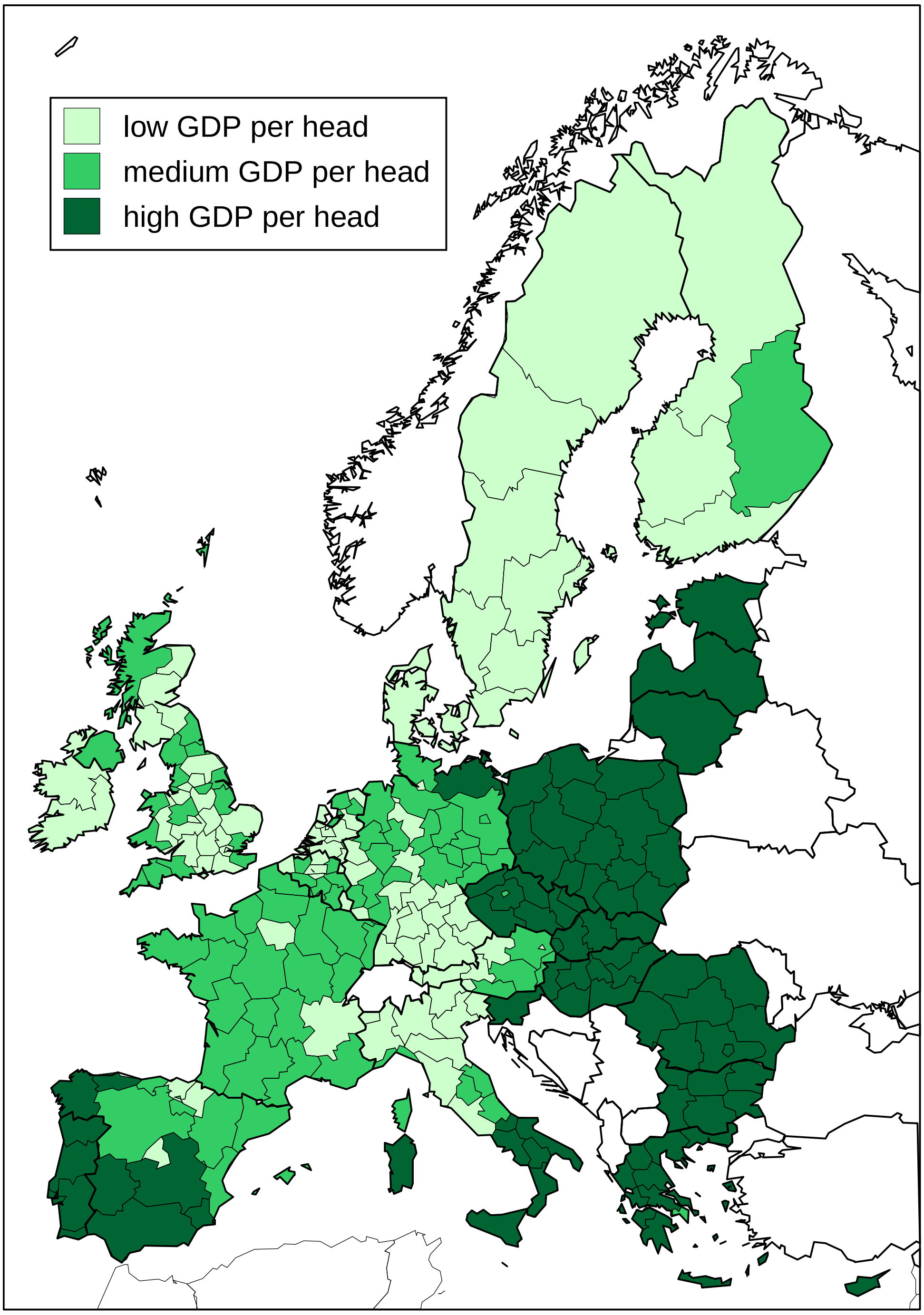


Figure A2: Household energy consumption

Figure A3: GDP per head, 2005 in EUR



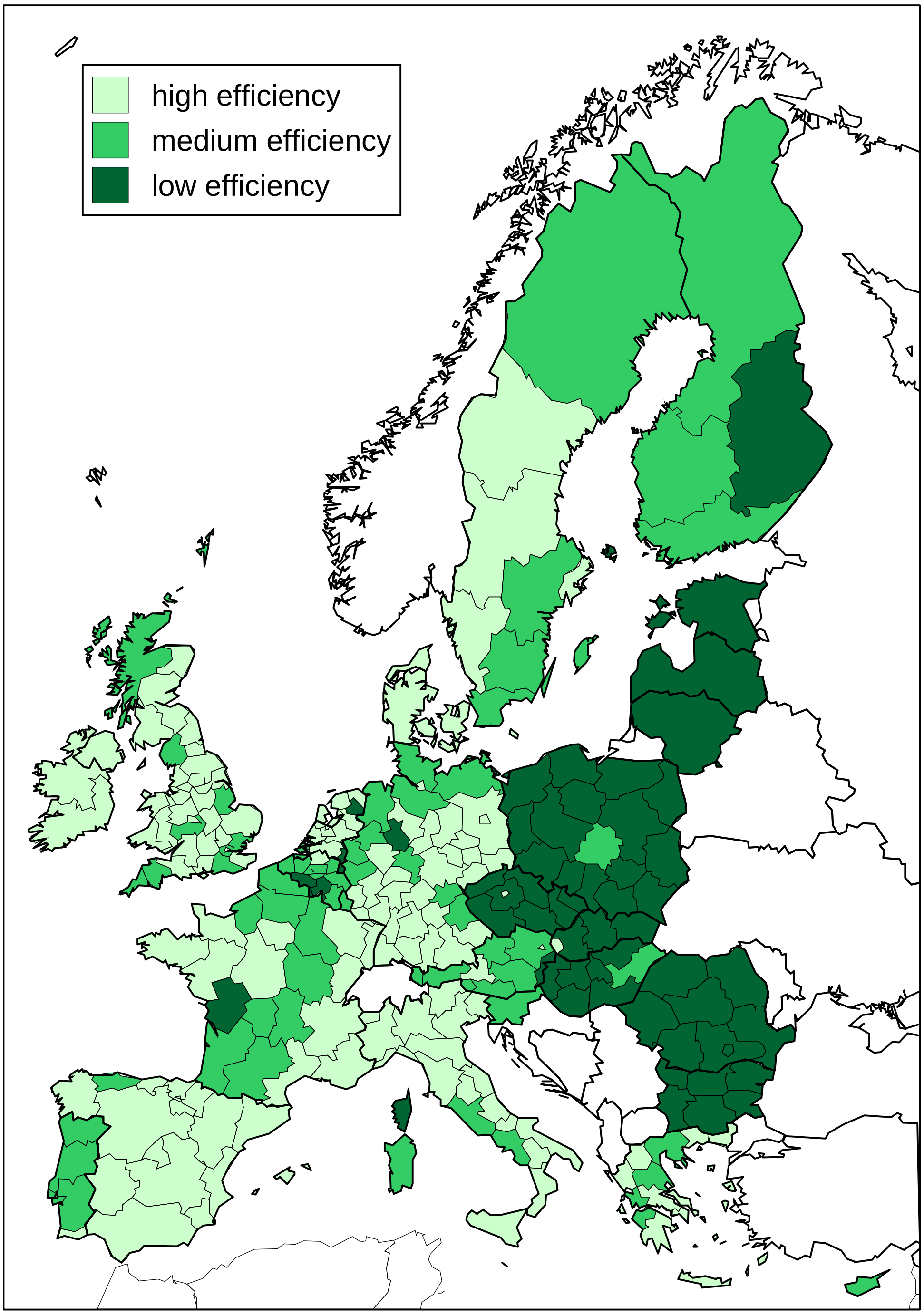


Figure A4: Energy efficiency

Table A1: Average value of Summary Index and index components, population by regional groups, (population weighted average)*

	Population 2006	Energy dependence	Household energy consumption	GDP per head, 2005, EUR	Energy efficiency, average 2004/2005	INDEX
Low vulnerability	172.9	56.1	24.1	3.5	7.0	**25.6**
Medium vulnerability	219.6	76.4	19.8	25.1	10.4	**43.3**
High vulnerability	99.8	66.1	9.5	77.1	32.3	**66.3**

*except population the index value and the values of the index components are normalised. The minimum value is 0. This corresponds to the lowest vulnerability across EU regions. The maximum is 100.